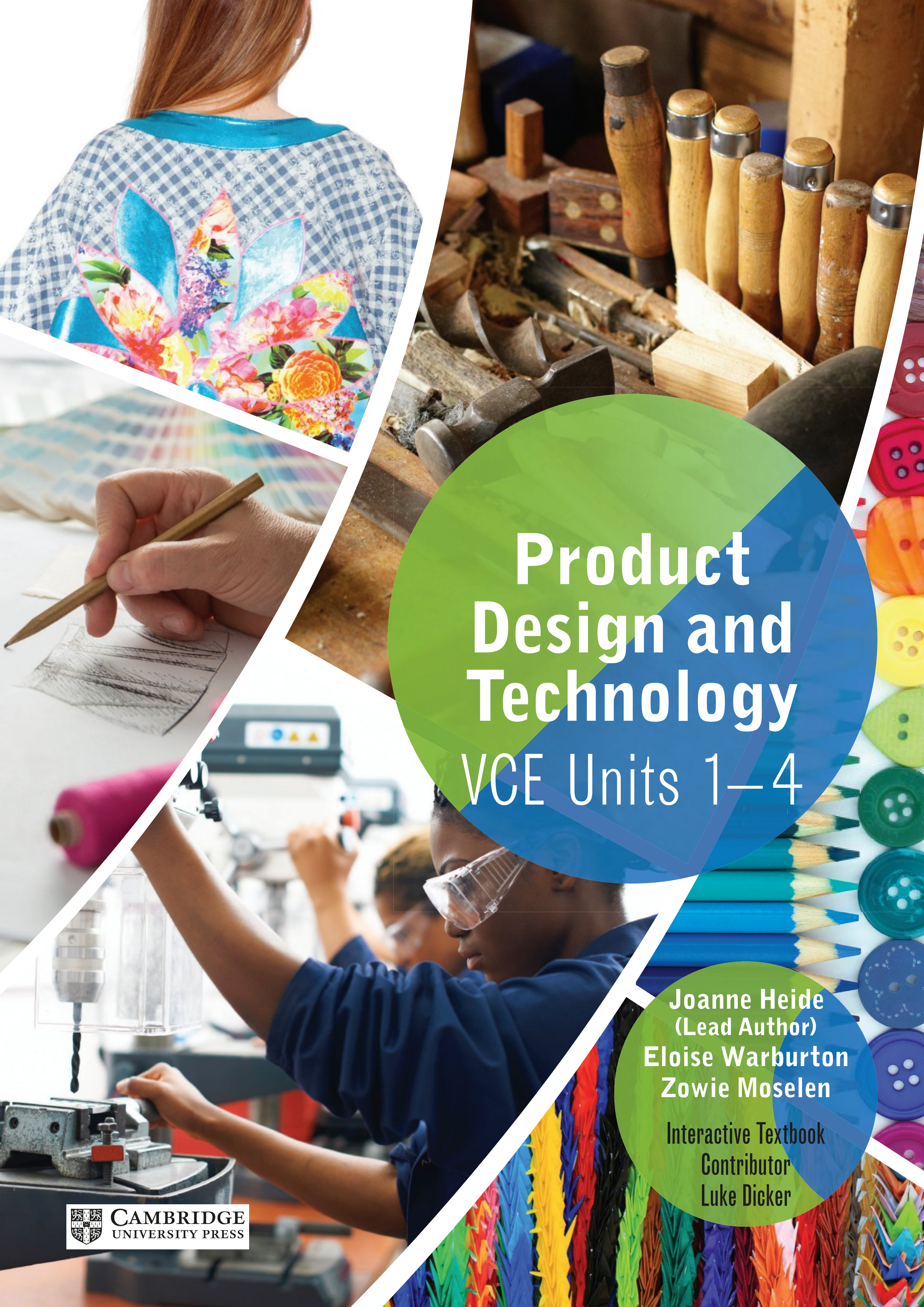

Product Design and Technology

VCE Units 1–4

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Interactive Textbook
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Foreword

The concept of empathy has been the major inspiration behind this easy-to-navigate combination of textbook and workbook. The two publications are precisely linked with the 2018–2022 VCE Units 1–4 study design's key skills and key knowledge and have been created to support the satisfactory completion of outcomes within each unit. The student will be expected to take on the role of designer with an empathetic perspective of an end-user's needs and wants to achieve a successful product. This is an approach that is recognised internationally in the training of future designers.

Specialist teachers in resistant materials and non-resistant materials have contributed to the publications. The authors have also drawn upon their passions for design and creativity and their individual experiences beyond the classroom as practitioners of design.

The two publications also consider sustainability issues that prevail in our world, which is a fundamental responsibility of all designers today. Students will investigate a broad range of areas that influence design, from cultural factors and contemporary and historical design movements to new and emerging technologies. A variety of case studies throughout the textbook give students insight into ways designers are innovatively working to solve real-world problems and improve our well-being, driven by creative and critical-thinking approaches.

Key knowledge points from the study design listed at the start of each chapter in the textbook are elaborated upon in depth and provide relevant activities. The information learned is transferable from one chapter to another and can be revisited at any time to further develop students' understanding of the design process. This serves to strengthen and reinforce broader concepts related to design. The final chapter of the textbook provides information on the VCE Product Design and Technology exam, and a variety of activities are included in the workbook to support exam revision.

The workbook contains an extensive range of rich visual activities and templates that are developed from the key skills listed in the study design under each unit and align with the written content and activities contained in each chapter of the textbook. The first section of the workbook includes reference material that students will need to know throughout VCE Units 1–4, from the product design process stages and steps to the nine product design factors. Subsequent chapters provide activities to aid folio requirements.

The Interactive Textbook supports the application of computer-aided design, which is demonstrated through video examples and additional materials, giving the students the knowledge and skills in designing a range of products using SketchUp.

Joanne Heide

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About the authors

Textbook authors

Joanne Heide

Joanne Heide, Bachelor of Arts (Visual Arts), Postgraduate Diploma in Fine Art from the University of Melbourne (VCA), Graduate Diploma in Education (Secondary), and Master of Fine Art from Monash University, has been a secondary teacher since 1999 and on obtaining her teaching degree taught Product Design and Technology in London for eight years. She has headed both Technology and Art Departments and teaches Product Design (Resistant Materials), Art and Visual Communication Design to years 7–12 students. She also teaches Systems Technology and Dance. Joanne is a Vice President of the Design and Technology Teachers Association (DATTA VIC). She has run various workshops at DATTA VIC conferences, presented at the National Gallery of Victoria (NGV) with a focus on how design exhibitions support student learning and recently chaired Class Tech at the 2017 Future Schools Conference.

Eloise Warburton

Eloise Warburton, Bachelor of Design (Fashion) Honours from RMIT, Graduate Diploma in Education (Secondary) and training in Vocational Education. Eloise teaches VCE Product Design and Technology (Textiles), VCE VET Fashion and junior Art. She has presented for the Melbourne Museum, Catholic Education Melbourne, and developed content and run workshops for Home Economics Victoria, as well as completing VCAA Exam assessing. Eloise is passionate about facilitating industry relevant design education.

Zowie Moselen

Zowie Moselen, Bachelor of Creative Industries (Visual Arts), Bachelor of Education (Secondary), has taught Product Design and Technology (Textiles) for seven years in various schools in Queensland and Victoria. Zowie also taught Junior Textiles, Media studies and Visual Communication and Design. She is an avid crafter who loves teaching students the skills needed to bring their own ideas to life.

Interactive textbook contributor

Luke Dicker

Luke Dicker, Bachelor of Visual Arts, Graduate Diploma in Education (Secondary), is an Indigenous teacher who entered the field of Design and Technology in 2006 and has been teaching years 7–12 Design and Technology since 2010. Luke was awarded the Victorian Design and Technology Secondary Educator of the Year in 2013 by DATTA Vic for outstanding teaching in Design and Technology education. Luke has an innovative approach to teaching and uses flipped learning by developing instructional and screen capture videos. He has developed a large range of designs and components for students' use through the SketchUp 3D Warehouse.

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The experience of leading this project and guiding my fellow writers through every step of the process has been a richly positive one, particularly with their shared enthusiasm, cooperative team approach, and creative and innovative ideas. I hope our combined passions and depth of knowledge in the topics covered and activities provided in these publications will not only support students' learning but stimulate interest in the value of empathy and user-centred design. I'd like to thank Margie Dela Cruz at Cambridge University Press for making this process a smooth one. Greg Buckle for his cricket ball design story and friends, family and work colleagues for their support and encouragement. I would like to thank my current and past students who happily agreed to provide examples of their work in the textbook: Natalie Dubinski, Monica Ngo, Thanh Thy Tran, Tina Tran, Luke Abella, Baptiste Zacharia, Dylan Vella, Liam Grech, Cassandra Rico and Kevin Nguyen. I'd also like to thank DATTA Vic for offering their professional support over the past few years, allowing me to rise to the position of vice-president, which has exposed me to various learning and leadership opportunities.

Eloise Warburton

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Zowie Moselen

To my partner Simon, for his unwavering support, patience, kindness and encouragement in all aspects of my life including this textbook. To my family, my mother Krischa for always being loving, proud, supportive of everything I do in my career. My father Bill, for always pushing me to be the best I can be. My twin, Jean, thanks for being my other half in life and Aunty Irena for always being my cheer squad. To my work colleagues, Leah, Emir, Maire-Louise and Pam for continued advice on this project. To my friends, Claire and Lucy for their support during the writing process.

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Luke Dicker

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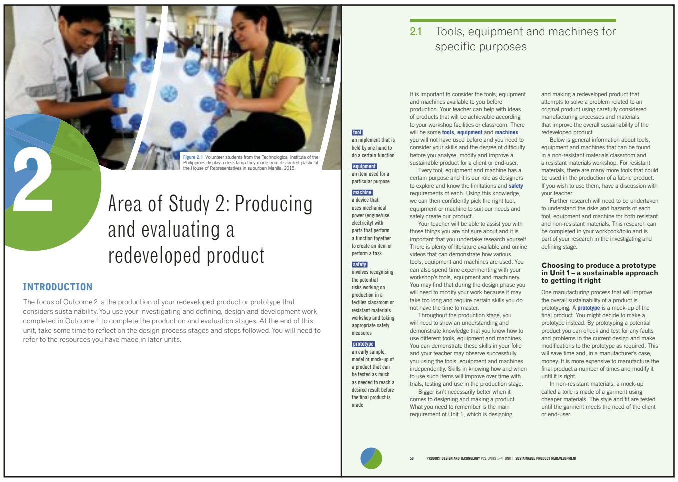
How to use this textbook


2 Area of Study 2: Producing and evaluating a redeveloped product

INTRODUCTION

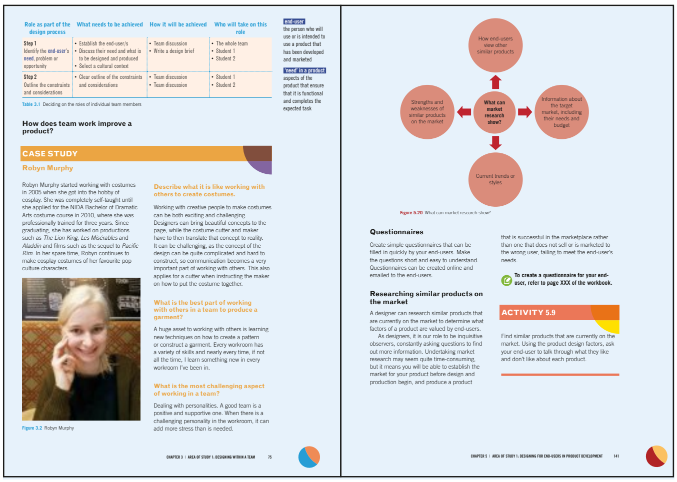
2.1 Tools, equipment and machines for specific purposes

Chapter openers introduce the key knowledge and key skills addressed in the chapter and prepare students for the chapter ahead.

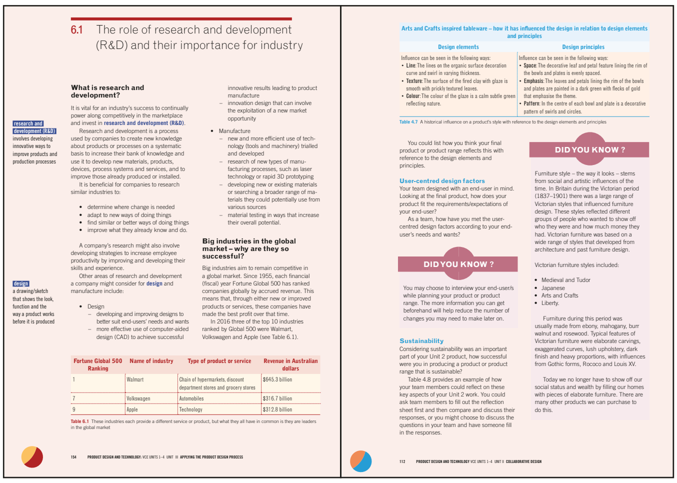
Numbered chapter headings allow easy navigation between the textbook and the interactive version.

Case studies examine real-world application of theory, explore innovative designs and their designers, and provide detailed accounts of industry practice.

Learning activities explore chapter outcomes, develop skills, build knowledge and understanding as well as encourage creativity.


CASE STUDY

ACTIVITY 5.9


6.1 The role of research and development (R&D) and their importance for industry

DID YOU KNOW ?

Glossary terms are bolded in the text, defined in the margins and collated at the end of the textbook for easy reference.

Did you know? boxes highlight interesting information to enrich your learning.

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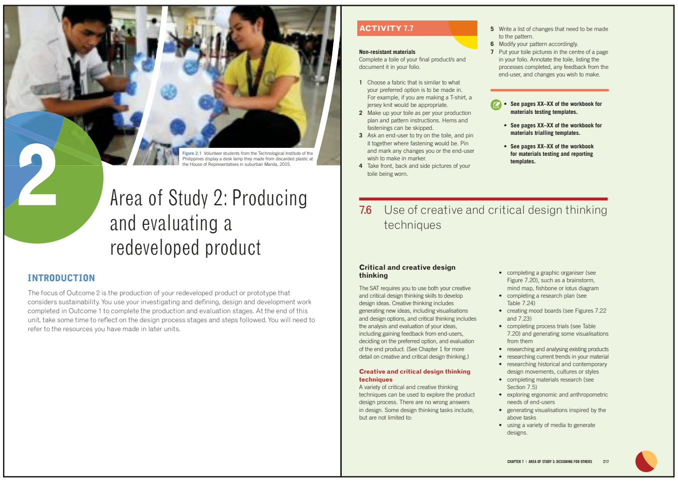
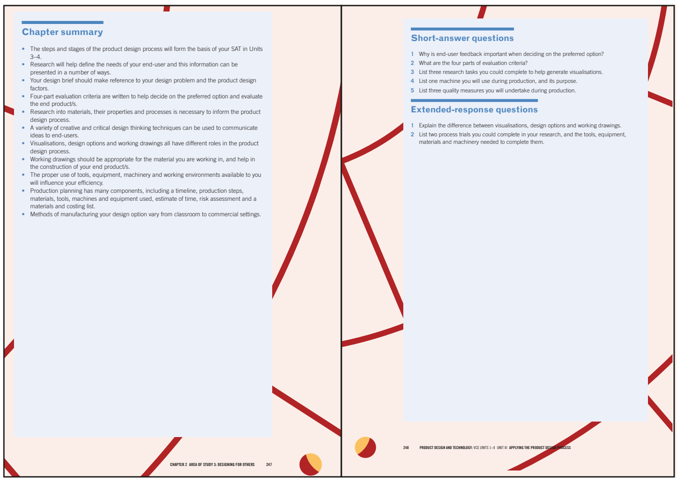


The workbook icon directs students to further their learning by accessing the workbook, which provides activities that blend theory and practice by applying design and production process.



End-of-chapter material includes chapter summaries, chapter summary tasks and extension tasks to test your knowledge and reinforce key knowledge and application of skills.

To access links to the websites referred to throughout this textbook, go to www.cambridge.edu.au/pdtweblinks

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Unit 1
Sustainable product redevelopment

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Figure 1.1 German designer and manager of the Redesign label Christina Schelhorn arranges an upcycled cocktail dress in cotton from the 1950s at TheKey.to sustainable fashion trade fair, Berlin, 2009

1 Area of Study 1: Sustainable redevelopment of a product

INTRODUCTION

This area of study requires you to follow the investigating and defining and design and development stages in the product design process and solve a problem related to the purpose and function of an existing product. You will need to consider sustainability in the product's redevelopment and carefully consider the redeveloped product's impact on society and the environment.

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KEY KNOWLEDGE

- the environmental, economic and social impacts associated with the origin/source, manufacture, use and disposal of products
- approaches used by designers to incorporate sustainability practices in product design
- impacts of unsustainable products and resource use on environmental, social and economic systems
- systems, models and strategies used to assess the sustainability of a product
- methods of incorporating relevant product design factors in a design brief
- methods of developing criteria for evaluating a finished product
- creative and critical design thinking techniques
- methods of generating, analysing and evaluating ideas for the redeveloped product
- the importance of acknowledging the IP rights of the designer of the product
- the role of annotations and appropriateness of different drawing techniques in the design and development stage of the product design process using digital and manual methods:
  - visualisations
  - presentation drawings
  - working drawings
- relevant material and process research methods such as tests, trials, comparisons and production process samples
- the role of scheduled production plans:
  - timeline
  - steps needed for production
  - materials and equipment list
  - risk management for safe, efficient and accurate production of a product
  - quality measures.

KEY SKILLS

- investigate practices of designers that address sustainability issues
- analyse the sustainability of an existing product
- develop a design brief for the modification and improvement of a product
- develop evaluation criteria for the finished product
- use the product design process
- appropriately acknowledge the IP of others
- develop and apply drawing skills for a range of purposes, using digital computer-aided design (CAD) and/or manual methods
- develop a scheduled production plan.

1.1 The environmental, economic and social impacts associated with the origin/source, manufacture, use and disposal of products

sustainable design thinking awareness and application of user-centred design (product design factors) to promote sustainable design of products by considering social, economic and environmental sustainability

end-user/s the people who will use or are intended to use a product that has been developed and marketed

negative environmental impact when design does not comply with sustainable design principles

Saving our planet with sustainable design

All design in the twenty-first century and beyond should be sustainable. **Sustainable design thinking** isn't a separate area of design or something a designer might consider incorporating, it is a responsible way of approaching design as a designer because our planet and all life on it is precious. It is not an easy task to resolve, but it is possible to do things better than we have done in the past and through good design improve our planet's sustainability.

Sustainable design combines three interconnected pillars of sustainability:

- social
- environmental
- economic.

When designers are working on a product or range of products, they need to empathise with their **end-user/s** and understand and have insight into their social, environmental and economic situation and how it may impact positively or negatively as they work through the design process. This insight will help designers to accurately define the end-user/s' need or problem and successfully create ideas for innovative solutions.

Three pillars of sustainability

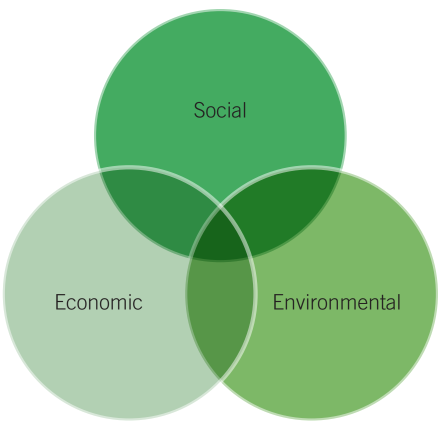

Figure 1.2 Three pillars of sustainability

Within each of the three pillars are areas of thinking you can explore further, some of which are listed below.

Social	Environmental	Economic
Culture/values/behaviour Employment conditions Recycling Health	Energy use Biodiversity Water conservation Waste	Life-cycle analysis/assessment Product stewardship Environmental legislation Design for disassembly (DfD)

Climate change and sustainable development – the United Nations

The United Nations is an international organisation that was founded in 1945. We live in a complex time and the United Nations deals with issues that confront us in the twenty-first century. Some of these issues include climate change and sustainable development. As a result, the United Nations wants our designs to meet our present economic needs but also ensure that the future of our world is not compromised, that our world will still have the ability to provide for our children's children.

Looking at sustainability design principles

With careful design thinking, designers can skilfully create products that lessen the **negative environmental impact** by:

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Figure 1.3 The United Nations logo

- using materials with low impact on the environment
- sourcing materials locally or **bio-regionally**
- designing products that require little energy to produce
- designing products that are durable and last longer, reducing consumption and waste
- designing products that need less washing or maintenance, and are easy to repair.

Life-cycle analysis/assessment (LCA)

To assess the scientific environmental impact of a product over its life, a life-cycle analysis/assessment looks at the stages of a product's life from manufacturing to its use and end of life.

What is cradle to cradle (C2C)?

Cradle to cradle thinking involves considering a product's life cycle and the impacts it has socially, environmentally and economically through its stages of life (see Table 1.1). The founders of the Cradle to Cradle Products Innovation Institute, Michael Braungart and William McDonough, developed cradle to cradle thinking. Their theory behind this thinking is to improve quality and sustainability by moving away from a current situation that is not so bad towards something that is better.

The five stages of a life-cycle analysis/assessment

1 Extracting and processing raw materials Involves changing **raw materials** that are sourced by such means as logging and mining and preparing them for **manufacture**, sourcing fibres both naturally and generating them synthetically
2 Manufacture Involves making products or separate components for products, either by hand or using tools, equipment and machinery
3 Transport, distribution and packaging Involves transporting Raw material for processing From processing to manufacture From manufacture to **distribution** (retailers) From distribution (retailers) to place of use
4 Use, reuse and maintenance Product is used the way it was intended, parts and components are repaired and replaced as required and may have the potential to be reused/**recycled** Laundering
5 Disposal/end of life Disposal of the product or components Donation to charity **Landfill** Recycling – upcycling or downcycling (cradle to cradle)

Table 1.1 The stages of a product's life

bio-regionally relating to the ecology, economy and culture of the place where you live

cradle to cradle the impact a product has through its life socially, economically and environmentally

raw materials the basic material from which a product is made

manufacture the making of products either by hand or using tools, equipment and machinery

distribution the movement of products from the manufacturer to the end-user/s

recycled when a product or parts or components of a product can be used again or the material is reuseable

landfill burying of waste material

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What are sustainability models?

Not only do designers need to consider a product's environmental impact, but also governments, manufacturers and transportation companies who are closely linked to a product's life cycle. This can happen through the implementation of strategies with an environmental focus that ultimately ensure that the life stages of a product are efficient and harmless to the environment. This might involve extending a product's life so that it is less likely to be discarded early, ensuring that parts can be replaced easily when they are worn out or damaged, minimising the amount of material used in production and increasing the efficiency of the product. Other approaches include design for disassembly (DfD), which means that when a product has reached the end of its life its parts or components can be easily disassembled and upcycled or downcycled (see the Herman Miller office chair case study on page 15).

modular design a way of designing that subdivides parts of a product into smaller parts called modules

If you choose to design a product that is designed for disassembly, you will need to consider some of these design-for-disassembly principles:

- lesser parts
- pure-material parts
- **modular design**
- fixings that snap, clip or slot into place and out again
- avoid contaminant adhesives.

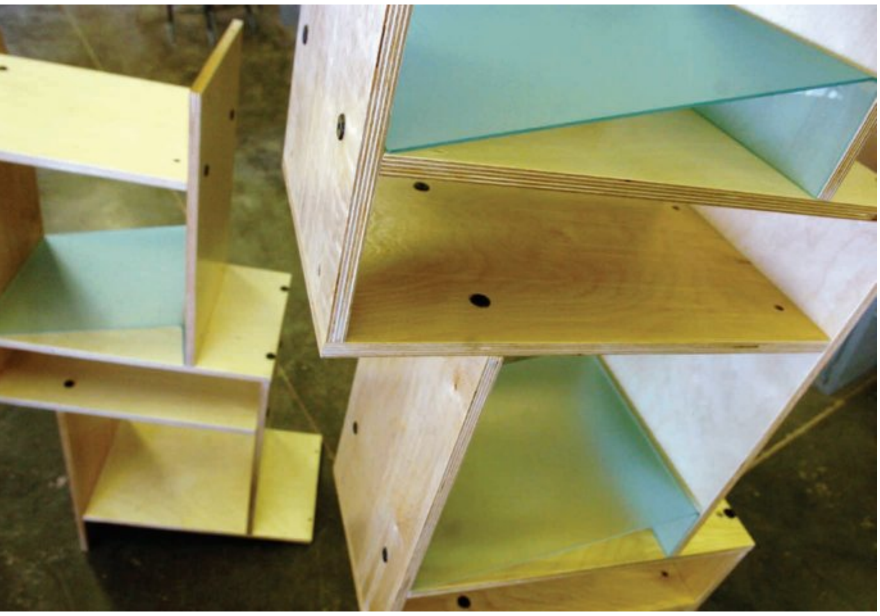

Figure 1.4 A modular shelf system

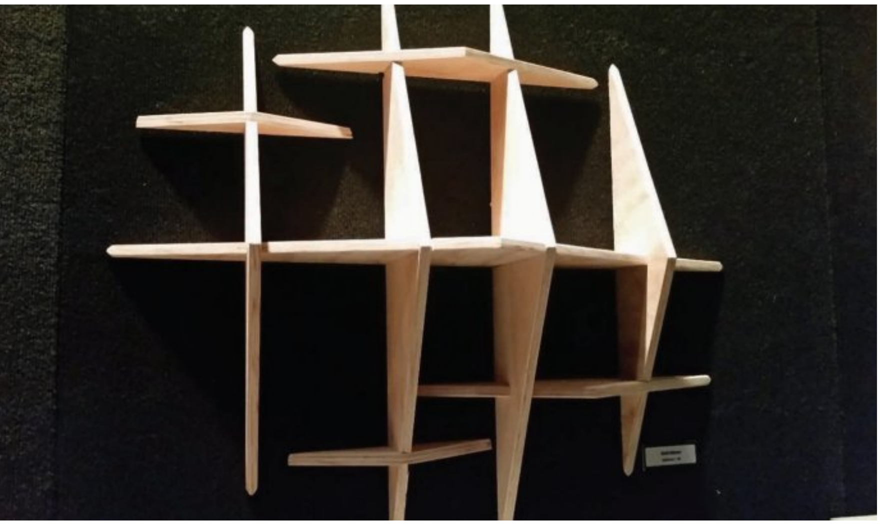

Figure 1.5 A modular hanging shelf made by Kevin Nguyen

Modular furniture is fun to design and make and achievable, particularly if you are still developing your production knowledge and skills. You might consider redeveloping a sustainable piece of modular furniture in Unit 1.

Design for disassembly can be difficult for garments on a commercial scale, as they are often made of blended fabrics (two or more fibres combined together), making separation and reuse difficult. German outdoor company Vaude designed a jacket in their Ecolog range made entirely of polyester, including zips, thread, buttons and so on, which made it easy to recycle and turn into new products. Sadly, too few products were returned, making this economically unsustainable for the company, and the return program is no longer running.

Cradle to cradle and upcycling

The concept of upcycling was first introduced in Michael Braungart and William McDonough's book *Cradle to Cradle: Remaking the Way We Make Things*, published in 2002. Upcycling involves recycling parts or components of a product to produce a product of the same or perhaps even greater quality. As a result of this process, products originally intended for landfill now become part of sustainable design thinking – cradle to cradle.

In some cases of upcycling, people may argue that it goes too far when antiques or used furniture that is still in good condition is turned into eyesores in order to suit current trends or the creator's 'tastes'.

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DID YOU KNOW?

Online store Etsy sells a lot of 'home-made' wares. Many of these items are upcycled. These products have become fashionable over the past few years.

Cradle to cradle and downcycling

When a product reaches the end of its life cycle, potentially useless products, parts or components of a product and waste materials can be recycled but produce a product of lesser quality. This is referred to as downcycling.

Extended producer responsibility (EPR) refers to the responsibility the producer has beyond the factory gates. Producers should be aware of the issues related to end-of-life management, such as the collection, reuse and recycling of their products.

ACTIVITY 1.1

Brainstorm ideas for a garment or product you could redevelop that considers sustainability.

ACTIVITY 1.2

Refer to Figure 1.2, which shows the three pillars of sustainability. Draw your own diagram on A3 paper and within it list ways your garment or product ideas listed in Activity 1.1 might consider sustainability.

Complete the three pillars of sustainability activity on page 25 of the workbook, Activity 1.1.

Figure 1.6 A worker making wooden frames for sunglasses using wood that would otherwise go to waste from the furniture industry, mainly teak and rosewood, Indonesia, 2016

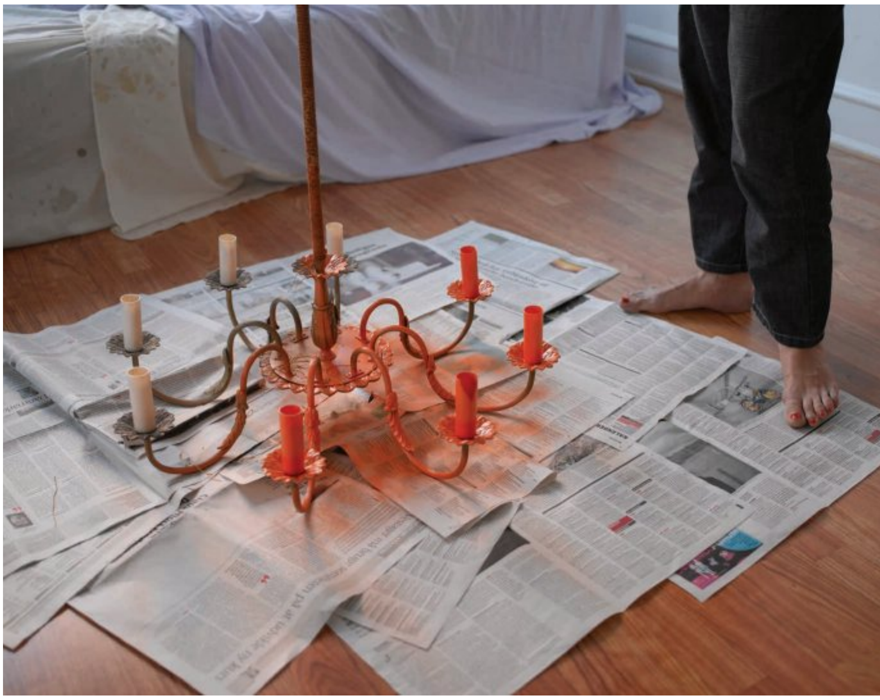

Figure 1.7 A once-elegant brass chandelier is downcycled and spray-painted orange.

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1.2 Impacts of unsustainable products and resource use on environmental, social and economic systems

E-waste

If you have ever wondered what happens to our computers, mobile phones, microwaves and refrigerators when we don't want them any more, you might be surprised to learn that millions of tonnes of this 'e-waste' are illegally exported and dumped in African countries each year. It is cheaper for Western countries to recycle them this way than in their own countries. Unfortunately, only a fraction of this waste is recycled, making it an unsustainable scenario.

The people who sift through these landfills' burning components to find scrap metal such as gold, silver, copper, iron, aluminium and palladium to sell locally do so in an unhealthy environment where appliances leak lead and mercury.

To ensure that the Australian people are not harmed by illegal importing or potentially might harm others by illegal exporting, the Department of the Environment and Energy has developed the *Hazardous Waste (Regulation of Exports and Imports) Act 1989*.

Figure 1.8 Obsolete products that are potentially e-waste

ACTIVITY 1.3

Go online and find a list of materials that can be recycled from e-waste. Using this list as a guide, make a list of materials you might consider using in Unit 1.

For non-resistant materials, you might consider how parts of your garment might use these materials.

ACTIVITY 1.4

Choose two materials listed in Table 1.2 and research their properties and/or characteristics. Would you consider using either both or one of these materials in the production of your product? Why or why not?

Materials that can be recycled from e-waste

Metal: Non-ferrous metals such as aluminium and copper can be re-smelted and remanufactured. Ferrous metals such as steel and iron can be reused.
Plastic: ABS plastic or a blended resin such as ABS/polycarbonate or polystyrene is also found in computers and can be reused as packaging. PVC (polyvinyl chloride) could be recycled, but recycling cost means PVC is usually sent to landfill. A plastic called polypropylene is usually found in computers.
Glass: The best type of recycling for glass is the processing of shards to make material for new tubes and lead-based glass products.

Table 1.2 Materials that can be recycled from e-waste

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Manufacturing of products and the environmental impacts

Hardwoods

One of our planet's threatened resources is rainforests. Rainforests produce exotic and very valuable hardwoods, and we are losing around 80 000 acres of tropical rainforest each day. Deforestation is on the rise because of commercial logging, cattle ranching, agriculture, dam-building and mining.

Softwoods

Softwoods are a greener choice of wood and take a lot less time to grow than hardwoods.

Plastics

Bakelite was invented by Leo Baekeland in 1907 and was the world's first synthetic plastic. Multiple times per day we are exposed to chemicals from plastic, whether from the air we breathe, the water we drink, the food we eat or dust. The negative environmental and social impacts the production of plastic causes today are varied. For example:

- The human body absorbs chemicals from plastic that are known to change hormones and can cause other health problems.
- Groundwater can be contaminated by chemicals filtering from plastic buried deep in landfills.
- Invasive species use plastic waste to travel from one habitat to another, plastic that can last for thousands of years in water.
- Marine animals often ingest plastic debris laced with chemicals that cause injury and poisoning.
- Close to 4% of the planet's oil production is used in the production of plastics.

Metals

Recycling of metal is important because the world produces a lot of scrap metal and without a recycling plan there would be an enormous amount of wasted metal and this waste would have a huge environmental impact. Non-ferrous metals are often recast and re-smelted; ferrous metals, however, are recycled more than almost any other material.

Planned obsolescence

Expensive marketing and the opportunity to show off a new and better version of a commodity is hard for people to resist. When a product is not desirable any more because of the way it functions, or perhaps because its style looks dated or its technology is no longer current, it becomes obsolete.

E-waste is a good example of the negative impact obsolete products can have environmentally, socially and economically. The twenty-first century is driven by money, and money is made very quickly by industries that continually release new products that are perhaps only slightly improved yet more attractive than the previous model, such as iPhones.

Some industries encourage this process by using planned obsolescence. This is when parts or components of a product cannot be repaired or replaced and the product becomes useless within a certain period of time, which then stimulates consumer demand and helps generate profit. An example of a product that has been developed over time with planned obsolescence in mind is a light bulb. Companies that manufacture light bulbs plan for the product to break down after a certain period of time. A light bulb usually needs to be replaced after 12 months, yet some of Thomas Edison's original light bulbs are still glowing in museums after 100 years.

Impacts of fashion

With many products we own made offshore, (including about 25% of the products we own being made in China), designers and consumers must become increasingly aware of their supply chain. The fashion industry has a less-than-glamorous record of taking advantage of low wages in developing countries, which can lead to unsafe working conditions and ethically unsustainable practices. The Rana Plaza tragedy in Bangladesh in April 2013, where over 1000 garment workers died and 2500 were injured when the factory they were working in collapsed, highlighted that the fashion industry still has a way to go in ensuring that its supply chain does not exploit vulnerable workers.

Since the global financial crisis, clothing has become more affordable than ever. Compared

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to our grandparents, we now spend a smaller proportion of our income on clothes, but own more clothes than ever (EL Cline, *Over-dressed*, Penguin, New York, 2012). The average person sends 30–40 kilograms of textile waste to landfill a year, and in 2011 Australian charities spent $20 million sending unuseable clothes to landfill (T Jack, 'A Polemic on Peak Fashion', *The Vine*, 26 June 2011). Poor-quality design, including poor materials and construction, as well as trend-based style, increase this burden on the environment.

Figure 1.9 Rana Plaza building collapse, 2013

ACTIVITY 1.5

List five of your favourite garments or other products. What is going to happen to them once you are done with them? Will anyone else want them? Then brainstorm ways you could redevelop the products to have less impact on the environment once you are done with them.

Environmental impacts and approaches used by designers and consumers in relation to textiles and furniture production

Consumers need to be mindful of a product's life when purchasing a product, and should consider the product's impact not only throughout the life of the product, but what will happen once they no longer want it.

Table 1.3 uses the LCA stages to demonstrate environmental impacts and approaches used by designers and consumers in relation to textiles and furniture production.

Complete an LCA (Environmental Impacts) of an existing product on page 26 of the workbook.

The life-cycle analysis/assessment stages (LCA)

Stage	Environmental impacts	Approaches used by designers and consumers
Extraction and processing of raw materials	**Non-resistant materials** Fabrics such as cotton are heavy in their use of water, and need pesticides. (One T-shirt uses up to 2700 litres of water to produce.) The fashion industry is one of the worst polluters on the planet. Synthetic fabrics use finite resources such as petroleum. **Resistant materials** Wood harvested from natural forests (illegally felled wood)	**Non-resistant materials** Sourcing organic or pesticide-free fabrics Reuse of old materials and upcycling **Resistant materials – IKEA** Sourcing of materials from forests certified as responsibly managed IKEA supports the Forest Stewardship Council. (Refer to page 59 for more information on the Forest Stewardship Council.) IKEA uses renewable and recyclable materials, including metal, plastic, cotton, glass, rattan.

Table 1.3 The life-cycle analysis/assessment stages (LCA) of resistant materials and non-resistant materials products *(Continued)*

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Stage	Environmental impacts	Approaches used by designers and consumers
Manufacturing	**Non-resistant materials** Dyeing fabrics can use hazardous chemicals that damage the environment and pollute waterways. An investigation by Greenpeace found rivers in China near textile factories contained hormone-disrupting chemicals (*Dirty Laundry*, 2011). **Resistant materials** Waste residue, solid or liquid, in production Damage to the environment during mining or harvesting of the basic material	**Non-resistant materials** New technologies to dye fabric include DyeCoo's waterless dyeing, which uses gas instead of water, and Nike's ColorDry water-free dyeing process. Dyeing a T-shirt can take up to 30 litres of water. **Resistant materials – IKEA** Reusing waste material in the production of other products IKEA recycles the following materials: cardboard, paper, glass, plastic, metal, wood.
Transport, distribution and packaging	Much of what we buy comes from overseas. One-quarter of things we buy now are made in China. These products must be shipped or airfreighted, impacting the environment. Online shopping is becoming increasingly popular, and many purchases are distributed in individual packaging, impacting the environment. **Resistant materials** Use of transportation methods that are harmful to the environment in relation to the energy consumed during transportation to site of usage	Designers – Use local manufacturers and material suppliers, so less damage to the environment through transport and distribution. **Resistant materials – IKEA** Consumers construct IKEA products themselves. This means IKEA products can be shipped to stores more economically. Consumers shop in their local IKEA store. Less packaging is used when shipping and buying products. IKEA lessens the environmental impact by producing flat-packed furniture that requires less transportation. IKEA transports goods that use fuel-saving strategies, such as trains that are powered by electricity generated from renewable energy. The IKEA company encourages use of bicycles to transport goods.
Use, reuse and maintenance	**Non-resistant materials** For garments, this stage makes the most impact on the environment: 82% of energy the garment will use will be in the use phase (K Fletcher, *Sustainable Fashion and Textiles*, Routledge, New York, 2008), including washing and drying. **Resistant materials** Flat-packed furniture lacks quality joinery, so the length of use of the product will be lessened and reuse unlikely.	**Non-resistant materials** Providing informative care labels, including encouraging less tumble-drying and excess washing Designing products that are easy to repair Designing clothes that require less laundering (see 'Chef's whites' case study on page 14) H&M developed smarter labelling systems to reduce environmental impacts of laundering. Advice was practical, and encouraged users to use cold water when washing, and air freshening garments instead of washing. **Resistant materials – IKEA** All products come with care and maintenance instructions and handbooks consumers should follow to ensure a longer-lasting product.

(Continued)

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Stage	Environmental impacts	Approaches used by designers and consumers
Disposal/end of life	**Non-resistant materials** The average person sends 30 kilograms of textile waste to landfill each year. Many of the fabrics used in clothing today are blended (two or more fibres combined to improve performance), which makes them more difficult to be repurposed. **Resistant materials** The energy and effects associated with the disassembly and disposal of a product at the end of the life cycle The recyclability of the disassembled material Flat-packed parts not assembled correctly by the consumer means the product's parts or components of the product won't last as long.	**Non-resistant materials** Upcycling old products into new ones **Closed-loop production**, such as Kuyichi's Deposit Denim, which recycles donated jeans into yarn, and gives buyers a discount when they donate their old jeans. Ensuring that garments are suitable for reuse if being donated to charity Use of pure fibres that can be repurposed easier **Resistant materials – IKEA** IKEA is looking at ways to encourage customers to recycle or reuse products when they no longer want them. IKEA has partnered with a charity and take customers used beds, mattresses, appliances and sofas and give these items to families who need them. Furniture that cannot be reused will be disassembled and recycled with minimal environmental impact.

closed-loop production
use of post-consumer waste to create new products

Table 1.3 The life-cycle analysis/assessment stages of resistant materials and non-resistant materials products
(continued from previous page)

- **Complete the activity on Extended Producer Responsibility (EPR) and the product to be redeveloped on page 41 of the workbook, Activity 1.11.**
- **Complete the activity on design for disassembly: analyse your product to be redeveloped on page 40 of the workbook, Activity 1.10.**

1.3 Approaches used by designers to incorporate sustainable practices in product design

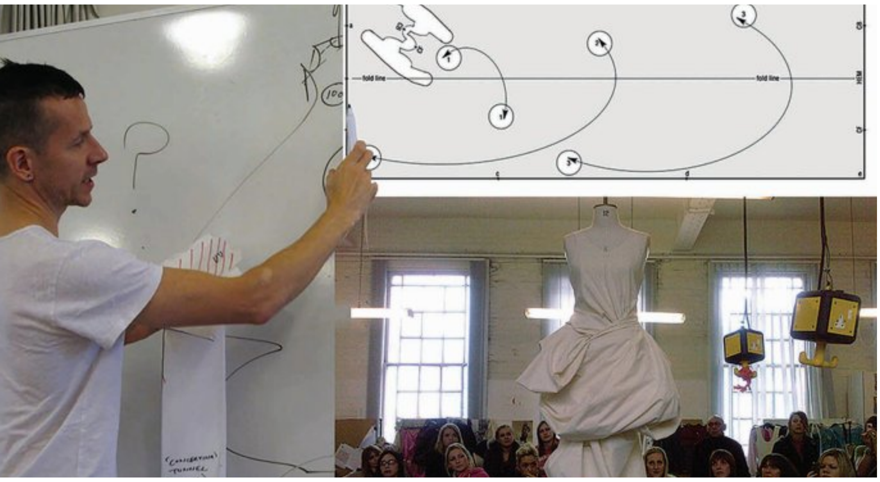

Figure 1.10 Subtraction cutting with Julian Roberts

Zero waste pattern making – textiles

Typically, 10–15% of fabric is wasted when cutting out a garment (F Pryor, 'Fashion Futures', Textile and Fashion Hub, Melbourne, 2014). Some fashion designers are approaching a 'zero waste' approach to pattern making:

- Daniel Silverstein uses pre-consumer waste (offcuts) to create new fabrics and to create embellishments on garments, resulting in less fabric ending up in landfill.

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- Holly McQuillan uses **zero waste techniques** by designing the cut of garments to tessellate as pattern pieces on a flat cloth, resulting in minimal waste of fabric.
- Julian Roberts uses what he calls **subtraction cutting**. Instead of cutting away pattern pieces to make up a garment, he subtracts the spaces where the body will go, such as neck or armholes. This utilises most of the fabric, minimising waste.

zero waste techniques a philosophy that encourages minimal to zero waste of materials in the production of garments

subtraction cutting a method of hollow construction that can be used variously to make men's and women's fashion garments, accessories and interior/exterior products, developed by Julian Roberts

CASE STUDY

Adidas and Parley ocean plastic shoes

Sportswear giant Adidas collaborated with Parley for the Oceans to create a sustainable shoe made of discarded plastic found in the ocean, near the Maldives. The upper is constructed of 95% of the collected waste, both reducing pollution and environmental impacts in the ocean on sea life, and not having to source as many new materials. Discarded plastic bottles, among other things, are melted down, extruded and spun into yarn, ready to be made into new products. Adidas is now using the technology to create jerseys for elite European soccer teams and high-performance sportswear.

Questions

1 Why do you think sustainability is a major influence in product development?

2 How can producing sustainable products further the growth of a large company such as Adidas?

Figure 1.11 Adidas and Parley shoes made of recycled plastic

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CASE STUDY

Chef's whites

The use phase of a life-cycle assessment is known to make the most environmental impact in the stages of a garment's life. But what if we could reduce the amount of times a garment needs to be washed?

A chef's white jacket could be seen as a sustainable design, created out of necessity. The double-breasted jacket design unbuttons to reveal a second clean layer, which can be reversed and rebuttoned during a chef's shift, perhaps for a second service. This allows the garment to be worn for longer, reducing both the amount of times the garment needs laundering and the impact the product has on the environment at the use phase.

Question

How does the design of a chef's white jacket promote sustainability?

Figure 1.12 Chef's whites

Some social initiatives in fashion

Figure 1.13 GOTS certification on a garment

- Baptist World Aid Fashion Report: A yearly report and comparison on some of Australia's major clothing labels and retailers, looking at ethics in manufacturing.
- Good On You: An ethical shopping app to help consumers make more sustainable choices.
- GOTS (Global Organic Textile Standard): A reputable certification standard for organic textiles and their supply chains, including social criteria.
- People Tree: A fair trade clothing company that is GOTS-certified.
- Social Studio: An Australian not-for-profit enterprise that trains refugees and migrants in fashion and manufacturing, and offers a retail space to sell their goods.

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CASE STUDY

Herman Miller

Designing for the environment is a philosophy of the Herman Miller company and around the world their facilities are powered with 100% renewable energy.

This innovative company is known for its contemporary interior furnishings, solutions for health-care environments, and related technologies and services.

Living up to its philosophy of designing for the environment, the Herman Miller company has produced the Mirra chair. This office chair has a lot of environmentally friendly qualities:

- it is made of 42% recycled materials
- it is made with no polyvinyl chloride (PVC)
- it is 96% recyclable
- it is **Greenguard**-certified.

Questions

1 How does the design of the Mirra chair promote sustainability?
2 What benefits does the Mirra chair have for the environment?

Figure 1.14 View of a reception desk and waiting room at the Time and Life building, New York. The 'Time-Life' chairs are Herman Miller designs.

Greenguard-certified means the Mirra chair meets some of the world's most stringent, third-party chemical emissions standards and helps manufacturers produce, and consumers identify, interior materials and products that reduce indoor air pollution, creating healthier indoor environments.

The philosophy behind the Mirra design is an office chair that uses the least amount of material needed for each component (designed with environmental considerations in mind) and can easily be disassembled (DfD). The construction of the chair involves a one-piece, frameless backrest made of polymer and pierced with 567 geometric shapes. This geometric structure creates three flex zones that provide a suitable level of flexibility for the right ergonomic support and natural adjustment. This makes the chair extremely comfortable, which improves the user's well-being and encourages more productivity in the workplace.

Designers need to think of ways to design products that are not just about making products that can be upcycled or downcycled. Designers need to have a clear understanding of what people do with the products that are designed and produced and design products with the lowest environmental impact from cradle to cradle, such as the bicycles designed and manufactured for Melbourne Bike Share.

Complete the DfD activity on page 40 of the workbook, Activity 1.10.

Greenguard
Certification that gives assurance that products designed for use in indoor spaces meet strict chemical emissions limits, which contribute to the creation of healthier interiors

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CASE STUDY

Figure 1.15 Melbourne Bike Share

Melbourne Bike Share

Since 2010, Melbourne Bike Share has encouraged sharing and promoted sustainable activity. In various locations around the city of Melbourne, bicycles have been made accessible to everyone. This means people are encouraged to use a more sustainable mode of transport that not only benefits the environment but promotes a healthy mode of transport, encouraging people to enjoy the outdoors, which increases their well-being as they ride along the extensive bike paths the city has to offer.

Questions

1 Do some research and find similar initiatives from around the world.
2 List the benefits these initiatives have, not only for the environment but for the general well-being of communities.

Figure 1.16 Another and more recent bike scheme is the oBike. The oBike is a hi-tech bike-sharing platform and the first of its kind in Australia. These bikes are located throughout some of Melbourne's inner suburbs.

ACTIVITY 1.6

What else might the city of Melbourne need that is sustainable and will improve the quality of life for Melburnians? To understand what is happening globally to drive a sustainable future, a good place to start is Sustainia100, which every year showcases 100 sustainable innovative design solutions from around the world. Visit the Sustainia100 website.

Find a designer whose ideas and work impress you and list some ways you could apply their thinking and design style to your own work in Unit 1.

The future of sustainable design thinking – biomimetic design

Biomimicry

Nature has been solving problems for billions of years. Biomimicry is an innovative and clever way designers are looking at sustainable design solutions and developing products and processes that mimic the models, systems and elements of nature (refer to the Velcro example on page 17).

Over time, as our understanding and application of biomimetic design increases, we will improve our human practices and protect our natural systems and solve complex twenty-first-century human problems that will last now and into the future.

Like sustainable design, biomimetic design can be viewed as a contemporary design

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movement. Contemporary design refers to design that is happening now. What is contemporary today will be history in the future, so contemporary design is forever evolving and transforming. As biomimetic design evolves and transforms, it will become an increasing focus for designers, engineers and scientists as the need to protect the future of our planet increases.

How might you consider applying biomimicry concepts to your redeveloped product? Refer to Activity 1.7 to get you started.

ACTIVITY 1.7

How could you consider applying the concepts of biomimicry in your own redeveloped product in Unit 1? Make a list of Australian flora and fauna that might inspire ideas for a product based on biomimicry.

Ideas to get you started:

- Great Barrier Reef
- Kakadu National Park.

DID YOU KNOW?

George de Mestral, a Swiss engineer, observed under a microscope that burdock burrs, which cling to clothing and animal fur, have a simple design structure made from hooks. This observation of nature led him to develop Velcro, which was patented in the United States in 1955. Velcro is a design solution that cleverly mimics a model from nature.

Figure 1.17 A strip of Velcro

DID YOU KNOW?

The Al Bahar Towers in Abu Dhabi are designed using Islamic design principles. Historically, bay windows have been covered with a protruding carved wooden lattice work called a *mashrabiya*, and it is this traditional covering that through research and development has been redesigned in a modern way to cover the surface of the Al Bahar Towers. Like traditional Islamic architecture, its design mimics geometric patterns and forms that can be found in nature. Like the petals of a flower, this outer structure reduces solar glare and solar gain by closing in the heat of the day and opening up as the desert air cools.

Figure 1.18 A *mashrabiya* in Yemen

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DID YOU KNOW?

Through evolution, a shark's skin has developed overlapping scales so that water flows efficiently over its body, enabling it to travel through water more quickly. Australian designers from the Speedo company designed what was called 'Fastskin' primarily for competition swimming. The Fastskin material, which was polyurethane-based, mimicked shark skin and the swimsuits proved successful in international competition.

Figure 1.19 A Sri Lankan factory employee uses a sewing machine to make a high-tech shark skin-mimicking Fastskin FSII swimsuit at the Linea Aqua factory, a local joint venture with Speedo and Brandot, in the Sri Lankan town of Hanwella, 2004.

DID YOU KNOW?

The Education Resource Centre (the Core) at the Eden Project in Cornwall is made with responsibly sourced material and minimal waste. The design of the Core mimics spirals on a sunflower or pineapple, with dragonfly wings being inspirational to its design. It includes large self-heating greenhouses made from frames that take on geometric shapes, pentagons and hexagons.

Figure 1.20 The Education Resource Centre (the Core), on the right of this image, at the Eden Project in Cornwall

Complete the case study into sustainable design on page 27 of the workbook, Activity 1.3.

Complete the LCA brainstorm activity on page 55 of the workbook, Activity 1.22.

1.4 Systems, models and strategies used to assess the sustainability of a product

One of the ways designers and companies may choose to assess the sustainability of a product is by creating an eco-design checklist. The checklist covers the five stages in a life-cycle analysis/assessment discussed on page 5 and is usually checked off once a product idea, concept or existing product has been defined.

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This kind of checklist contains questions that provide support for the analysis of a product's impact on the environment. It will start with a needs analysis and then cover questions on sustainability within each life-cycle stage.

Table 1.4 contains a list of questions a designer or company might include in an eco-design checklist.

Needs analysis How does the product fulfil social needs?
1 Extracting and processing raw materials What problems could arise during the production and supply of materials and components?
2 Manufacturing What problems could arise during the production process?
3 Transporting, distribution and packaging What problems could arise during the distribution of the product?
4 Use, reuse and maintenance What problems could arise when using, servicing and repairing the product?
5 End of life and final disposal What problems could arise in the recovery and disposal of the product?

Table 1.4 Checklist for the analysis of a product's impact on the environment

ACTIVITY 1.8

Previously in this chapter, Activity 1.2 asked you to brainstorm ideas of products you could redevelop using the sustainability design principles. Choose an idea from this task and review your idea against the checklist for the analysis of your product's impact on the environment.

1. What conclusions can you draw from this activity in determining how sustainable this redeveloped product might be?
2. Do you need to reconsider anything with regard to your design or modify it in any way?

What is design thinking?

Design thinking embodies a methodology in which designers creatively and innovatively explore design ideas that are not problem-focused, applying solution-based or solution-focused thinking. Instead of looking at the problem, designers look at creating a more desirable future by cleverly investigating design possibilities, using imagination, logic and systematic reasoning that is user-centred.

d.school

At the forefront of teaching design thinking is the Hasso Plattner Institute of Design at Stanford – or d.school, as it is known. The d.school incorporates engineering, medicine, law, humanities, business, education and science faculties. User-centred design is the institute's focus, and each faculty works collaboratively, taking on design problems from around the world and creatively finding solutions.

The school has developed various phases of design thinking and one of these phases is empathising with end-user/s to gain a greater awareness of the design problem and solution needed. This will allow you as the designer to accurately define the problem so you can work towards a successful product.

These phases do not follow any particular order and are not a step-by-step process. Instead, they are phases that can be repeated until an innovative outcome is reached.

Thomas Edison's light bulb invention is a good example of this way of thinking and designing. This user-centred invention created a better future situation because Edison was able to empathise with end-user/s and develop an innovative product solution that he knew end-user/s needed and would want to use.

The 'Product Design Process: Stages and Steps' diagram supports the same design thinking in four stages and 10 steps (see Figure 1.21). As in the d.school's approach to design thinking, these stages and steps can be repeated and revisited.

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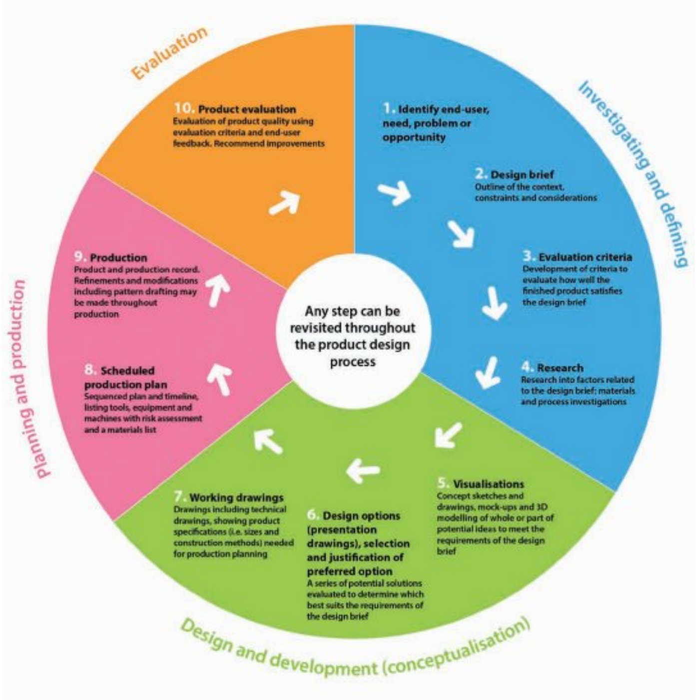

Figure 1.21 The product design process diagram from the *VCE Product Design and Technology Study Design* (@VCAA)

ACTIVITY 1.9

The design process followed in Unit 1 requires you to work through similar phases or design stages.

1 Think about how you might empathise with your end-user/s during stage 1 of the design process to gain a better understanding of their problem that requires a solution. Make a list of questions you could ask your end-user. Refer to the product design factors in the reference section of the workbook to help you with this activity.

2 Gather this information and incorporate it into your design brief.

1.5 Methods of incorporating relevant product design factors in a design brief

Your main goal when writing a design brief is to communicate the design problem by forming a statement that expresses this information clearly and could be understood by all those involved in the product design process, from the investigating and defining and design and development stages, through to the planning and production and evaluation stages.

The design brief needs to briefly cover as many details as possible.

Two important pieces of information that will help you write a clear design brief are:

- the responses your end-user/s provided to your questions earlier, which give you a more empathetic understanding of what your end-user/s needs
- the product design factors.

The product design factors cover a range of important aspects every designer needs to think about. There are nine product design factors listed in the study design. Each factor has parameters that provide more detailed information on what to look for with each factor.

Product design factors

The nine product design factors are:

- purpose, function and context
- user-centred design
- innovation and creativity
- visual, tactile and aesthetic (design elements and principles)
- sustainability (social, environmental and economic)
- economics – time and cost
- legal responsibilities
- materials – characteristics and properties
- technologies – tools, processes and manufacturing methods.

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Important product design factors to include in a Unit 1 design brief are:

- purpose, function and context – what the purpose of the product is, how it will function and where it will be used
- innovation and creativity – what parts of the product could be redeveloped and more innovative than the original design
- sustainability – how you are considering sustainability in your redeveloped product
- materials – what materials will be suitable according to your end-user/s' needs
- economics – what budget you are working with and what time frame.

The design brief – constraints and considerations

The constraints are a series of aspects you can't change, and because of this they guide the design and production of the product in a particular direction. For example, perhaps your client insists on the product being made from bamboo or silk. If this were the case, you would write this constraint in the following way: 'The redeveloped table must be made from bamboo, which is a sustainable material.'

A helpful way to make sure you have listed all the constraints mentioned in your design brief is to carefully read through your design brief and underline or highlight the constraints in the same colour.

You can also follow this process when you list your considerations to make sure you have thought about all aspects that you as a designer have to consider with the design task at hand.

An example of a consideration might be: 'What types of weather might the table be exposed to if occasionally used outdoors?'

- **Learn the nine product design factors on page 29 of the workbook, Activity 1.4.**
- **Complete the nine product design factors and your redeveloped product activity on page 57 of the workbook, Activity 1.24.**
- **Refer to the folio checklist on page 42 of the workbook, Activity 1.12.**
- **Complete a design brief draft on page 30 of the workbook, Activity 1.5.**

1.6 Methods of developing criteria for evaluation of a finished product

Evaluation criteria are used throughout the product design process. In Unit 1, you must generate evaluation criteria to help evaluate your finished redeveloped product or prototype. Four-part evaluation criteria allow you to ensure that your design meets your brief and form the basis of your product evaluation at the end of the product design process.

Remember, Unit 1 focuses on redeveloping a product or prototype and sustainability. It is important that you consider these aspects in your evaluation criteria.

1. Criterion question: Turn a constraint or consideration into a question that can be asked of a finished product. For example, you might change 'The end product must use sturdy construction methods to extend its life' to 'How well were sturdy construction methods incorporated into the final product?'
2. Relevance: Explain why this is important to your design situation.
3. The process used to achieve this during production. Describe what steps you could take to ensure that this happens.
4. Checked/tested on the finished product: List the ways you will check or test this criterion on the finished product.

To help you get started with completing four-part evaluation criteria for the finished product, complete the following activity.

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Evaluation criteria for the finished product

	Constraint or consideration	A question	Justification and relevance to the design brief	The process used to evaluate the success of the product	How the finished product could be tested or checked
How to	Include questions that can be asked of a finished product.	Turn your constraint or consideration into a question	Explain why this is important to your design situation	Think of the processes you can use to ensure success in this criterion	Describe how you will test this on the finished product/s.
Example	The end product/s must use sturdy construction methods to extend its life'.	How effective was the end products life extended with sturdy construction methods?	The product needs to have a longer life cycle and should be more durable than the existing design, so less demand for new products is generated.	Research and test construction methods with sample materials. Compare the durability of these methods with the existing product.	Try out the product, testing the strength of the construction. (e.g. sitting on your redeveloped chair, applying pressure to the seams of your redeveloped skirt).

Table 1.5 Evaluation criteria for the finished product

Complete your evaluation criteria on page 160 (Chapter 7) of the workbook.

ACTIVITY 1.10

1 Turn a constraint into a question and explain its relevance.
2 Turn a consideration into a question and explain its relevance.

DID YOU KNOW?

A prototype is a high-quality version of a final product that uses substitute materials and processes. You can choose to make a prototype in any unit. The prototype should aim to meet all of the evaluation criteria developed from the design brief.

1.7 Creative and critical design thinking techniques

The term 'design thinking' covers the activities we complete as designers when solving design problems. There are no wrong answers in design thinking! Sustainability, including considering impacts on the economy, society and the environment, also forms part of design thinking.

Creative thinking

Creative design thinking involves the generation of new ideas. In the product design process, this can include brainstorming/graphic organisers, visualisations and design options.

Creative thinkers think 'outside the box'. This means they solve problems, meet challenges and explore solutions to design problems in ways that are not typical. This way of thinking allows for more innovative and successful product solutions.

You can view creative thinking as a process that manifests differently for each individual. Some starting points might include:

- generating sketches based on a secondary source, such as a photo from nature

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- looking at historical design and reinterpreting styles for a modern end-user
- redeveloping a part or component of a product, such as a sleeve or the seat of a stool.

There is no wrong answer with creative thinking. Don't limit your thinking, because all ideas are valuable and you never know what could inspire you.

Some creative thinking words include:

- explore
- visualise
- generate
- develop
- improve.

Critical thinking

Critical design thinking involves analysing and critiquing design ideas. In the product design process, this includes using evaluation criteria to analyse design options, evaluating your finished products and analysing existing products.

As a designer, you will work with an end-user/s closely, not only initially empathising and understanding what they need and why, but defining the limits early (constraints) and what you need to achieve throughout the design process in order to meet the end-user/s' needs successfully. Applying critical thinking throughout the design process means that you constantly check the limits and goals of the project and eliminate possibilities along the way, so that a lot of uncertainty is removed.

Undertaking as much and as varied research as possible, from other designers to particular environments and existing products, is important to see how other designers have solved design problems.

Some critical thinking ideas include:

- looking at the advantages and disadvantages of an existing product and discussing, questioning and refining your ideas
- showing your end-user/s your ideas and getting feedback
- testing materials and processes and deciding what is most suitable
- using evaluation criteria
- comparing your redeveloped product to the original.

Some critical thinking words include:

- compare
- critique
- reflect
- analyse
- discuss
- review
- test
- refine.

Figure 1.22 Analysing an existing design (critical thinking) and using it as inspiration for a new design (creative thinking) by student Madeleine Hosemans

Figure 1.23 Redeveloped basic skirt by student Madeleine Hosemans (non-resistant materials)

Figure 1.24 Redeveloped dog kennel using plywood, a sustainable material, by student Baptist Zacharia (resistant materials)

- **Complete the creative and critical thinking activities on pages 20, 35, 37 and 38 of the workbook, Activities 0.9, 1.6, 1.7 and 1.8.**
- **See the reference section for a list of designers and design movements activities on pages 6 and 8 of the workbook, Activities 0.4 and 0.5.**
- **Complete the ideas for exploration activity on page 56 of the workbook, Activity 1.23.**

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1.8 Methods of generating, analysing and evaluating ideas for the redeveloped product

There is no one correct way to go about designing. The product design process is a continuous cycle and ideas should continue to develop.

Some suggestions for generating ideas for a redeveloped product or prototype

- Get passionate about design.
- Look at existing products – online, in books and magazines.
- Look at current trends using social media.
- Look at specific designers' work.
- Look at cultural movements in design (see Chapter 3).
- Visit design exhibitions and stores.
- Take photos of different things that appeal to you.
- Do quick sketches of things that appeal to you.
- Use the creative thinking technique SCAMPER – substitute, combine, adapt, modify, put to another use, eliminate, reverse.
- Research existing products.
- Use sources unrelated to your material as inspiration, such as art, architecture or nature.
- Take more notice of all the amazing design that is around you.

Analysing the existing product

Use the product design factors to analyse aspects of existing products and their suitability and potential to be a redeveloped product or prototype that considers sustainability. Looking at areas for improvement should also form part of your analysis; specifically, how you can improve the purpose/function and sustainability of the existing product.

ACTIVITY 1.11

On a plain sheet of paper, paste an image of the product you are developing. On the left side, annotate the product, identifying the product design factors. On the right side, using the product design factors, list three ways you can improve the product.

Graphic organisers

A graphic organiser is a visual exploration of ideas and research areas. Graphic organisers include mind maps, brainstorms, lotus diagrams and fishbone diagrams.

Explore your ideas using graphic organisers on page 44 of the workbook, Activity 1.14.

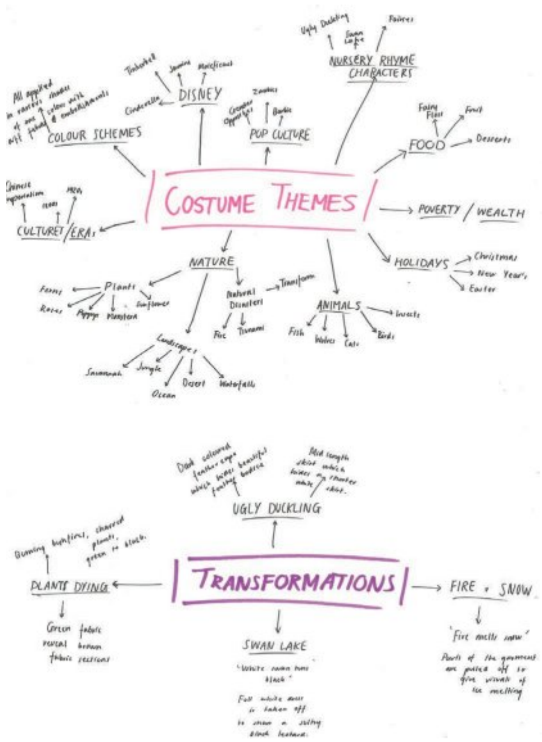

Figure 1.25 Brainstorm by student Madeleine Rosenbrock

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Mood boards

A mood board is a visual collection of images and inspiration. Mood boards are sometimes used in the fashion industry to collect ideas and inspire the design team. They can include existing products as inspiration, colour palettes, text, material samples and other secondary sources of inspiration, such as art, architecture, nature and graphic design.

Figure 1.26 Mood board by student Natalie Dubinski (resistant materials)

DID YOU KNOW?

Existing styles of clothing can be a starting point for fashion designers and product developers based in Australia. Design teams will often send staff on buying trips to destinations such as Europe, the United States and Japan to interpret trends and view successful styles ahead of season in Australia. It is up to the designer to use these trends as inspiration, while respecting the intellectual property of the existing designs.

Evaluating your ideas

A good designer is always reflecting and refining and applying critical thinking to improve their designs. In Unit 1, some ways to do this during the product design process could be:

- discussing your ideas with friends or classmates to get some feedback
- reflecting on your visualisations to decide which ones best meet the brief, picking your top three, which could potentially be your design options
- evaluating purpose and sustainability within your design work and considering how you have improved the existing product.

- **Complete an analysis of your redeveloped product using the nine product design factors on page 43 of the workbook, Activity 1.13.**

Figure 1.27 Mood board by student Cindy Yang (non-resistant materials)

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1.9 The importance of acknowledging the IP rights of the designer of the product

What is intellectual property?

Intellectual property (IP) relates to the protection of ideas (as opposed to physical property) that are generated through intellectual or creative activity. Intellectual property also includes patents, trademarks, design registration, confidential information/trade secrets, copyright, circuit layout rights and plant breeders' rights. This could include (but is not limited to) artwork, designs, products, books, songs, jewellery, garments, computer chips, movies and recipes.

IP Australia is the Australian Government organisation that is responsible for providing and delivering intellectual property information to designers. Designers and inventors, anyone who creates a new and innovative product, need to be aware of intellectual property so someone else won't benefit from their creation. There are different ways they can protect their work and it's important they choose the best one.

Forms of intellectual property

Copyright

Copyright is the protection of original expression of ideas, such as artwork, books, music, movies, photography and games. It is the expression of the idea that is protected, not the idea itself. It applies automatically, with no cost to the creator, and lasts at least 70 years, under the *Copyright Act 1968*.

Commercially available products, such as garments in stores, are not covered under copyright, as the ideas are considered 'industrially applied' (*Fashion Law Handbook*, Marque Lawyers, Sydney, 2015); however, flat work, such as prints, patterns and sketches, is covered.

Australian inventions are protected by copyright in other countries. Some of the countries that grant copyright protection to Australian inventions under international treaties include China, Japan and South Korea.

Design registration

Design registration is the protection of the look of products, such as garments or furniture, but not how the products work. Designs must be registered with IP Australia before they are commercially available, and found to be new and distinctive, and not similar to existing products in order to be registered, protected and legally enforceable under the *Designs Act 2003*. This costs $250–$370 per design, and can last up to 10 years (IP Australia, 'Design time and costs', 2016). This can get costly for a fashion or product designer who has many pieces within their collection.

Design registration 'aims to protect designs that have an industrial or commercial use. A registered design gives you, the owner, exclusive rights to commercially use, license or sell it' (IP Australia, 'Design time and costs', 2016).

Patents

There are two types of patents in Australia:

1. a standard patent, which gives control and protection over an invention for up to 20 years
2. an innovation patent, which lasts up to eight years and is a fast, cost-effective option.

A patent is the protection of how something functions or works. This can include pharmaceuticals, electronics appliances and devices, and machinery.

The invention must be seen as 'new, useful and inventive or innovative' (IP Australia, 'Design time and costs', 2016) for a patent application to be successful. This protects the inventor's idea being used for commercial benefit by others. Applications may also need to be applied for in other countries if the product might be sold or produced overseas. You must not discuss your invention in public

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prior to applying for a patent. If you do, you could lose your rights to a patent.

Trademarks

A trademark is a unique identifier of a business. Branding and logos are more commonly understood as trademarks, but trademarks can also include letters, numbers, phrases, fonts, colours, sounds, smells and shapes. For example, Levi Strauss has trademarked the distinctive stitching on their jeans pockets, as has Dr. Martens with the yellow stitching on their boots.

Why is IP important?

It is important both to respect the intellectual property of others and to protect designers from plagiarism, as well as allow them to make profits from their ideas. Many designers look at existing works for inspiration, such as fashion designers researching trends or an industrial designer examining existing products on the market. However, copying an existing design and claiming it as your own could be seen as intellectual property theft, and there can be legal and economic ramifications. This could also damage the reputation of a designer who is found to be breaching the intellectual property of others. It has even been suggested that profits from counterfeit goods have been used to fund terrorism (D Thomas, *Deluxe*, Penguin, New York, 2007).

DID YOU KNOW?

David Unaipon was a prolific designer of Indigenous heritage. His image appears on the Australian $50 note. In 1909 he patented an improved handpiece for sheep shearing (Patent Specification. Mechanical motion. Sheep Shears No. 15,624 1909 D. Unaipon, SA). Unfortunately, even though he obtained a patent he was never properly protected, and others gained financially from his invention.

How should you acknowledge IP within your work?

First, you as a designer must make sure your design work is original and your own. Any idea that is not your own must be acknowledged within your Product Design and Technology folio. For example, during your research you might find the work of another designer interesting and take inspiration from it, and put an image of their work in your folio.

The acknowledgement should be clear and obvious; for example, listing the owner of the intellectual property as well as any other information you have, such as the date created, the publication the image may be from and the photographer. It is encouraged that you do this as you go. Appropriate acknowledgement of the work of others also forms part of your assessment in Units 3–4 of Product Design and Technology.

Types of intellectual property

	Copyright	Design registration	Patent	Trademarks
What does it protect?	Original artistic work	The visual appearance of a product that is new and distinctive	How something functions or works	Something that distinguishes a business from others, such as logos, branding, fonts, colours or scents
Example	An original painting	The shape of a table, the cut of a dress	Polymer bank notes	'Tiffany Blue'
How long for?	70 years +	5–10 years	8–25 years, depending on the type of patent	10 years for each registration, which can be renewed
How much?	Free	$250 + for each design	Thousands of dollars, including renewal fees	Hundreds of dollars
How to apply?	It is automatic	Register your design with IP Australia before it is seen by the public	Apply with IP Australia, and overseas if needed	Register with IP Australia, but no legal requirement if it is your intellectual property

Table 1.6 Types of intellectual property

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To avoid issues with intellectual property and plagiarism, you are also encouraged to source a wide variety of inspiration in your research, not just existing products. Nature, architecture, art, graphic design and many other areas can be sources of inspiration.

ACTIVITY 1.12

Go through your folio. Have you used any inspirational images? Make sure you have acknowledged the owner of the intellectual property.

ACTIVITY 1.13

Research some of the requirements that design companies impose on staff to protect intellectual property. Share and discuss your findings with a classmate.

Complete an activity on IP on page 39 of the workbook, Activity 1.9.

CASE STUDY

Dyson versus Hoover

These famous vacuum cleaner companies went to Her Majesty's High Court of Justice in England to decide who was first to use bagless technology, with Dyson accusing Hoover of infringing its patent. James Dyson spent many years trying to find a backer for his idea, an idea that took 20 years to develop.

In October 2000, the High Court ruled in Dyson's favour and ordered Hoover to stop selling their bagless vacuum. Dyson had said that in 1999 they offered Hoover to pay £1 million to settle their claim but Hoover refused. As a result of the High Court's ruling, Hoover now had to pay £4 million in damages for infringing the patent on Dyson's bagless cyclone cleaner. The company requested to appeal to the House of Lords, but this request was rejected.

Figure 1.28 Dyson bagless vacuum cleaner, the first vacuum cleaner created by James Dyson. The distinctive Cyclone feature allows continuous suction. Centrifugal force separates dirt and dust from the air, which is then collected in a clear bin. As there is nothing to block the airflow, the system doesn't clog up or lose suction.

Question

Research similar intellectual property infringement cases. Divide your class into groups of four and in pairs hold a debate arguing both sides of the dispute.

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1.10 Role of annotations and appropriateness of different drawing techniques

Visualisations – concept sketches and drawings

Visualisations are quick thumbnail sketches that are informed by your research. They don't have to be resolved, just a communication of your ideas. They don't have to be in colour, or even a whole product. Designers communicate their ideas through drawing, including digital techniques. When ideas are first sketched (freehand), some designers work very quickly and can produce very simplistic visualisations with rough annotations, while others may take a little more time and produce more detailed visualisations and lengthy annotations.

You might be surprised at the rough quality of drawings some very successful designers produce. During the concept sketching phase, it is more about getting the idea onto paper than sketching a perfect idea.

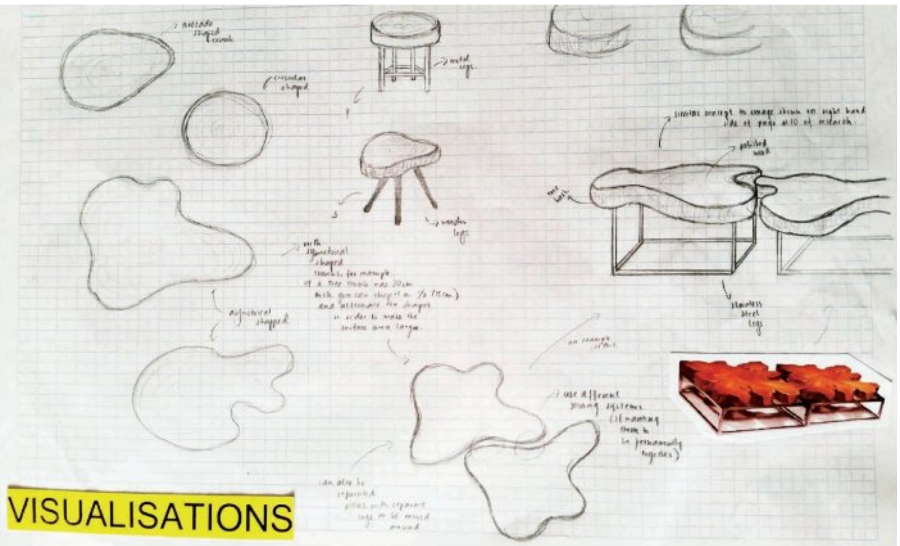

Figure 1.29 Visualisations by student Natalie Dubinski

Figure 1.30 Visualisations by student Cindy Yang

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ACTIVITY 1.14

Try quickly sketching the existing product you are redeveloping. Then try sketching the product again, but change a minimum of three things. Repeat this process until you have a product of your own design.

Use the elements and principles (Table 1.7) as you sketch the existing product you are redeveloping. As you sketch, you might consider changing the shape, colour and texture, and balance of objects and parts.

Role of annotations

Annotations are used to show your thinking and explain your visualisations, research and design options. This can include:

- describing the materials/fabric used; for example, bamboo, cotton drill weave
- describing construction techniques used; for example, mitred corner, French seam
- describing how the design/visualisation meets the design brief and the product design factors
- explaining design features
- acknowledging IP – listing the designer, artist, etc. responsible for the image.

Figure 1.31 Including annotations and notes to your design can help in the development of the product.

Throughout the product design process, you will generate a variety of drawings, each with its own specific purpose and style. Annotations are also important at this stage. While you are sketching, you are also thinking about parts of your design – perhaps the function, shape, colour and possible materials, for example – and those thoughts need to be put into words on the paper simultaneously.

Use of design elements and principles to support annotations of design work

Annotations should complement your design work, and not state details already visually obvious. They should also not detract from or clutter your design work. Think about the overall layout and visual appeal of your folio work. Product design factors, your design brief and evaluation criteria and the design elements and principles provide a great word bank of appropriate language for annotations.

Perhaps you have sketched an idea for the redevelopment of a simple Parsons side table (a modernist table designed by Jean-Michel Frank in the 1930s) and have coloured the tabletop red. When annotating this, you might use the design principle of emphasis and the design elements of colour and shape to talk about your idea.

For example: 'The idea for a sustainable redeveloped side table is inspired by an original Parsons side table. I have emphasised the simple square tabletop by colouring it bright red to make it look modern.'

Design elements	Design principles
Point	Balance
Line	Contrast
Shape	Repetition
Form	Movement
Texture	Rhythm
Tone	Pattern
Colour	Proportion
Transparency	Asymmetry
Translucency	Symmetry
Opacity	Space-negative/positive
	Surface qualities

Table 1.7 The design elements and principles

See the reference section on page 3 of the workbook, Activity 0.3.

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Use of the nine product design factors to support annotations of design work

The nine product design factors will help you think about aspects such as the possible function of the product, whether it is innovative and materials you might use. When you annotate your design work, you can do it in a way you feel comfortable with. This might involve using arrows that point to specific parts of an idea or writing a block of information next to an idea.

Here is an example of how you might annotate your design work if you were redesigning a Parsons table using two product design factors:

Product design factor

Function – A 1930s simple Parsons table is the inspiration for a redeveloped sustainable side table. The end-user/s requires a side table that will be easy to move around and a comfortable height when placed next to a lounge chair or couch. The end-user/s would like to use it as a homework table and play the occasional board game on it.

Product design factor

Material – Parsons tables have typically been made from wood, plastic or metal. To make the table sustainable, I am going to use plywood. The natural look of plywood will appeal to the end-user/s and the material is durable and easy to work with.

ACTIVITY 1.15

Explain your design work to a classmate. Describe the design features and explain how they meet the needs of the end-user/s as stipulated in the design brief. Use this information you gather as the basis of your annotation.

ACTIVITY 1.16

Use a colour code key to annotate product design factors and design options in your visualisations.

Design options

Design options communicate what the product will look like in colour. They are skilled drawings for presentation that are annotated to explain design thinking, features not obvious in the drawing, such as intended construction methods, and how the design is meeting the brief. These drawings can be more stylised and can be generated by a variety of methods, including computer-aided design (CAD) and use of mediums such as coloured pencils, Copic markers, collage, ink or watercolour pencils.

Presentation drawings for design options – resistant materials

Once you have completed a range of annotated visualisations, the next step in the design and development stage is creating design options in the form of presentation drawings.

Presentation drawings of design options for resistant material products can be drawn using isometric (30-degree) or oblique (45-degree) views to convey your picture in 3D. (See workbook page 47 for templates.) If you prefer to use a digital method, or have chosen to produce a digital folio, SketchUp (CAD) is quick to learn and gives you many options of surface materials and views of all sides of your work.

Design options – resistant materials

Figure 1.32 Design options 1 and 2 for a stool by student Natalie Dubinski *(Continued)*

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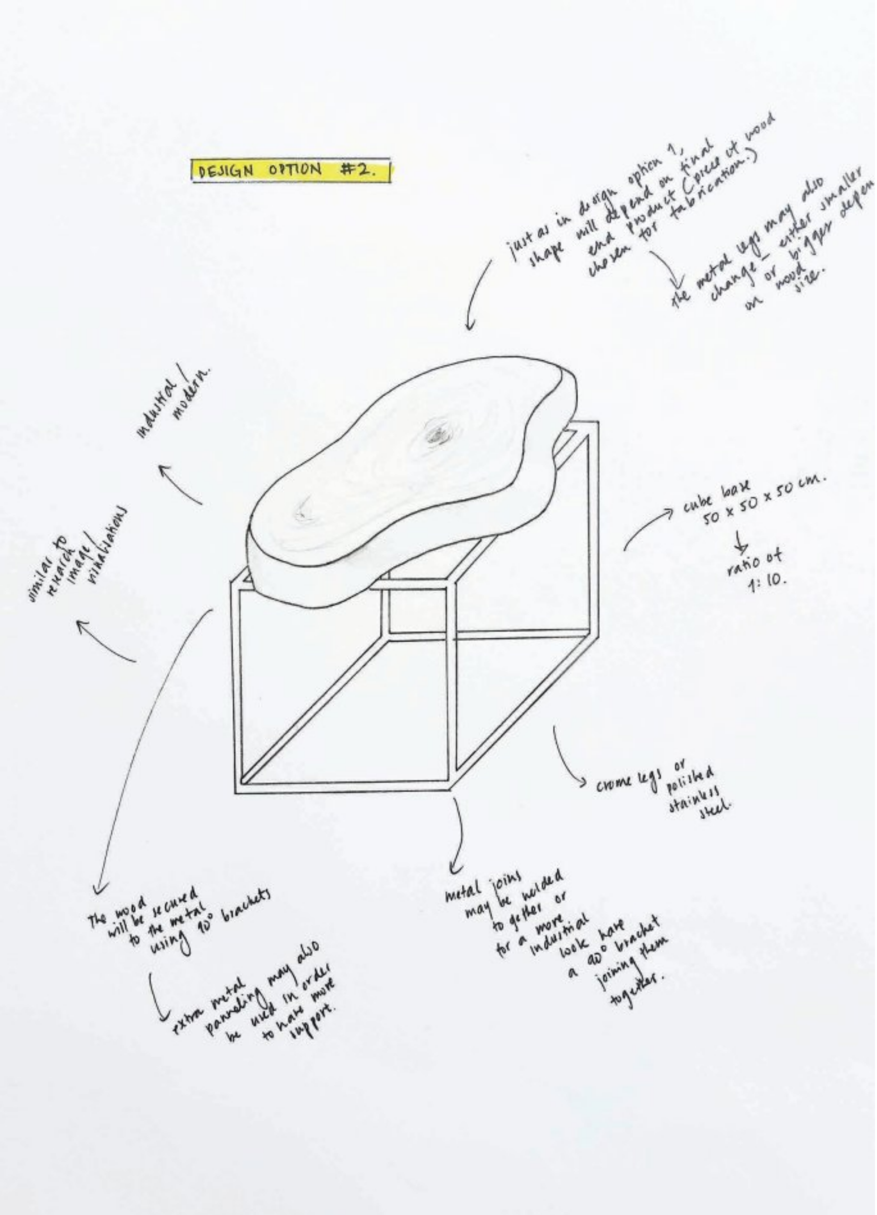

Figure 1.32 Design options 1 and 2 for a stool by student Natalie Dubinski

Presentation drawings for design options – non-resistant materials (textiles)

A fashion illustration for non-resistant materials is an appropriate drawing style for the design options. Fashion illustrations often have exaggerated body proportions, often being much taller and more stylised than a realistic figure. A figure template is a good tool to use under your paper when drawing your design options for textiles. Front and back views are suggested for design options in Unit 1, and could include zoom drawings and fabric samples.

Design options – non-resistant materials

Figure 1.33 Design option by student Cindy Yang

Figure 1.34 Design option by student Madeleine Rosenbrock

Working drawings

Working drawings are clear, detailed, scale drawings that accurately depict your preferred design option and how it should be constructed, and show 2D views of a 3D object. These technical drawings are suitable for both resistant and non-resistant materials.

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DID YOU KNOW?

To generate accurate working drawings in resistant materials, third-angle orthogonal drawings are created that typically show the top view (plan), front view and side view.

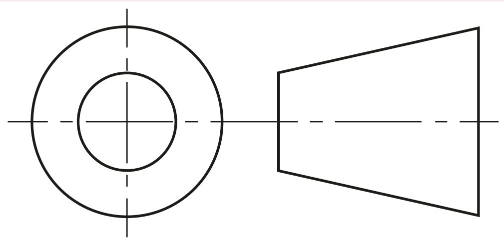

Figure 1.35 Third-angle orthographic projection symbol

This is a great time in the product design process to really think about how your product looks and how it should be made.

Working drawing – resistant materials

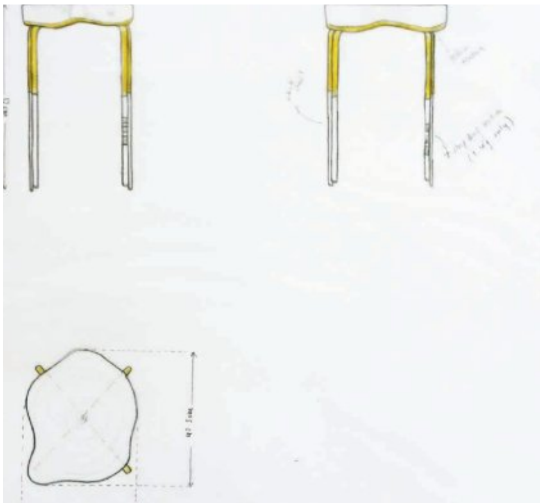

Figure 1.36 Third-angle orthogonal drawing by student Natalie Dubinski

Working drawing – non resistant materials

Working drawings are individual garments drawn without a body, as if the garment was laid flat. You must draw a front and back view of your design option (side is optional), annotated to explain key measurements of the design, such as bust, waist, hip and length. Visible stitches, darts, design lines, gathers, seams, pleats, hems, zip placement, buttons and so on should be depicted. Use a standard, non-stylised figure template.

Figure 1.37 Working drawing by student Cindy Yang

If you are using a commercial pattern, this must be acknowledged in your folio; for example, by providing a photocopy of the pattern sleeve. Also note the modifications you have made to the pattern in your folio.

ACTIVITY 1.17

Creating a manual working drawing for textiles

1. Use a lightweight piece of paper, such as bank or tracing paper, and a figure template that is front-on and of average proportion. (See workbook page 51 for templates.)
2. Place your figure template under your paper and draw a line down the centre front of the body, with a greylead pencil.
3. Draw one half of your garment, starting with silhouette, seams, then add the garment details such as buttons and visible stitching. If you have any straight lines, draw these with a ruler.
4. Fold your paper in half down the centre front line, and trace the other half of your garment on the other side of the paper.
5. Open the paper and adjust the design for any asymmetrical design features.
6. Once you are happy with your drawing, draw over it with fineliner and a ruler.
7. This drawing can be used as a silhouette to draw your back view.

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Working drawing for resistant materials (manual)

Completing a working drawing of your product is not an easy task. There are regulations you need to follow that are published by Standards Australia and can be found on their website.

Orthogonal drawings are used to show 2D views of a 3D object. Orthogonal drawings allow a manufacturer to make the product to the designer's specifications because all details are shown. Orthogonal drawings show three views of a product:

- front view
- top view (plan view)
- end view.

Working drawings contain various types of lines that are used to represent different aspects of the product. For example, a thick continuous line is used to outline the product drawn, while a thin broken line is used to show hidden detail.

The typical arrangement of the three views is shown using third-angle projection. The diagram in Figure 1.36 shows a chair drawn using third-angle projection, with each view accurately aligned using projection lines. It is important to note that the top view is always situated above the front view and measurements are shown in millimetres.

There are many websites and YouTube videos that demonstrate how to draw in this way, and your school library will contain books on technical drawing.

Adobe Illustrator

Adobe Illustrator, a computer-aided design (CAD) program, is most commonly used in the fashion industry for working drawings, also known as technical drawings. Often garments are produced offshore, in countries where English is a second language. This makes this accuracy and detail in the working drawing paramount when a designer is communicating how they want their designs to be manufactured.

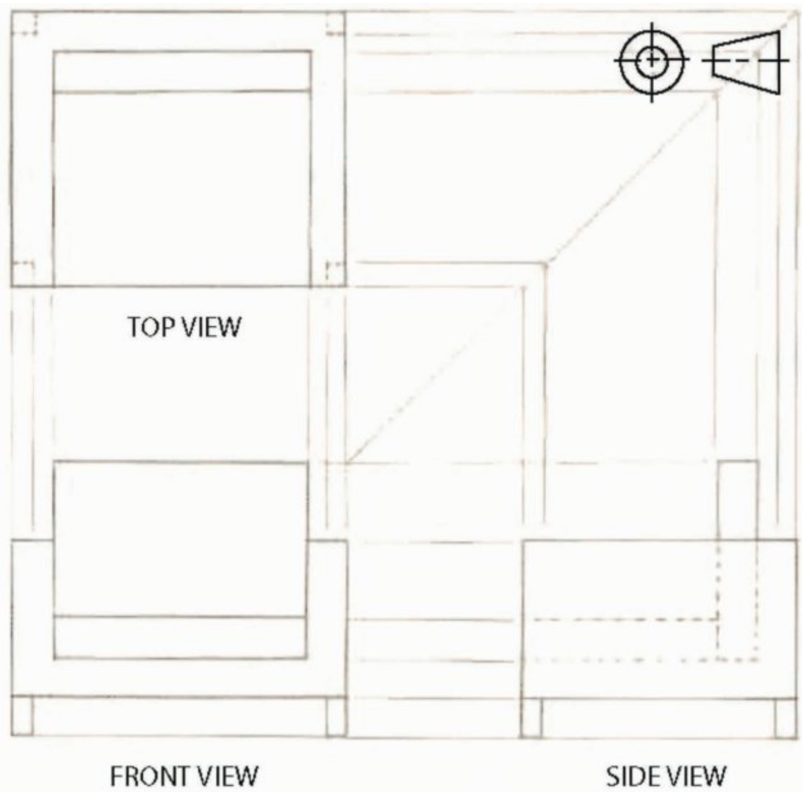

Figure 1.38 Working drawing by student Cassandra Rico

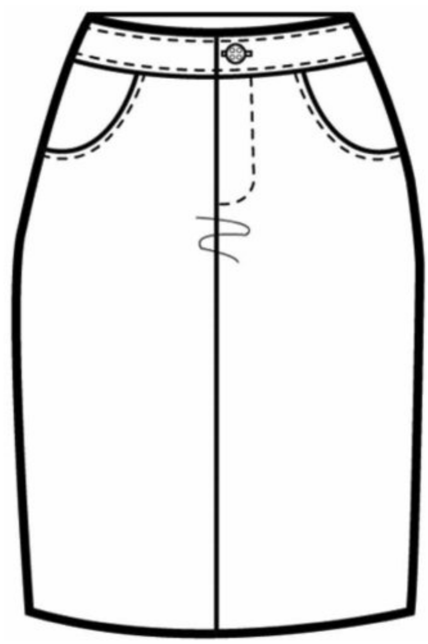

Figure 1.39 Working drawing of a skirt

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Initially in production, a working drawing would be sent off to a manufacturer, along with key measurements of the sample size they would like created and sometimes an existing garment that is similar. The manufacturer will then send the sample (or prototype) they have drafted and sewn back to the design team. A 'fit model' will then try on the sample garment for the design team to assess the design and the fit of the garment. This process is repeated until the design team is happy and the garment is ready to be mass-produced. Many jobs in the Australian fashion industry oversee this stage in the product development process, so working drawings and CAD are important skills to learn.

- **Complete the visualisations activity for resistant materials on page 45 of the workbook, Activity 1.15.**
- **Complete the generating design options for resistant materials on pages 47 and 48 of the workbook, Activities 1.17 and 1.18.**
- **Complete the working drawing activity for resistant materials on page 53 of the workbook, Activity 1.21.**
- **See the reference section for drawing templates for non-resistant materials on pages 13–17 of the workbook.**
- **Complete the generating design options for non-resistant materials on page 49 of the workbook, Activity 1.19.**
- **Complete the working drawing activity for non-resistant materials on page 51 of the workbook, Activity 1.20.**
- **Complete the end-user/s feedback on visualisations on page 46 of the workbook, Activity 1.16.**

1.11 Relevant material and process research methods, such as tests, trials, comparisons and production process samples

It is important that early on you develop a fairly clear idea of the materials you would like to use for your Unit 1 product. Asking your teacher about materials suitable to use in your resistant materials workshop or non-resistant materials classroom will help you to make a better choice and ensure that you make a product that is achievable using the facilities your school provides.

Unit 1 is about a redeveloped product that considers sustainability, so relevant materials are those that are sustainable in some way. For resistant materials, bamboo and plywood are a good choice.

Research throughout the product design process is crucial for a successful finished product that meets the brief. You must research materials, processes, tests, trials or comparisons that are explicitly relevant to your design situation and will inform your choices and strengthen your skills for production.

For more information on this section of study, refer to Chapter 2, pages 55–61.

Non-resistant materials – textiles

Areas of research that can be helpful to complete include:

- research into fabrics and their properties
- materials testing to compare and decide on fabrics suitable for your design option
- product process samples.

Fabrics

Two key elements that make up a fabric's properties are its construction and fibre. Fibre refers to what it is made of (for example, silk) and construction refers to how it is put together (for example, knitted). When describing fabrics, always list the fibre and the construction.

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Fabric components				
Fibres		Construction		
Natural	**Synthetic**	**Knits**	**Weaves**	**Non-woven**
Wool	Nylon	Jersey	Basic weave	Leather
Cotton	Acrylic	Rib	Twill	Felt
Linen	Acetate	Tricot	Satin	Webbing
Silk	Polyester	Interlock	Sateen	
	Elastane	Raschel	Corduroy	
	Viscose		Loop pile weave	
			Cut pile weave	
			Jacquard	

Table 1.8 Fabric components

More information on fibres and fabrics can be found in Chapter 7.

Listing fibre and construction methods

Sample	Fibre	Price	Properties	Suitability to your situation
(Attach here)	Silk	$	Refer to Chapter 7	Why is this suitable?

Table 1.9 Example of a table used for listing the fibre and construction methods

Production process samples for resistant and non-resistant materials

It is up to you to research and explore potential production processes to include in your design. For example, if your design includes a zip, there are many types to consider, including single welt, invisible, exposed and fly front.

If your product includes wood joints, there are also many types to consider, including lap joints and halving joints.

Use your existing knowledge, as well as teacher advice and do research. You should trial a technique to assess its suitability. Include a sample of the technique in your folio, annotating it to explain what you have learned.

Production process samples for non-resistant materials

Mola Quilting Appliqué Embroidery (machine or hand) Beading Dyeing Fabric printing Boning Buttonhole making	Cuff making Gathering Piping Pleating Pocket making Rolled hemming Blind hem Sleeve insertion Zip insertion	Lining a garment French seams Ditch stitching Fly front Cover stitching Darts Square corners Pintucking Collar making

Table 1.10 Potential production process samples for non-resistant materials – textiles

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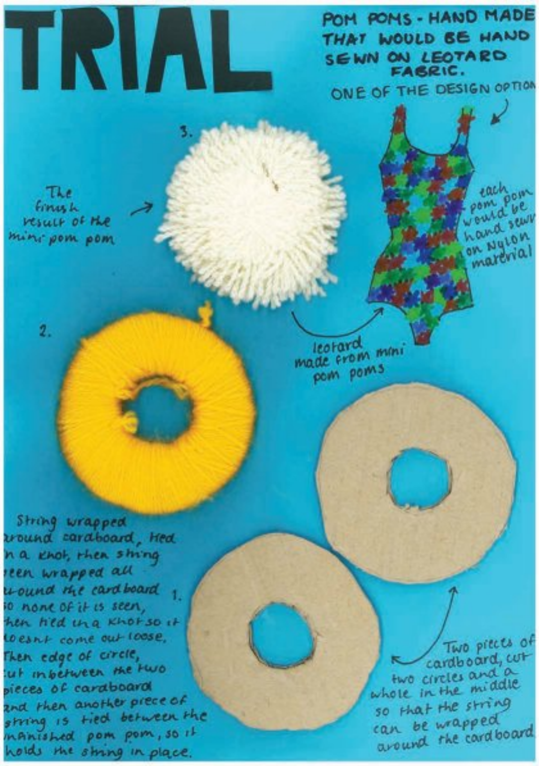

Figure 1.40 Trial of a pom-pom by student Katarina Kristo

Resistant materials – wood, plastics and metal

Helpful ways to research include:

- research into materials and their properties
- visiting manufacturers of different materials who may not only provide information on their product but also give you offcuts for testing
- materials testing to compare and decide on materials suitable for your design option
- production process samples.

When researching different resistant materials, it is important to be aware of these important points.

Wood

The two main categories for wood are hardwoods and softwoods. Waste material from these woods produces manufactured boards such as plywood. It is important you establish early on what category the wood you are going to use falls into.

Plastic

There are two types of plastic: thermoplastics, which can be recycled, and thermosetting plastics, which are non-recyclable.

Metal

Some metals are pure and others are alloys, which means they are mixed with other metals. For more information, refer to Chapter 2.

ACTIVITY 1.18

What are you investigating if you are testing the following properties in a material sample?

- Conductivity
- Tensile strength
- Ductility

Listing materials and production methods for resistant materials

Sample	Material	Production	Price	Properties	Suitability to your situation
(Attach here)	Plywood	PVA glue and nails	$	Refer to your VCE Units 1–4 workbook	Why is this suitable?

Table 1.11 Example of a table used for listing materials and production processes

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veneering
gluing a thin sheet of wood or other material onto a product to improve its appearance

kerfing
sawing cuts into a length of wood

forging
a metal shaping technique

riveting
a metal pin with a head at one end that is pushed through two sheets of material with a rivet gun, joining them together

3D printing
a printing process that typically uses plastic to make 3D models

laser cutting
computer-aided design (CAD) that is used to direct a laser that cuts materials

vacuum forming
heated plastic that is formed over a mould using the force of a vacuum

Production process samples for resistant materials

Wood	Metal	Plastics
Biscuit joint	Bronze brazing	**3D printing**
Dovetail joint	Cold bending	**Laser cutting**
Housing joint	Folding	Blow moulding
Mortise and tenon joint	**Forging**	Casting
Rebate/shoulder butt joint	**Riveting**	Injection moulding
Routing (decorative edge)	Rolling	Riveting
Mitre joint	Silver soldering	Turning (using an engineer's lathe)
Veneering	Turning (using an engineer's lathe)	**Vacuum forming**
Kerfing	Welding	
Wood turning (using a wood lathe)		

Table 1.12 Potential production process samples for resistant materials

ACTIVITY 1.19

What materials test could you undertake in your school resistant materials workshop or non-resistant materials classroom to investigate the following properties of materials? Choose two properties listed that would be suitable:

- malleability
- elasticity
- hardness
- strength
- toughness
- comfort
- drape
- colourfastness
- durability
- pilling
- snagging.

Refer to the workbook for more detailed tasks on properties of materials.

- **Complete the activity on materials research on pages 161 and 162 of the workbook, Activities 7.6a and 7.6b.**
- **Complete the activity on testing the properties of materials on page 163 of the workbook, Activity 7.7.**

1.12 Role of scheduled production plans, including a timeline and steps needed for production

In Unit 1, the scheduled production plan includes:

- a timeline
- steps needed for production
- materials and equipment list
- risk management for safe, efficient and accurate production of a product
- quality measures.

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The scheduled production plan with timeline visually maps out the production of your design option, listing the steps of production in sequential order, as well as allocating the time each step will take. As you have not made the product before, reflect on past products you may have made and how long they took, and ask others for advice. Your production planning documents can be referred to frequently during the product design process, to see what is next, if you are up to date or if changes will have to be made. The steps must make reference to your working drawings; for example, sew zip into bodice or mark out holes for screws.

Hints for non-resistant materials/textiles

If you are modifying a commercial pattern, the instruction inside can provide some assistance when writing your scheduled production plan. Simplify this into your own language and look up words you don't know (copying would be plagiarism), and include design features specific to your design option in your timeline. Production processes such as darts and zips are best done when the garment is still flat and in pieces. Production processes such as hemming are often done last.

Hints for resistant materials

Starting out with correct measurements and an understanding of a logical order of production stages is important. It might be helpful to make templates/models/mock-ups or production process samples or parts of your product first before you mark out and start production. This will help to avoid any mistakes such as inaccurate measurements and wastage of good material.

- **Complete your production process trials on page 58 of the workbook, Activity 1.25.**
- **Complete scheduled plan of production on page 59 of the workbook, Activity 1.27.**
- **Complete a weekly production record on page 63 of the workbook, Activity 1.28.**

ACTIVITY 1.20

Write your timeline, using the template from the workbook, by imagining someone else is going to produce your product. What do you think comes first? What do you think comes last?

Materials and equipment list

A materials and equipment list notes all the consumables and equipment to be used when producing your preferred design option.

- Materials are generally things that will need to be supplied, such as fabric or wood.
- Tools and equipment are used to create the product with the above materials, and are usually school-supplied.

Give a detailed description of the item (for example, textiles – fibre and construction of fabric; wood – thickness, length and type of wood), as well as how much you will need. List all of the tools and equipment needed to produce your preferred design option.

ACTIVITY 1.21

List all the materials and equipment you will need to produce your redeveloped product, using Table 1.13 as a guide.

Complete your materials and equipment list using the template on page 64 of the workbook, Activity 1.29.

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Materials and equipment list for resistant and non-resistant materials

	Resistant materials example Acrylic notebook riser	Non-resistant materials example Knee-length dress
Materials, including quantity	• 1 sheet of acrylic – 400 mm × 400 mm × 3 mm	• Commercial pattern (for example, Simplicity Dress) • 1.5 metres of polycotton twill weave, 140 cm wide • 1 spool of thread • 1 60 cm nylon zip • 0.25 metres of interfacing, iron on • 1 set of hook and eyes
Tools and equipment needed	• Measuring tape • Scroll saw • Coping saw • Flat file • 400 grade wet and dry sandpaper • Sanding block • Brasso for polishing • Rag • Strip heater/line bender	• Paper scissors • Pins and pincushion • Fabric scissors • Sewing machine (including bobbin, bobbin case, plain and zipper foot) • Overlocker • Iron and ironing board • Hand sewing needle

Table 1.13 Example of a materials and equipment list for resistant and non-resistant materials

Risk assessment for safe, efficient and accurate production of a product

Risk assessment is crucial for the safe, efficient and accurate production of your redeveloped product. Before you commence production, you must commence a risk assessment of your work environment/s, including the tools, equipment and machines and processes you will need to complete your product, for the safety of yourself, your class and your teacher.

You should also consider the safety of the end-user/s when using the finished product.

1. Identify the hazards:
   - What are potential hazards of your Product Design and Technology resistant materials workshop or non-resistant materials classroom?
   - What could be a risk?
2. Assess the risks:
   - What could happen from these hazards?
   - What is the likelihood they will occur? (likely, possible, unlikely)
   - What harm could occur? (Use the rubric below.)
3. Control the hazards and the risks:
   - How can you minimise the risks?
4. Check the controls:
   - Regularly review your controls and procedures.
   - Ensure that you are practising your suggested risk management.
   - Inform your teacher of any machine faults or risks.

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Risk assessment – a suggested approach

Process	Example – resistant materials (wood/ metal/plastic) Bending acrylic		Example – non-resistant materials (textiles) Cutting out fabric	
1 Identify the hazards	• Electrical hazard with the potential to cause harm through exposure to heat, gases and fumes		• Using the iron • Working with heavy rolls of fabric • Working at a bench height • Using scissors and pins • Trip hazards – fabric scraps	
2 Assess the risks (describe potential injuries)	• Burns on hands or fingers • Fragments in eyes • Toxic gases and fumes		• Burns on fingers from the iron • Back injuries due to incorrect manual handle procedures	
Level of harm and likelihood	Level of harm = minor	Likelihood = unlikely	Level of harm = minor	Likelihood = unlikely
3 Control the hazards and the risks	• Keep hands and fingers away from heater and strip • Use in a ventilated area • Allow the strip heater to cool down before storing it		• Keep fingers away from hotplate of iron and unplug when not in use • Use a buddy lift system to carry heavy rolls of fabric • Carry scissors closed, by the blade end • Use a pincushion only to store pins, and if you prick yourself, dispose of that pin in a sharps container • Clean up work area as you go	
4 Check the controls	• Continue to implement controls		• Notify teacher of any issues	

Table 1.14 Example of a risk assessment

Level of harm		
Level	**Label**	**Description**
1	Insignificant	No/little injuries, no first aid required
2	Minor	Some first aid required
3	Moderate	External medical circumstance
4	Major	Extensive injuries
5	Catastrophic	Death or major injuries

Table 1.15 Level of harm and description of possible injury

Likelihood	
Low	Most unlikely to happen
Medium	Could happen
High	Very possible

Table 1.16 Likelihood of possible injury

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Common hazards in the non-resistant materials classroom
• Using sewing machines and overlockers to sew fabrics • Using dyes, ink, chemicals and stovetops to dye and print fabric • Using scissors, pins, unpickers and fabric while cutting out and while sewing • Using irons and iron press while producing garments • Working at varied heights on benches and tables • Lifting heavy rolls of fabric (both of these hazards can lead to back injuries, a common injury in this environment) • Trip hazards generated through excess fabric/mess on the ground

Table 1.17 Hazards in the textiles classroom

Common hazards in the resistant materials workshop	
Machines	
• for sawing – scroll saw	Cuts
• for sanding – belt and disc sander	Dust/noise
• for polishing – buffer	
• for joining metal (arc, MIG and oxyacetylene)	Burns/flashback
• for drilling wood, metal and plastics – pedestal and bench drills	Moving parts
Portable machines • vacuum former and strip heater/line bender	Burns
Hand-held tools	
• hand tools to saw – coping and tenon saws	Cuts
• hand tools to sand – orbital sander	Dust
• hand tools to drill – electric hand drill	Moving parts
• hand tools – electrocution from power cord	Power cords
• hand tools to saw, join and finish materials – chisels, various files, rasps	Cuts/striking
Working at varied heights on benches and tables	Back injuries
Using chemicals, varnishes, paints, stains, glues and solvents	Vapours/fumes
Lifting heavy materials incorrectly, trips and falls	
For more detailed information, refer to Chapter 2.	

Table 1.18 Hazards in the resistant materials workshop

If the risk is too high and it is likely something might happen, it may be an unsuitable method of production and other ways should be sought to complete that step or process. Your teacher will be able to offer other suggestions to help you achieve your end product.

It is important to be aware that the resistant materials classroom (wood, metal and plastics) has considerably higher risk than a non-resistant/textiles classroom.

Your teacher will demonstrate how to use certain tools and machines, have you complete online safety training modules or perhaps ask you to demonstrate your competency using specific tools and equipment before production can commence.

Complete your risk assessment using the template on page 65 of the workbook, Activity 1.30.

Quality measures

Quality measures are ways of ensuring the quality of a product during its production. During the planning and production stages of Units 1–4, you must suggest quality measures you are going to apply in your scheduled production plan, and when producing the product you must action them. This will ensure that your product is of the quality you desire. Some ways you can ensure quality are listed in Table 1.19.

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Complete your quality measures in the table on page 169 of the workbook (Activity 7.13) using Table 1.19 and your own research as a guide. Note: this activity is located in chapter 7 of the workbook.

Complete an evaluation of a redeveloped product using evaluation criteria on page 67 of the workbook, Activity 1.31.

What is quality assurance?

Quality assurance is a set of activities based around procedure intended to establish confidence that goals and requirements for a product will be met. It focuses on the early prevention of defects in a product.

Ways to ensure quality in your product for both resistant materials and non-resistant materials

	Resistant materials (wood/ metal/plastic)	Non-resistant materials (textiles)
Pattern drafting and modification	• Measure the space/environment where the product will be used. • Look at similar existing products for measurements to base your own product on. • Use a ruler/tape measure/spirit level and other measuring devices in your workshop to mark out materials accurately, and have your working drawings with you at all times for guidance. • Complete a prototype to test the suitability of selected materials (if time allows).	• Take accurate measurements of end-user/s to help with pattern selection/drafting/modification and generation of working drawings. Note: Pattern sizes vary and often are not the same as store sizes. Never assume your size without using the size guides provided in the pattern. • Use a ruler and greylead pencil to neatly draft patterns and/or make modifications, and have your working drawing with you at all times for guidance. • Complete a toile to test the pattern/fit before completing your final garments (if time allows).
Material selection	• Collect samples of potential materials, completing tests and trials (see page 211) and discussing them with your end-user/s and teacher. • Select the most suitable materials (see Table 7.13 on page 202–203).	• Collect samples of potential fabrics, completing tests and trials (see page 208) and discussing them with your end-user/s and teacher. • Select the most suitable type of fabric construction (knit, weave or non-woven – see Table 7.8 on page 198) for your pattern and design. Often there are suggested fabrics on the back of a pattern.
Cutting out materials	• Cut materials using suitable hand tools, electric hand-held tools or machines. • Ensure that your work is marked out accurately and double-check your measurements. • Secure your work before cutting for accuracy and safety. • Make sure the teeth on any saws are not damaged, as this will make cutting more difficult and will affect the overall quality of your work.	• Make sure the fabric is ironed before being cut out, at the correct temperature. • Use the **straight grain** or **maximum stretch** to lay out the pattern pieces. (Grain will be marked on commercial pattern pieces, and often a cutting guide is provided to help with layout.) • Pay attention to any **nap**/direction your fabric has, or any stripes or patterns that need to be matched up at the side seams. • Use **notches**, tailor's tacks, tracing wheels and paper, fading pens and so on for any internal markings on the pattern, such as darts, buttonholes or pocket placement.

Table 1.19 Example of ways you can ensure quality in your product for both resistant and non-resistant materials

(Continued)

straight grain
the lengthwise warp yarn that runs parallel to the selvedge (finished edge) in woven fabrics

maximum stretch
the grain (warp or weft) of knit fabric that provides the most stretch, which should be cut across the body

nap
a raised surface on fabric, such as velvet or suede

notches
small indentations on pattern pieces that help with matching up seams

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tacking
a temporary long stitch to assist with sewing; can be done by hand or machine

seam allowance
the distance between the stitch and the raw edge on a garment; this can vary between knitted and woven garments

	Resistant materials (wood/ metal/plastic)	Non-resistant materials (textiles)
Producing your product	• Check the tools and machines you will be using and make sure they are in good condition and safe working order before you begin production. Ask your teacher for help and guidance if you are unsure. • Remove any materials or tools and equipment not needed for a workable bench space. • Make sure you have all the joining materials planned for ease of production. • Keep parts or components of the product you are making in a safe place and out of the way. • Follow safety rules in your workshop to ensure that you are not injured and your work is not damaged through a careless approach.	• Test machines before sewing to ensure that they are running correctly. • Trial any processes (see Table 7.23 on page 216) before completing them on your final garment/s. • Have a clean workspace and clean hands when working on your product/s. (Make-up stains are hard to remove.) • Use **tacking** for difficult processes (such as a zip). • Ensure that your **seam allowance** is parallel to the raw edge of the fabric. Guides on the sewing machine or a magnet may help with this. A pattern will specify the correct seam allowance. • Use the correct machinery and accessories for the right fabric (see Tables 7.9 and 7.10 on pages 199 and 200). • Use overlocking/zigzag stitches on raw edges to prevent fraying. • Iron seams and processes as you complete them. • Ensure that all seams line up at major intersections. • Ensure that seams don't have any puckers, and fix any mistakes as you go. • Ensure that any hand-sewn fastenings (such as buttons or hooks and eyes) are secure. • Hang your garment up between practical classes to avoid it getting creased.
Finishing your product	• For a quality product, it is important that you apply suitable planned finishing techniques that are undertaken with skill and care. • Provide user instructions to help end-user/s extend the life of the product.	• Measure the hem accurately before sewing it, which could include trying it on an end-user/s. • Trim any excess threads. • Ensure that the product is ironed. • Provide a care label/user instructions to help end-user/s extend the life of the product.

Table 1.19 Example of ways you can ensure quality in your product for both resistant and non-resistant materials *(continued from previous page)*

What are quality control measures?

Quality control is a set of activities intended to ensure that quality requirements are actually being met. As you work through your production tasks, you will need to undertake tests along the way to make sure your product is meeting the requirements of the design brief. You might need to test materials to check that they function as required.

ACTIVITY 1.22

Create a list of 5–10 quality measures you will apply during the making of your redeveloped product.

ACTIVITY 1.23

Using the list you created, complete a risk assessment for the production of your garment or product, using Table 1.15 as your template.

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Chapter summary

- Chapter 1 is your first experience at working through the investigating and defining and design and development stages. Each stage consists of a series of steps in the design and development of a product. It is important you hold onto this folio work in case you choose to study further units in this subject.
- An LCA is used to assess the environmental impacts of a product.
- Designers use a variety of strategies, and consider the three pillars of sustainability when designing.
- The product design factors should be reflected in your design brief.
- There are a variety of methods to generate ideas for your redeveloped product.
- IP must be acknowledged in your folio.
- Annotations are used to explain your design thinking.
- Materials and processes should be tested to understand their suitability.
- The components of a scheduled production plan (the timeline, steps needed for production, materials and equipment list, risk management for safe, efficient and accurate production of a product and quality measures) all allow for safe, efficient and accurate production.

Short-answer questions

1. List the five stages of an LCA.
2. Explain what are quality control measures.
3. Identify the three types of drawing techniques undertaken during the design and development stage.
4. Describe the components of a scheduled production plan.
5. Discuss why it is important to acknowledge intellectual property rights.

Extended-response questions

1. You are redeveloping a dress or chair (select one). List and describe three production processes you are going to research and explain their relevance to the production of the dress or chair.
2. With reference to the three pillars of sustainability, discuss why cheap products may not be a long-term solution.

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Figure 2.1 Volunteer students from the Technological Institute of the Philippines display a desk lamp they made from discarded plastic at the House of Representatives in suburban Manila, 2015

2 Area of Study 2: Producing and evaluating a redeveloped product

INTRODUCTION

This area of study focuses on the production of your redeveloped product or a prototype that considers sustainability. You use your work done in the investigating and defining and design and development stages completed in Outcome 1 to undertake the planning and production and evaluation stages. At the end of this unit, take some time to reflect on the steps in the stages of the product design process. You will need to refer to the resources you have made in later units.

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KEY KNOWLEDGE

- tools, equipment and machines for specific purposes
- processes applicable to selected materials
- risk management for safe, accurate and efficient application of production processes using materials, tools, equipment and machines
- digital and manual techniques to manage and record production processes and progress
- methods of evaluating a redeveloped product to determine quality and suggest improvements
- the role of marking out, cutting, shaping, joining and finishing procedures used to determine appropriate, efficient and effective production processes to make a redeveloped product.

KEY SKILLS

- apply risk management in the production of the redeveloped product
- use materials, tools, equipment, machines and production processes to safely and accurately make a redeveloped product
- use marking out, cutting, shaping, joining, assembling, decorating and/or finishing processes to make a redeveloped product
- record progress and adjustments to the scheduled production plan
- respond to evaluation criteria
- evaluate the redeveloped product and suggest improvements.

2.1 Tools, equipment and machines for specific purposes

tool
an implement that is held by one hand to do a certain function

equipment
an item used for a particular purpose

machine
a device that uses mechanical power with parts that perform a function together to create an item or perform a task

safety
involves recognising the potential risks working in a textiles classroom or resistant materials workshop and taking appropriate safety measures

prototype
a high-quality version of a final product that uses substitute materials

It is important to consider the tools, equipment and machines available to you before production. Your teacher can help with ideas of products that will be achievable according to your workshop facilities or classroom. There will be some **tools**, **equipment** and **machines** you will not have used before and you need to consider your skills and the degree of difficulty before you analyse, modify and improve a sustainable product for a client or end-user/s.

Every tool, equipment and machine has a certain purpose and it is our role as designers to explore and know the limitations and **safety** requirements of each. Using this knowledge, we can then confidently pick the right tool, equipment or machine to suit our needs and safely create our product.

Your teacher will be able to assist you with those things you are not sure about and it is important that you undertake research yourself. There is plenty of literature available and online videos that can demonstrate how various tools, equipment and machines are used. You can also spend time experimenting with your non-resistant materials classroom or resistant materials workshop's tools, equipment and machinery. You may find that during the design and development stage you will need to modify your work because it may take too long and require certain skills you do not have the time to master.

Throughout the planning and production stage, you will need to show an understanding and demonstrate knowledge that you know how to use different tools, equipment and machines. You can demonstrate these skills in your folio and your teacher may observe you successfully using the tools, equipment and machines independently. Skills in knowing how and when to use such items will improve over time with trials, testing and use in the production stage.

Bigger isn't necessarily better when it comes to designing and producing a product. What you need to remember is the main requirement of Unit 1, which is designing and making a redeveloped product that attempts to solve a problem related to an original product using carefully considered manufacturing processes and materials that improve the overall sustainability of the redeveloped product.

Below is general information about tools, equipment and machines that can be found in a non-resistant materials classroom and a resistant materials workshop. For resistant materials, there are many more tools that could be used in the production of a fabric product. If you wish to use them, have a discussion with your teacher.

Further research will need to be undertaken to understand the risks and hazards of each tool, equipment and machine for both resistant and non-resistant materials. This research can be completed in your VCE Units 1–4 workbook or folio and is part of your research in the investigating and defining stage.

Choosing to produce a prototype in Unit 1 – a sustainable approach to getting it right

A **prototype** is a high-quality version of a final product that uses substitute materials and processes. A prototype can be produced in any unit but must be full-scale and aim to meet all of the evaluation criteria developed from the design brief. You might decide to make a prototype instead. By prototyping a potential product you can check and test for any faults and problems in the current design and make modifications to the prototype as required. This will save time and, in a manufacturer's case, money. It is more expensive to manufacture the final product a number of times and modify it until it is right.

Mock-ups are trial models, process trials or calico toiles that are suitable for development stages only.

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Figure 2.2 Designer Zian Assaad (Zion Couture) working on a calico toile

Figure 2.3 Former Mayor of London, Boris Johnson, next to a prototype of the New Bus for London, 2010

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Tools, equipment and machines in the non-resistant materials classroom

Cover stitch machine	A cover stitch machine is used for hemming knits or top stitching seams that need stretch. This machine is useful when you are sewing knits.
Embroidery sewing machine	An embroidery sewing machine creates patterns on textile fabrics. The modern computerised embroidery machine has a hoop and frame that holds the framed area stretched under the needle. The framed fabric moves automatically to create the image from a pre-programmed pattern.
Hand sewing needles	Sewing needles have a sharp point at one end and the other end has a space for the thread to pass through. There are many types of sewing needles. They can be used for upholstery, embroidery, beading and quilting as well as hand sewing.
Iron	A small hand-held appliance that uses heat and steam to remove creases from fabric.
Ironing board	The ironing board should be well padded with a flat surface. It is used with an iron to press seams and iron fabrics using the correct heat and steam.
Overlocker	Used to seal edges of fabric to stop fraying or to seal a seam, and to construct knit garments. The overlock blade will trim seams as it sews.
Pincushion	A small cushion that is used to store pins when they are not in use. They come in all shapes and sizes. Pincushions are tightly stuffed to ensure that the pins stay in place.
Pins (metal, plastic or glass heads)	Pins must be rustproof. If not, they might tarnish your fabric. They also should be sharp and fine. Over time, the points may break off. Check your pins before using on your fabric. If the pins are hard to place into the fabric, forcing them may cause blemishes in your fabric. Metal, plastic and glass head are the three types of pins used.
Scissors	Scissors should be sharp to help with precise and neat cutting of fabric and thread. Never cut paper or anything else with your fabric scissors! It is the quickest way of making a fantastic sharp pair of scissors dull and not be able to cut fabric smoothly. The three typical scissors you can find in the textile room are fabric shears, pinking shears and embroidery.
Sewing machine	A machine used to stitch and join materials together
Tailor's chalk	Tailor's chalk comes in multiple colours as a small piece of chalk or as a pencil with a small brush on the end. It is useful for marking on light and dark fabric. The mark it leaves on the fabric can be removed easily by washing or brushing with a hand.
Tailor's ham and sleeve board	The ham and sleeve board are used to help iron curves and sleeves.
Tape measure	A tape measure should be 150 centimetres or 60 inches long with metal tips at each end. Your measurements need to be correct, so ensure that the tape measure hasn't stretched. Older tape measures have a tendency to be slightly stretched.
Thread	The thread colour should match your fabric, unless you are doing a contrasting top stitch. If you cannot find the correct colour for your fabric, one shade darker on the spool will usually blend and match after stitching. The thread you will most likely be using for your product will be either polyester or cotton. Other thread types include silk, metallic and nylon/rayon.
Unpicker/seam ripper	This tool is most useful when starting out on a sewing machine. It helps cut and remove the unwanted stitches. The trick to using the tool is, the prong with the ball goes under the stitch while the large prong stays above. This means the tool will slide through the stitches and the ball will protect the fabric.

Table 2.1 Tools, equipment and machines in the non-resistant materials classroom

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Figure 2.4 Thread comes in many different types – always check if you are using the right thread for your fabric.

Tools, equipment and machines in the resistant materials workshop

Workshop – Methods of joining	Workshop – Machines and tools
Screws and bolts – are used for joining wood, metal and plastics and there are different types of screws used with these materials **Screws for wood** – cross, countersunk, round and slotted heads **Screws for metals and plastic** – self-tapping screws **Machine screws** – used with washers and nuts **Bolts** – square or hexagonal and the head tightened with spanners **Nuts** – contain a threaded hole and are combined with a bolt to join two or more pieces together **Nails** – are used in wood and are quick to use but not as strong as screws **Pop-rivets** – are used mostly for joining metal; you can purchase plastic rivets for joining other materials, such as polypropylene **Types of bits for drills:** **Flat bits** – are used on wood and plastics to drill large holes **Twist bits** – are used for drilling small holes into wood, metals and plastics **Countersink bits** – make holes for screw heads **Spade bits** – are used on wood and can drill out large holes **Non-permanent joints (knock-down fittings)** – are blocks or brackets made from metal or plastic and allow furniture to be assembled and disassembled very easily; they are not as strong as traditional wood joints **Glue** – usually used to reinforce other methods of fabrication; you need to choose the right glue for the production task	**Hammer** – claw, crosspein and ballpein are designed for a number of jobs **Mallet (made from beech)** – is used for driving gouges and chisels and assembling wooden joints **Rubber mallet** – like the beech mallet, it is used for assembling wood joints and also bending over sheet metal without damaging it **The teeth on saw blades are designed for cutting different materials** **Coping saw** – used for cutting wood, plastic and curves **Hacksaw** – used for cutting metal and can be used to cut plastic **Tenon saw** – used for cutting wood and straight cuts **Rip saw** – used for cutting wood **Bench hook** – used for holding wood in place for cutting **Jigsaw** – has varying speeds and interchangeable blades and you can cut straight or curved cuts **Mitre box** – is used to allow a saw to cut mitre joints at an angle **Try square** – used to check angles are sawn to right angles and products have been assembled square **Spirit level** – used for making sure horizontal and vertical surfaces are level **Plane** – smoothing and block are used to shave off thin layer of timber **Hand drill** – used for making holes **Spanners** – come in various sizes and used for turning a nut or bolt **Screw drivers** – straight tip and Phillips head are used for removing or driving screws **Cabinet rasps** – used for shaping, removing and refining materials **Surform (surface forming tool)** – for shaving edges and quickly removing material **Spoke shave** – used for planing curved surfaces **Nail punch** – used to drive nails into wood **Marking gauge** – used to mark out lines for cutting **Try square** – used for marking right angles in practical work **Clamps** – sash clamp, G Clamp, corner clamps, quick-grip clamp **Machine vice** – used for holding material while drilling or milling **Files come in lots of different shapes** – hand file, flat file, half round file, square file, round and triangular file **Files with a rough cut** – used for removing material **Files with a fine cut** – used for finishing (smoothing) **Chisels are used for shaping wood and metal** **Wood chisels** – bevel-edged, mortise and firmer chisels are hit with a mallet **Cold chisels** – are used on metals and are hit with a hammer **Gougers** – are chisels with grooves and are used for sculpting **Abrasive paper (sandpaper)** – is held around a foam or cork sanding block

Table 2.2 Tools, equipment and machines commonly used in the resistant materials workshop

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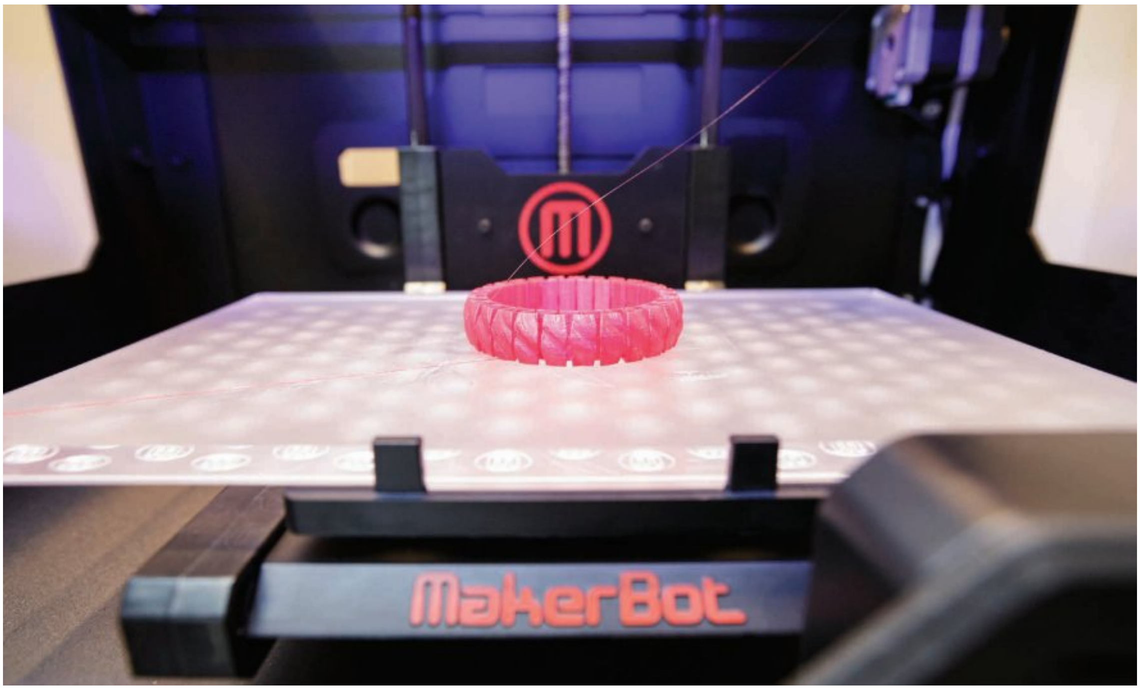

Figure 2.5 A flexible plastic bracelet printed by a 3D printer

Hand-held portable power tools and machinery

Hand-held portable power tools for general use	Machinery for general use
Electric drills – cord and cordless Jigsaw – cord and cordless Scroll saw	Laser cutter Computer numerical control (CNC) machine Bench polishing buffing wheel Bench or pedestal drill
Working with plastics – hand-held portable power tools	**Working with plastics – machinery**
Strip heater/line bender	3D printer Vacuum former
Working with wood – hand-held portable power tools	**Working with wood – machinery**
Wood – carving tools Electric sanders – belt, palm, orbital finishing sander and random-orbit sander Veneer trimmer Domino jointer Biscuit joiner Router – router bits fitted with ball bearing pilots Mortising machine	Belt and disc sander Disc sander Drum sander Dowelling machine/horizontal borer Sliding router table Wood lathe Mitre saw
Working with metal – portable power tools	**Working with metal – machinery**
Metal inert gas (MIG) welder Arc welder Oxyacetylene welder Spot welder Metal/tube bender Angle grinder	CNC milling machine CNC lathe Manual bending machine Centre lathe

Table 2.3 Hand-held portable power tools and machinery

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ACTIVITY 2.1

Discuss with your teacher and other students in the class possible tools, equipment and machines you will need to use to complete your Unit 1 product. Make a list of the tools, equipment and machines that are required for the production steps in your scheduled production plan.

ACTIVITY 2.2

If there are any tools, equipment and machines you are not familiar with, make notes on how to safely and correctly use what is available to you in your workshop. If you are still not confident with how to use something, ask your teacher for another demonstration.

- **Complete the tools, equipment and machines activities for resistant materials and non-resistant materials on pages 69–77 of the workbook, Activities 2.1a and 2.1b.**
- **Complete the resistant materials measuring quiz on page 21 of the workbook, Activity 0.10.**

2.2 Role of marking out, cutting, shaping, joining and finishing procedures used to determine appropriate, efficient and effective production processes to make a product

The production process has many aspects that you need to consider and stages you need to work through. Not thinking through suitable production steps to ensure a quality product at the end can lead to disastrous outcomes. There are many processes you will complete during the production stage. Before making your redeveloped product or prototype, you will need to look at and select efficient and effective production processes that are achievable within the facilities you have available to you.

The previous activities you undertook required you to research and select appropriate tools, equipment, machines, materials and production processes. The completion of these activities will support you in the production phase of your work.

Now it is time to look at your brief and ask yourself the following questions:

1. What is the expected quality of this redeveloped product?
2. How much time have I got to complete the product?
3. What will be the hardest part of production?
4. What will take the longest time?

Below are some basic marking out, cutting, shaping, joining and finishing procedures you will follow to complete your resistant materials and non-resistant materials product or prototype. As you make your product or prototype, you will use a combination of different production processes throughout the production stage.

Refer to Chapter 1 for a detailed example of this process for resistant and non-resistant materials.

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Resistant materials

Basic marking, cutting, shaping, joining and finishing procedures for a resistant materials product

Measuring	Refer to working drawings for measurements or measured template/mock-up/prototype
Marking out	Mark out measurements from working drawing/s onto selected materials
Cutting	Cutting template/mock-up or materials for a product
Shaping	Shape selected materials, prototype, parts or components as required
Joining	Use selected joining methods to attach parts or components of a product
Finishing	Apply selected finishes to the surface of the products/parts/components for aesthetic value

Table 2.4 Example of production processes for resistant materials

marking out
measuring the selected materials with reference to the working drawing/pattern

cutting
to cut out pieces from a larger fabric or material ready for assembly

shaping
altering the shape of a material or parts

joining
connecting material or parts together

finishing
completing the product to aesthetically achieve the look required by the client or end-user/s

Non-resistant materials

Basic marking, cutting, shaping, joining and finishing procedures for a textile product

Measuring	• Measuring your end-user/s with a measuring tape • Altering pattern pieces • Making a toile • Measuring seam allowance
Marking	• Using tailor's chalk to mark fabric Basting or tacking
Cutting	• Cutting pattern pieces out • Cutting fabric
Shaping	• Adding darts to fit the end-user/s • Pleating • Gathering
Joining	• Seaming
Finishing	• Pressing/ironing fabric • Hemming the edges • Buttons • Zippers

Table 2.5 Example of production processes for non-resistant materials

basting or tacking
large stitches used to hold fabric together before sewing

Properties of selected materials and selected production processes

When choosing certain processes for the production of your resistant materials or non-resistant materials product or prototype, have a look at the production processes you selected to work through and the material samples you completed in Chapter 1.

The properties of the materials you previously researched should have helped you select suitable production processes. This informed approach should ensure that your product or prototype will demonstrate quality on its completion.

It is a good idea to revisit the testing and trialling of materials and their properties if you are not certain of some of your findings, as the properties of the material could limit the procedures. For example, a cotton fabric may be easy to cut out but may need extra attention in the finishing stage to ensure that all creases are removed, or drilling numerous holes in a sheet of acrylic could prove challenging and may require a jig to be constructed first.

Ask questions like those listed in Table 2.6 to gain a better understanding of a material's suitability.

The answers to these questions will guide you to choose the correct procedure. Some procedures will not work on different fabric or materials.

Resistant materials – acrylic	Non-resistant materials
1 What is the name of the material you wish to use? 2 Is the acrylic opaque or translucent? 3 Does the material chip or scratch easily? 4 What is a suitable thickness? 5 Is the acrylic flexible?	1 What is the name of the fabric you wish to use? 2 Is the fabric woven or non-woven? 3 Is the fabric light, medium or heavy weight? 4 Does the fabric tear easily? 5 Does the fabric fray or crease easily?

Table 2.6 Questions to determine a material's suitability

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Refer to Activities 2.3 and 2.4 and complete further research to ensure that you select suitable production processes and know how to undertake them efficiently, accurately and safely.

It is helpful to be aware that some procedures are simple but may not give the finish that you want for your product, while some are so complex the time to create them is not viable to the given time frame.

Non-resistant materials

Use the information below as a starting point for your research in procedures. Joining fabric is the most basic aspect of garment making. When researching different types of procedures, remember to look at how quality measures can be used in the process. Noting how to complete the process and procedure correctly will increase the product quality.

Joining fabric – seams

The process of seaming fabric is a basic functional element of all textile products. It is joining fabric together to create the finished garment.

Basic seam finishes

A seam can then be finished off by using methods to stop the fabric from fraying by neatening the raw edges. Finishing a seam is not required to produce a functioning product but it can improve the quality of the garment. It may also make the garment more comfortable for the end-user/s to wear.

Adding quality finishes – removing seam bulk and finishing seams

When producing a product, the seam allowance may add extra fabric between the seams, leading to a bulky looking product. Removing the extra fabric from the seam allowance will create a product that looks to be of higher quality. Depending on the fabric, you may need to use different types of seam bulk removal. Some techniques include **trimming**, **clipping**, **notching**, **corner removal** and **under-stitching**.

ACTIVITY 2.3

1 What are quality measures?
2 How do material properties affect the choice of production processes?
3 How do material properties limit the production procedures available?

ACTIVITY 2.4

Make a list of possible **quality measures** that might be suitable during the production phase of your Unit 1 product.

- **Complete the tools, equipment and machines activities on pages 69–77 of the workbook, Activities 2.1a and 2.1b.**
- **Complete the production process activity on pages 81–3 of the workbook, Activity 2.3 (a, b).**
- **Complete the resistant materials methods of joining activity on page 79 of the workbook, Activity 2.2.**

trimming removal of some of the seam allowance to reduce seam bulk

clipping removal of some of the seam allowance to reduce seam bulk in a curve of fabric

notching removing parts of the seam allowance as a guide in fabric construction

corner removal removing part of the seam allowance to reduce seam bulk in a corner

under-stitching helps the lining or facings to remain unseen in a garment; the seam allowance is sewn to the facing or lining close to the seam

quality measures ensure that the product is of the highest quality possible

2.3 Processes applicable to selected materials

You will work through a range of production processes to complete your product or prototype; each will have a differing range of difficulty. Processes in production of a product can be decorative, functional or both.

Functional and decorative processes

Functional processes will help the product to function as intended on its completion.
Decorative processes will add to the visual

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aesthetic of the product. The look of a product can be at the same level of importance as the function for some end-user/s. Studies have shown that if a product is aesthetically pleasing to the end-user/s, the end-user/s will rate the product to function better than a similar product (D Norman, *Emotional Design*, Basic Books, New York, 2004).

Many production processes may be applicable for the materials you select and achieve the same desired result, though some may be more **efficient** and/or **effective** than others. Trialling and testing processes will help you to make better decisions and your time won't be wasted on production processes that are not as efficient and/or effective as others. Complete small trials to find out the time taken and practise your skills. Also remember to note the trials and testing processes that were more difficult and time-consuming. This will help with your production timeline.

efficient completing a task quickly with minimal waste of time and materials

effective completing a task to the desired result

Tables 2.7 and 2.8 list some of the production processes you may wish to research further to find the most appropriate production processes for your product. The more detailed your research is on production processes, the more opportunity you give yourself for producing a quality product. This detailed research can be used as a reference point when you need to complete your quality measures.

Properties of materials

Resistant and non-resistant materials

The properties of different materials you choose may limit the production processes that are possible, so completing various trials of production is necessary. You might discover your main choice of production process is too time-consuming or another production process will produce a quality part, component or whole product. If you don't use all the processes that you trial – remember to keep a record of your findings. When choosing to use a material you have already trialled, you save production time as you won't have to undertake this testing again.

The more you trial and explore processes, the more your understanding of the limitations of materials and processes will increase.

The production processes that are required for each material can be different, depending on:

- the material components and properties
- where the product will be used
- the quality of the product
- the type of product
- care requirements of the product.

There are many production processes you can undertake according to the materials you select. Keeping in mind that Unit 1 is about redeveloping a product or producing a prototype that considers sustainability, it is important that you select materials and production processes that are suitable.

It is advisable that you consult with your teacher on the materials and production processes achievable in your school's resistant materials workshop or non-resistant materials classroom if you have not as yet undertaken the activity listed on the previous page. Choosing materials that show you are considering the environment in some way might involve researching the origins of the materials.

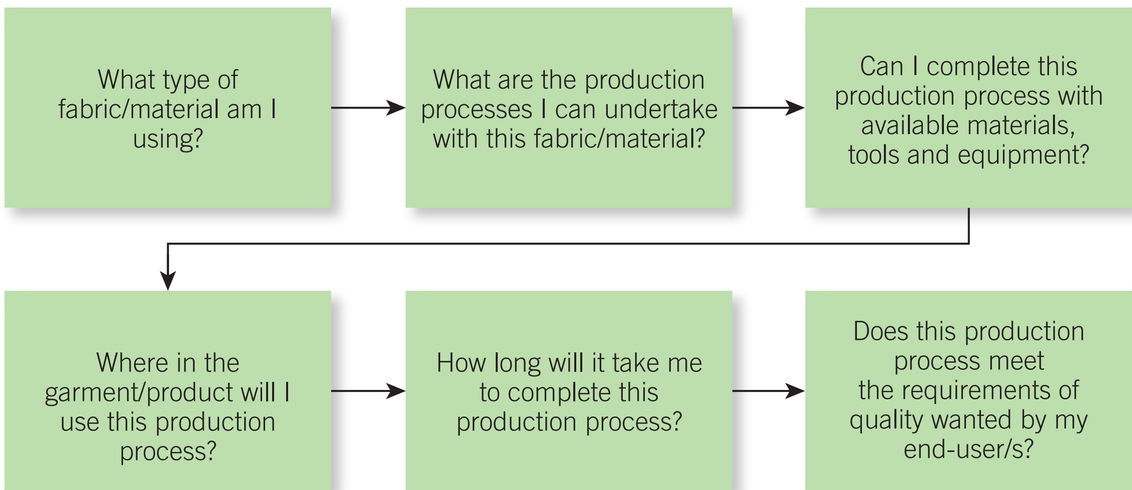

Figure 2.6 A general guide on how to choose a process

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Tables 2.7 and 2.8 contain a range of materials and suitable production processes that can be applied when working with resistant materials and non-resistant materials.

In Units 1 and 2, you can incorporate one or more materials from category 1 or 2 in your product design.

Production processes – resistant materials

Materials	Suitable production processes
Category 1 **Wood/timber** **Softwood** – most softwood trees are coniferous or cone-bearing trees and have needle-like leaves (for example, a pine tree). Softwood trees grow quickly and reach maturity around 30 years. This is why softwood is cheap to buy. **Hardwood** – most hardwood trees are deciduous and have broad leaves (for example, elm trees). Hardwood trees grow slowly and reach maturity around 100 years. This is why hardwood is expensive to buy. **Manufactured/composite boards** **Plywood** – is very strong, yet light and easy to work with and a sustainable material	Wood can be hand carved/worked with a variety of hand tools, including saws, chisels, rasps and files **Wood joints used for specific products** **Butt joint** – a quick and simple joint **Mitred joint** – is cut on an angle and is usually used for picture/mirror frames **Dowel joint** – uses a dowel, which is a wooden or plastic peg that fits into aligned holes to reinforce the joint **Mortise and tenon** – this is very strong and used in table and chair construction **Lap joint** – has a larger surface area for gluing than a butt joint and makes it slightly stronger **Halving joint** – has a similar strength to a lap joint **Dovetail joint** – is usually used in drawer construction and is very strong **Kerfing** – used for plywood products, involves cutting a series of kerfs (cuts) in a piece of wood in close proximity, so the wood can be curved **Veneering** – involves a variety of thin sheets of wood glued to manufactured/composite boards; products include tabletops and part of furniture **Lathe** – used for candle holders, chair legs **CNC machine** – can be used to mill parts of a product or make furniture, decorative ornaments and plaques
Plastics **Thermoplastic polymers** – recyclable and flexible, and are formed easily into shapes. The material has a plastic memory because a moulded shape can be reheated back to its original state. **Thermosetting polymers** – non-recyclable (not flexible) and cannot be reheated once formed	**Vacuum forming** – a pattern or mould is made of the product or part and vacuum formed. Products that can be designed and produced using vacuum forming include bowls, carved objects, parts for a product. **Strip heating/line bender** – products made from this machine include stands for electronic products, picture frames, display stands **CNC machine** – can be used to mill parts of a product or make furniture, decorative ornaments and plaques **Laser cutter** – uses a laser to cut materials. Products include jewellery, flat-pack furniture. **3D printing** – involves producing product parts or small products (in school workshops) by adding drop by drop or layer by layer material. Jewellery, moulds, containers and chess pieces are some examples. **3D rapid prototyping** – involves producing a product part that is not meant for surface application but is a mock-up (prototype) **Plastic pop rivets** – lamp shades

(Continued)

Table 2.7 Some production processes for resistant materials

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Materials	Suitable production processes
Metals **Ferrous metals** – contain iron; for example, mild steel, high-carbon steel and stainless steel **Non-ferrous metals** – don't contain iron; for example, aluminium, brass and copper **Alloys** – an alloy is a mixture of two or more metals and can be ferrous or non-ferrous	**Arc, MIG, oxyacetylene welding** – furniture pieces/bases and garden ornaments **Soft metal shaping sheet metal folder** – shaping sheet metals such as aluminium by folding parts and joining them using rivets or soldering Pop rivets for metal
Textiles/yarns/fibres/fabrics Natural Blended Synthetic	Knitting, felting or weaving fabric to make textile products Machine and hand sewing to make garments or textile products
Category 2 **Ceramics** Porcelain, terracotta, cement	Kiln-fired products include kitchenware, decorative ornaments, picture frames, jewellery Cement – tables/chairs/stools, garden ornaments and pots
Glass Lead glass (crystal), soda lime, borosilicate	Tabletops, shelving, decorative ornaments and jewellery

Table 2.7 Some production processes for resistant materials *(continued from previous page)*

Production processes – non-resistant materials

Boning	Boning helps the garment keep its shape.
Buttonhole making (sewing machine-made or hand-sewn buttonhole)	Buttonholes create a secure hole in the garment for a button to pass through. This allows for the button to be able to secure two pieces of fabric together.
Collar	A collar is part of the garment that frames or fastens around the neck.
Cuff	A cuff is the fabric at the edge of the sleeve covering the wrist. It stops the sleeve fabric from fraying.
Dart	Darts are used to provide shape to a garment with a tuck coming to a point.
Fasteners (buttons/snap fasteners/ Velcro/hook and eyes)	Fasteners are used to secure two pieces of a garment/product together.
Gathering	Gathering shortens a piece of fabric so it could be joined to a larger piece of fabric.
Hemming Blind Narrow Overlock rolled Rolled Slip stitch Top stitch	**Hemming** is used to prevent the fabric unravelling. Many different types of hems can be made with sewing, overlocker and cover stitch machines.
Piping	Piping is a trim or embellishment made of a folded strip of fabric that forms a 'pipe' and is sewn into the seam.

(Continued)

Table 2.8 Some production processes for non-resistant materials

hemming a finishing technique of sewing the edge of the cloth to stop the fabric unravelling

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Pleating	Pleating is a permanent securing of folded fabric. There are many different types of pleating, including box, sunray and knife pleats.
Pocket making	Pockets are used in garments to allow the user to carry small objects. There are many different types of pockets, ranging from a simple patch pocket to an inseam pocket.
Sleeve insertion	Inserting a sleeve is to add fabric to cover the arm. The style of sleeve will depend on the fashion style.
Surface decoration Beading Embroidery Lace Trims	Surface decoration is used to add a decorative design element to a garment.
Tucking	Tucking is when a fold or pleat is sewn into place.
Zip insertion Centre zip Exposed zip Invisible zip Open-ended zip Single welt zip	Zippers are fasteners that are used to join two sides of a garment, de/attach pouches or parts of a garment, or could be decorative.

Table 2.8 Some production processes for non-resistant materials *(continued from previous page)*

Sustainability – resistant materials

Sustainable wood and preserving the plants, trees, forests and woodlands is essential for our future survival.

Currently only 8% of the world's forests are properly protected from being destroyed. Sustainably managed forests produce sustainable wood, and this wood is renewable because the forest landscape is managed with a long-term rather than a short-term outlook of the resource in a way that prevents damage to ecosystems, wildlife and the trees themselves. This long-term outlook means the plants, trees, forests and woodlands should still be here for future generations.

Here are two sustainable woods you could consider using:

- Bamboo is sustainable, depending on its origin. It is harvested in 3–4 years and grows extremely quickly (making it sustainable) in countries such as Australia, Asia and the Americas. It is a very versatile material and has many uses, from furniture and scaffolding to flooring and fences.
- Radiata pine is grown as a plantation timber in Tasmania and is usually harvested after 35 years. It is certified under the Australian Certified Forest Scheme. This means it is sourced and processed from a certified native forest and plantation that is sustainably managed.

For more information on wood and sustainability, refer to the Forest Stewardship Council. The Forest Stewardship Council (FSC) is a worldwide organisation. Its goal is to take care of our forests while allowing us to continue to use forest products in manufacturing.

Figure 2.7 A truck loaded with pine logs being transported out of the plantation for processing, Toolara State Forest, Sunshine Coast, Queensland, Australia

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Sustainability – non-resistant materials

Figure 2.8 A tractor used to harvest the cotton from the fields, Campo Grande, Mato Grosso, Brazil, 2014

It is important to think about where you are sourcing your fabrics from. Cotton's environmental issues relate to water consumption, polyester fabrics are sourced from crude oil, and there are concerns with the disposal of fabrics. Each fabric has its own impacts on the environment, and it is your role as a designer to understand those impacts and choose which fabric will be best for the given situation.

Are you going to reuse old garments or repurpose some fabrics that have been sitting in your sewing room for many years? Before starting, remember to ask if you can use the garment/fabric. Blended fabrics (for example, polycotton) are harder to repurpose than 100% cotton fabric.

If you cannot use a preferred fabric, clearly state which fabric you wish to use when the final product is completed.

Resistant materials – get to know these words

Materials	Production processes
Material characteristics	Butt joint
Material properties	Mitred joint
Softwood/hardwood	Dowel joint
Manufactured/composite boards	Mortise and tenon
Thermoplastic	Halving joint
Thermosetting plastic	Dovetail joint
Ferrous metals	Kerfing
Non-ferrous metals	Veneering
Alloys	Lathe
Ceramics	CNC machine
	Vacuum forming
	Strip heater/line bender
	Laser cutter
	3D printing
	Welding – arc, MIG, oxyacetylene
	Soft metal shaping

Non-resistant materials – get to know these words

Materials	Production processes
Natural fibres	Boning
Blended fibres	Darts
Synthetic fibres	Gathering
	Buttonhole
	Fasteners
	Collar
	Cuff
	Piping
	Pleating
	Pocket making
	Sleeve insertion
	Surface decoration
	Zip insertion
	Hemming

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ACTIVITY 2.5

Discuss possible materials and production processes you will need to complete your Unit 1 product with your teacher and other students in the class. Use the list and notes you created in Activities 2.1 and 2.2 (tools, equipment and machinery) to research suitable production processes with suitable materials and their properties.

ACTIVITY 2.6

Select a range of materials you researched and production processes and complete some production samples.

2.4 Risk management for safe, accurate and efficient application of production processes

During your production, you will be using the knowledge that you have gained regarding material properties, production processes and finishing procedures. This knowledge will be combined with your understanding of how to use the selected tools, equipment and machines safely as listed in your risk assessment. Careful planning is essential when creating a product safely, as using the resources within a resistant materials workshop or non-resistant materials classroom does come with some risk. Some **hazards** and risks are low, but others could cause serious injury.

Throughout the planning and production stage, you will need to demonstrate an understanding of the safe use of different tools, equipment and machines. You can show this in the production record of your folio or electronic folio, digitally in the form of a photo or video, and your teacher will observe you using the tools, equipment and machines independently.

If you are unsure of how to use a piece of machinery or how to complete a production process, it is vital that you inform your teacher, who can demonstrate the correct safety procedures. Your teacher may have set rules and safety expectations of how each tool, equipment or machine must be used.

Risk management in the workshop – resistant materials

The workshop can be a hazardous place and it is important you know the risks involved when working with various tools, equipment and machines and how to use what you have available to you as accurately and efficiently as possible.

hazard
a production process, tool or machine that could cause injury

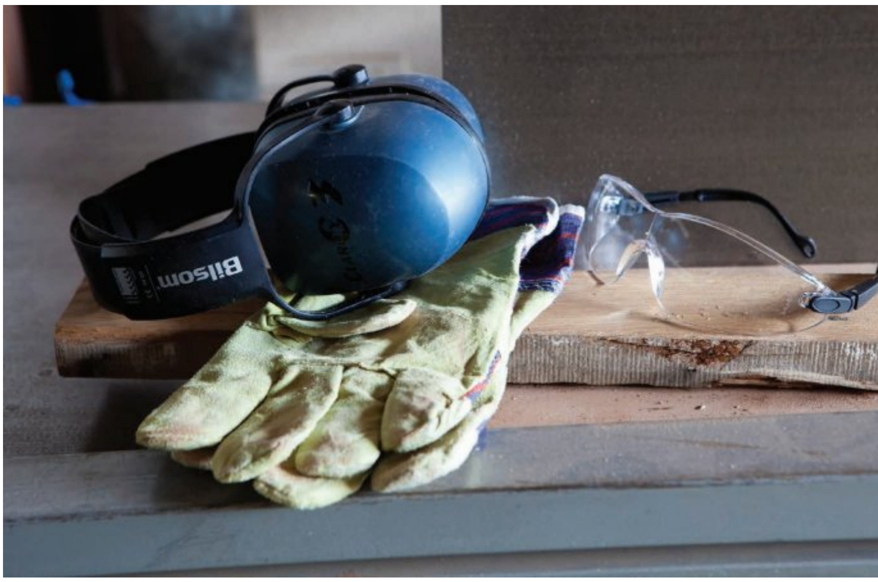

Figure 2.9 Safety earmuffs, safety glasses and protective gloves

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risk management following a process of working to recognise and control risk

Smart preparation and **risk management** involves identifying the potential hazards and minimising the risks you might encounter in the workshop before beginning production. This will help in the overall success of your work. You will be able to choose tools, equipment and machines for specific purposes with more confidence knowing what they can do (efficiency), how to use them (accuracy) and any potential risks you could encounter.

Personal protective equipment (PPE) worn in the workshop and how to use particular tools and machinery correctly when working with wood, metals and plastics

What to wear

- Wear appropriate clothing, such as an apron or smock, and roll long sleeves back.
- Tuck in your school tie.
- Tie long hair back.
- Wear goggles or a face shield when necessary.
- Wear a disposable respirator for vapours or dust.
- Wear leather gloves to protect your hands when working with sharp or hot materials.
- Wear earmuffs when necessary.

Working with machines and portable power tools safely

Activity 2.5 asked you to consider tools, equipment and machines you might use for particular production processes, make a list and research the ones you are not familiar with. This will better prepare you to undertake a risk assessment.

Machines

- If a machine has a safety guard, you must use it.
- Know where the off button and emergency stop are located on the machine.
- Secure any work with clamps/vice as required.
- Make sure separate machine parts are secured properly.

Portable power tools

- Secure your work with clamps/vice as required.
- Make sure the power cord is behind you.
- Work in a well-ventilated area if dust or vapours are present.

For hazards in the non-resistant materials classroom and resistant materials workshop, refer to Chapter 1.

ACTIVITY 2.7

Using the work completed for previous activities, discuss with your teacher and other students in the class how you can demonstrate safe working practices in the non-resistant materials classroom or resistant materials workshop to produce your garment or product. Jot down important points you have not considered.

ACTIVITY 2.8

Chapter 1 of the workbook provides examples of how to create a risk assessment. Using this information and information gathered in Activities 2.1–2.6, create a risk assessment for the production of your Unit 1 garment or product.

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2.5 Digital and manual techniques to manage and record production processes and progress

Recording

Recording your progress during production is a crucial part in the planning and production stage of the product design process. It will help you keep on track with your production and is a vital resource during the evaluation stage. A record of your production processes and progress can be created in a digital or manual format. Everyone has their own personal preference, and your teacher may request that you develop a journal to record your production processes and progress in a specified way. Have a discussion with your teacher on how they wish you to complete your production record. Below are some examples of how to record your progress during production.

Use a notebook

At the end of every lesson, pack up two minutes earlier and fill in the table (a link to the table can be found in the workbook). It might seem a bit of a hassle to complete it every lesson, but you will be thanking yourself at the evaluation stage for having made detailed notes. Place as much detail as you can into the table.

Word document

Use the downloadable table and save the document to your computer. Save your document with a clear name and save it in a folder. If you are worried about your computer reliability, always save a backup version on a USB flash drive or portable hard drive. You can also save your work using cloud services such as OneDrive, Dropbox or iCloud.

Email

Set up an email address. Make it an email that is not used for anything else, so you can easily trace the emails. At the end of every lesson, send an email to that address with any information and pictures. When you have completed the project, you will have a clearly dated record with pictures. It is as simple as printing out all the emails and placing them into your folio.

Online document

This is a great way of always having access to your file on any digital device that is connected to the internet. Having an online document means that you can quickly make a note, upload a photo and, when you have completed the project, print it all out at once or place the document in your digital folio.

Blog or video blog

Set up a **blog** online. There are many free blogging sites that are user-friendly, with all the coding already done. All you will need to do is upload a photo and some text. With an online blog, your end-user/s can be kept up to date on the progress of the product. You can ask for feedback and receive comments about the planning and production stages you are completing or, if you need help in modification, you can send a link to show what you have completed so far. At the end of the blog, you can simply print out the posts and place them into your folio, or if you have a digital folio, place the videos/photos/text generated in your digital folio.

blog
a website or web page written in a conversational style, usually by a person or small group of people

Creating a **video blog** (also know as a vlog) is an easy way to record your progress. Create a 30-second video of you talking about what you completed that lesson or record yourself completing processes. You can even record interviews with your end-user/s when you are discussing modifications. A video can show more detail than written words can and can be an effective way to record your work. You might even decide to use audio instead of video.

video blog
a form of web television, often referred to as a vlog, where entries are usually an embedded video or video link with supporting text and images

These are just some methods to record your production process, but the most important part is for you to create a record *every time* you work on your product. It is easy to start recording your process but then get absorbed in the production and forget to create a record.

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While at the time, we may think we can remember everything we have completed, it is hard to remember all the little things that happened many weeks ago. For example, do you remember what you had for breakfast three weeks ago on Monday? Probably not.

If you have forgotten to complete a record straight away, record as much information (dates, processes and so on) as you can remember and try to keep up to date from that point forward. The important thing to remember during production is consistency. If you keep up to date, it will make the evaluation stage easier to complete.

When you are recording your production process, remember to write down all aspects of the production. Some production processes may take many lessons to complete. Create a new record every time you start working on your product, even if it is 10 minutes. As designers, we need to think about the whole time taken to produce the product, and 10 minutes over several days can add up to an hour of work very quickly.

ACTIVITY 2.9

1 Why should a designer keep a production record?
2 What should be included in a production record?

ACTIVITY 2.10

Refer to page 63 of the workbook and format a production record that will work well for you. It needs to be something you can access and add to quickly and effectively with all the important details.

2.6 Methods of evaluating a redeveloped product: matching of the product to the requirements of the design brief

In this unit, you have produced a redeveloped product to meet the needs of an end-user/s. Once the redeveloped product is completed, it is time to evaluate how successfully it solves the design problem stated in the brief. In industry, product development does not finish when the product is completed because products are continually evolving. A product may solve one problem, but then another problem may need improvement or there might be a change in the end-user/s' expectations. A product will then need to be designed to meet those requirements.

Our dream as designers is to design a product that will fit all the end-user/s' requirements. We do this by developing a design brief that stipulates the requirements our product has to meet. We then evaluate the product to make sure it will meet the design brief. The end-user/s may provide positive feedback via the designs you complete, but it is important to remember that ideas might look great on paper but might not function as intended once transformed into a product. As a designer, you might see this as failure, but all the product might need is some modification to better meet the needs and wants of the end-user/s.

Improvements in a product can be large or small, and ensuring that improvements are made means your product will improve the overall quality of the end-user/s' life in some way. There are many ways you can judge the success of the product and whether it meets the requirements of the brief. It is important

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to reference the product design factors and their parameters to help you focus on and be more critical of your product.

Comparing the original product to the redeveloped product

You can determine the success of your redeveloped product compared to the original in the following way.

If possible, place the original and redeveloped product next to each other. If you don't have the original product in front of you, use the information from your research of the product in Unit 1. A product can be compared in many ways, from how it looks to how well it functions.

You can compare the redeveloped product to the original product yourself, but also ask your end-user/s, classmates and your teacher to compare them. The more feedback you can obtain, the more information you will have to include in your evaluation.

Look at the product design factors and the requirements of the design brief. Use these to structure simple questions that you or others can answer about the redeveloped product.

Here are a few questions based on product design factors and their parameters to get you started:

- Is it more sustainable?
- Does it look better?
- Has its quality improved?
- Does it function better?
- Is it easier to use?
- Does it cost more to make?
- Is it durable?

Scenario testing

Once the product is redeveloped, it might be more aesthetically appealing or have improved functions, but the real test is to see how well it meets the end-user/s' needs or wants.

By creating a checklist of the important product design factors identified in the design brief, you can get a better idea of how successful your redeveloped product is.

Here are a few questions based on some product design factors and their parameters to get you started:

1. Does the product fit in the area that it has been designed for?
2. Does the product function as it should?
3. Can the product be used safely in this scenario?
4. Can the end-user/s use the product correctly?
5. Do the product's aesthetics match the surrounding environment?

Write down your thoughts and observations from the set list of questions. Your observations might reveal issues or provide answers that you may have not thought about and there might be questions that arise that you had not considered. Talk through your findings and write everything down.

TIPS

Use criteria to compare features of your redeveloped product with the original as well as suggest improvements and respond to evaluation criteria.

User trials and product useability

A product may look great and tick all the boxes of the brief, but the real test is when an end-user/s uses the product. Ergonomic issues may arise if you have not thought through all aspects of the product. For example, the product may be too heavy to move by one person or holding the product may not be comfortable.

Create a score card for the end-user/s to rank how easy to use they believe the product is. Ask the end-user/s to use the product in the correct scenario (see scenario testing), then ask them to rank their experiences. Ranking can be done by numbers: 1 being very low and 10 being very high. Further information can be supplied by asking the end-user/s to explain why they ranked it a certain number. This can be done in a formal context (questionnaire) or informal (conversation that is taped.) All feedback from the end-user/s is useful.

Here are a few questions based upon product design factors and their parameters to get you started:

1. Was the product easy to use?
2. Would you use this product again?
3. Do you find this product aesthetically pleasing?

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Figure 2.10 A European Union consumer affairs commissioner answers media questions as she holds a press conference on dangerous consumer goods at the European Union headquarters in Brussels, 2009

Observing the end-user/s using the product is another way of gaining feedback, as you may notice something the end-user/s may miss or not see as important.

Safety testing

Safety is vital in product design. You may not be selling your redeveloped product in Unit 1, but you need to evaluate how you have made the product safe for your end-user/s.

An important question to ask yourself as a designer is: 'Have I made my redeveloped product safer than the original product?'

Ways to check your product's level of safety

1 Check with your end-user/s, classmates or teacher ways the product could be used correctly and incorrectly. How does your product meet its safety needs and what aspects are not safe? What modifications might need to be made to the redeveloped product to improve its safety?

2 What are the Australian Standards that are related to your product and how have you met those requirements?

Evaluation is a vital step in the design process. Evaluation of products can be done by the designer or the end-user/s. Gaining feedback about your product from a large range of people will ensure that you get a broad idea of how successfully the product meets the end-user/s' needs and wants stipulated in the design brief.

ACTIVITY 2.11

Use a qualitative approach and develop open questions derived from your design brief that you can ask respondents (your teacher, classmates, client or end-user/s) about your completed redeveloped product. Use the information from this activity to complete an analysis of your product or prototype in relation to the requirements of the design brief, consideration or constraints.

ACTIVITY 2.12

Using the example provided, complete an evaluation of your Unit 1 product or prototype. Refer to the workbook to help you undertake this task.

Complete the product comparison on page 84 of the workbook, Activity 2.4.

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Chapter summary

- Tools, equipment and machines must be selected specific to the task.
- Risk management is crucial for safe, accurate and efficient application of the redeveloped product.
- Digital and manual techniques can be used to record production processes and progress.
- You must compare the original product to the redeveloped one to evaluate its improvements.
- The evaluation criteria provide a structure to assess how well the redeveloped product meets the brief, including its sustainability.

Short-answer questions

1. Explain why it is important to regularly update your production record after each class.
2. List three ways you could compare your product to the original.
3. List a problem that may occur during production if your working drawings are not clear.
4. Describe two ways you could evaluate the suitability and accuracy of the production processes used in your redeveloped product.
5. List three ways you could manage trip hazards in your classroom or workshop.

Extended-response questions

1. You are producing a chair or dress. List three tools you are going to use in the production of this product and describe why they are suitable.
2. You are going to work with silk or acrylic sheet. Describe the extra care you must take with these materials during production.

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Unit 2
Collaborative design

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Figure 3.1 Working collaboratively happens in many different situations

3 Area of Study 1: Designing within a team

INTRODUCTION

This area of study requires you to follow the steps in each of the stages of the product design process and collaboratively produce a product or range of products for an end-user/s. This unit will give you an insight into team work and working with others. It will also provide information on the importance of researching historical contexts and how they can influence design.

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KEY KNOWLEDGE

- the role and application of the product design process to achieve a product within a collaborative environment
- user-centred design factors and how they influence the design of products
- historical and contemporary design movements, cultures or styles and how they can inspire new product designs
- economic, environmental and social issues of sustainability related to design
- critical and creative design thinking techniques, building on chapter 1
- the purpose of feedback to inform the selection and justification of viable design solutions
- methods of construction used to determine appropriate, efficient and effective production processes to make a product
- the role of scheduled production plans for collaborative work:
  - timeline
  - steps needed for production
  - materials and equipment list
  - risk management for safe, efficient and accurate production of a product
  - quality measures
  - estimated time needed for each step.

KEY SKILLS

- identify and allocate responsibilities within the team to conduct and share research
- investigate an historical or a contemporary cultural design movement or style
- research a design problem collaboratively using primary and secondary resources, and develop a design brief with relevant application of product design factors
- use digital technologies appropriately to support collaboration in the product design process
- present research and ideas using test reports, image/mood boards, material and product samples, diagrams, charts and/or drawings
- generate and select ideas using creative and critical design thinking techniques
- explain product functions and/or requirements, materials and construction methods using annotations in visualisations, design options and working drawings
- develop and use criteria, including those to evaluate product sustainability, and devise methods to check how the finished product will meet each criterion
- justify selection of materials based on their suitability and sustainability
- implement the design and development stage of the product design process using digital technologies, as appropriate
- provide critical and constructive feedback and justify preferred option selection
- devise a scheduled production plan with reference to working drawings.

3.1 The role and application of the product design process to create a product within a collaborative environment

Unit 2 is about collaborative design and allows you to work through the product design process where your team works together or individually through particular steps in the stages. Working collaboratively with people is not always easy, but it is the usual way of working as a designer once you enter the workforce.

Working collaboratively means the skills of each individual can be brought together to create successful **products**. In the design world, a product designer will not be an expert in all stages of the product design process but should work with other experts and rely on their expertise.

Be a clear and precise communicator with others in your team; it will help greatly with getting work done efficiently. Stay positive throughout the process. Always remain open to other people's ideas, even if you don't agree with them. Teamwork relies on open minds and positive attitudes.

Ways to work collaboratively

- Individually making a component of the team's one product, such as an outdoor garden table.
- Making a part of each product from the team's product range.
- Designing individual products with the same theme, such as a pyjama collection with the same theme, colours and fabrics.
- Utilising the strengths of the design team, allowing each group member to perform specific tasks. For example, one group member cuts out materials, and another member works on surface decoration techniques.

As a group, you also:

- have a group design brief and cohesive theme
- get influenced by design and cultural movements
- provide feedback to each other on design development
- collaborate using digital technologies.

Things to consider when working collaboratively

Those of you who studied Unit 1 will be familiar with the product design process and will have an idea of your areas of strength and areas of weakness from working through that process in Unit 1. It is a good idea to establish early on the strengths of each member in the team. Perhaps one of you is particularly skilled at technical drawing, while someone else is good at researching. Your team needs to have a discussion about the roles and expectations of each person.

product
a physical item that has been designed and made with an end-user/s in mind

- It important to make sure each person in your team shares the same expectations and overall purpose.
- Every person in your team needs to clearly understand their responsibilities within the design process.
- Make sure the members of your team check in with each other throughout the unit to ensure that each person's responsibility within the design process is on track.
- Encourage your team members to learn from each other and share their individual strengths.
- Help each other, because that's what team work is about.
- As you work through the product design process, certain steps within stages will be assessed as a team and others individually. This will be determined by your teacher.

Table 3.1 can be used as a guide to help your team decide on each person's role within the product design process.

Note: components are assembled (e.g. to build a product) but other kinds of parts are not assembled but composed (e.g. to build a product). Learn the difference between the words "assembling" and "composing".

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Deciding on the roles of individual team members

Role as part of the product design process	What needs to be achieved	How it will be achieved	Who will take on this role
Step 1 Identify the end user/s' need, problem or opportunity	• Establish the end-user/s	• Team discussion	• The whole team (four team members)
	• Discuss their need and what is to be designed and produced	• Write a design brief	• Student 1
	• Select a cultural context		• Student 2
Step 2 Outline the constraints and considerations	• Clear outline of the constraints and considerations	• Team discussion	• The whole team

Table 3.1 Deciding on a team member's role as part of the product design process

How does team work improve a product?

CASE STUDY

Robyn Murphy

Robyn Murphy started working with costumes in 2005 when she got into the hobby of cosplay. She was completely self-taught until she applied for the NIDA Bachelor of Dramatic Arts costume course in 2010, where she was professionally trained for three years. Since graduating, she has worked on productions such as *The Lion King*, *Les Misérables* and *Aladdin* and films such as the sequel to *Pacific Rim*. In her spare time, Robyn continues to make cosplay costumes of her favourite pop culture characters.

Figure 3.2 Robyn Murphy

Describe what it is like working with others to create costumes.

Working with creative people to make costumes can be both exciting and challenging. Designers can bring beautiful concepts to the page, while the costume cutter and maker have to then translate that concept to reality. It can be challenging, as the concept of the design can be quite complicated and hard to construct, so communication becomes a very important part of working with others. This also applies for a cutter when instructing the maker on how to put the costume together.

What is the best part of working with others in a team to produce a garment?

A huge asset to working with others is learning new techniques on how to create a pattern or construct a garment. Every workroom has a variety of skills and nearly every time, if not all the time, I learn something new in every workroom I've been in.

What is the most challenging aspect of working in a team?

Dealing with personalities. A good team is a positive and supportive one. When there is a challenging personality in the workroom, it can add more stress than is needed.

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Figure 3.3 Progress shots of a leather work for a cosplay costume

Give an example of how one product was made with multiple inputs.

Every single costume in any production has multiple inputs. A costume starts with the designer, which then is discussed with the cutter; from there the cutter will draft the pattern that the maker will construct. It then can be passed on to an art finisher for dyeing or breaking down. On larger productions, you can have multiple makers on the one costume. Then there are buyers on films and large productions who go out and purchase the fabrics and haberdashery. There are also associate designers who create concepts for the designer. There is never one person on a costume; it all is made in a huge team effort.

How do timelines and clear job roles help with complex projects?

It helps greatly with getting the work done on time and effectively. Although, sometimes there are delays with decisions that can majorly affect the time spent on costumes, as delays from the designer trickle down the line to the poor maker, who needs to catch up on the time lost.

How is working in a team different from working on your own personal projects?

I move at a much slower pace when I work on my own personal projects. When I am working on my own projects, it is usually with a new technique or material that I have never used before, so it's more of a learning process. For example, my current project is working with leather, which is a new medium for me that I've always been interested in.

CASE STUDY

Mutating Creatures

When designers have a shared vision and work well together through the design process steps and stages, a design business can thrive. This is exactly what has happened with a Brisbane-based design team, Dutch and German designers Michel Cornielje and Caroline Kaup. In 2012 they founded their company Mutating Creatures. The products they produce range from furniture and lighting, coffee holders and wall art to jewellery pieces such as earrings, rings and necklaces. Their primary production method is 3D printing. Both Kaup and Cornielje are committed to the environment and sustainable design thinking, using Australian hoop pine as a preferred material for their lighting and stools.

- **Select team members' roles within the product design process using the team member table on page 87 of the workbook, Activity 3.1.**
- **Complete a list of team members' names and their roles against the product design process wheel on page 90 of the workbook, Activity 3.2.**

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3.2 User-centred design factors and how they influence the design of products

want
aspects of the design that a user wants that do not relate to its primary function

useability
the ease with which the product can be used and understood by the user

An end-user wants a product that improves the quality of their lives in some way. Designers don't sketch and make the first idea that comes to mind; they know that the first step to a successful, quality product is to listen to the end-user/s' needs and wants.

Product design is about understanding the end-user/s, and empathetically creating something that is right for them. We need to understand what they want from a product, how it needs to function and look, and what they think about other similar products. A challenging and inspiring part of design is to meet the needs of the end-user/s. Designing for a large end-user group can be more complicated than designing for a single end-user because each end-user might have slightly different needs. No product will necessarily fit perfectly the requirements for every single end-user.

A true need of a product can be described as what is vital for the product to be successful/functional to do the expected task. The **want** can be what the user asks for in a product. The user may not recognise that they could be describing a want as a need. As designers, it is necessary to know the difference between them, while understanding that the need may be more important to the end-user/s than the actual **useability** of the product. A good example of this is a fast fashion garment. A person may buy a new jumper because they want to be up to date with the latest trends. The look (need) of the garment could be more important to the end-user/s than the warmth of the garment (want).

As designers, we need to think about our end-user/s throughout the product design process. Each of us has our own view of what we believe is aesthetically pleasing. It is a personal preference due to life experience with products and our own ideals.

End-users don't usually think like designers. The words they might give you as a starting point in your interview may have a different meaning for you as the designer. The personal experiences people have had with products will alter how they describe and associate with a product. Clear communication between the designer and end-user/s is key to ensuring that the investigating and defining and design and development stages of the product design process achieve a satisfactory solution to the design problem.

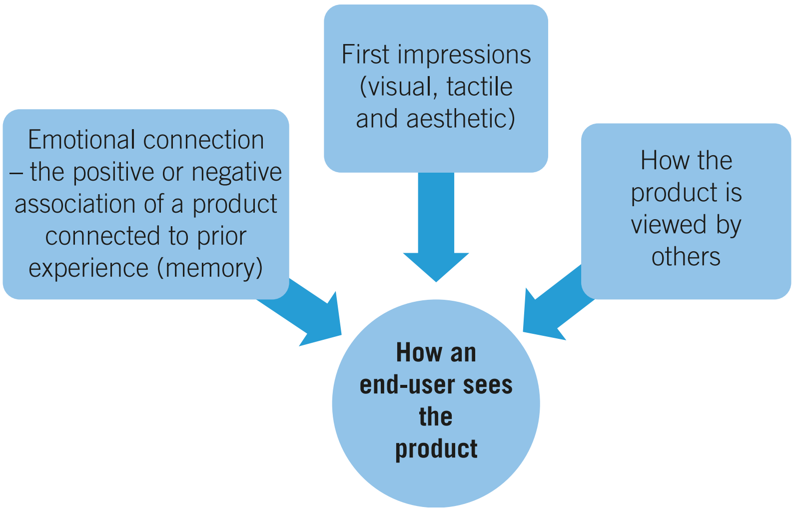

Figure 3.4 How an end-user sees a product

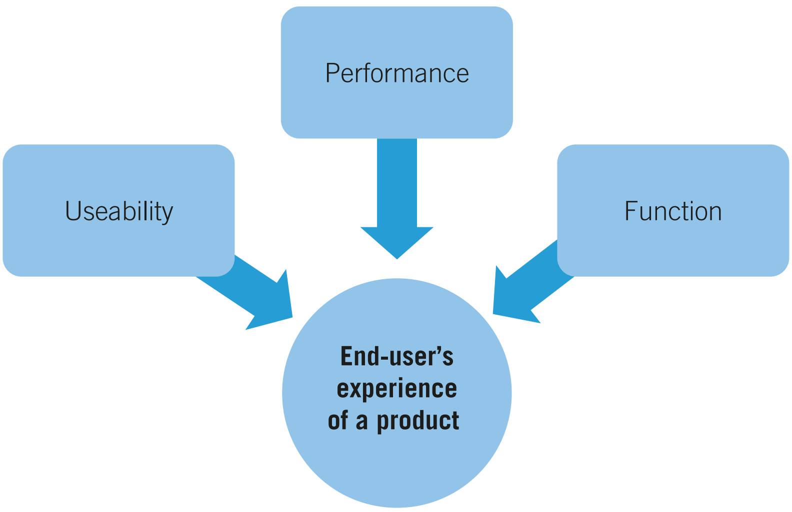

Figure 3.5 How an end-user experiences a product

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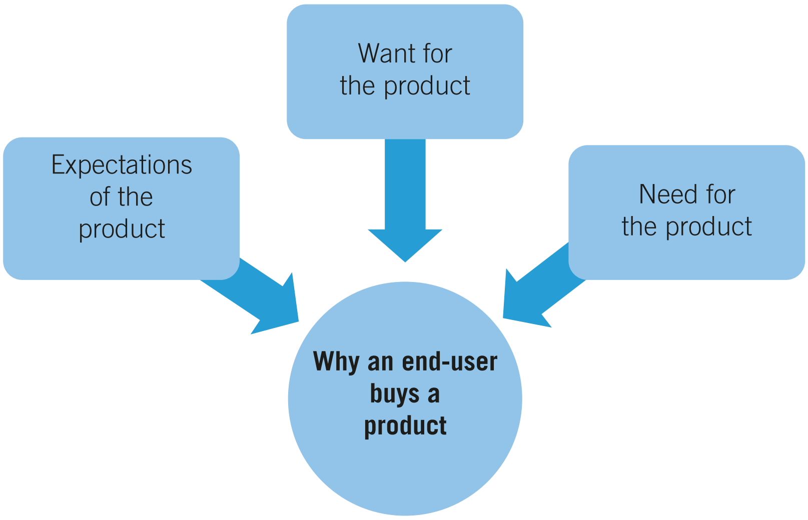

Figure 3.6 Why an end-user buys a product

Researching end-user/s

Research is vital in finding the wants/needs of the end-user/s, as it will guide the design process. Conducting research on the end-user/s could include watching them use a product, asking them to describe a product, word association, getting them to fill in a questionnaire, and many other activities.

Primary and secondary research

You can also separate your research into primary and secondary research developed from the design brief.

Primary research involves undertaking considered and prepared research that you have established from your design brief that answers specific issues or questions and could involve interviews, surveys or questionnaires. You might form a series of important questions to ask your end-user/s or undertake qualitative research. You might choose to take photos of existing similar products, objects or environments that inspire you. The research and collection of material samples and measuring and testing of them will help in the development of a quality product. Researching possible tools, equipment, machines and production processes and trialling these on samples is also part of primary research.

Secondary research involves looking at areas of information already researched by others. This might include looking at internet websites and e-books, books and magazines from your school or local library.

You can make a list of what you consider to be areas of primary research and areas of secondary research based on your design brief (considerations and constraints) and methods of undertaking this research.

Primary research	Research method
Constraint: Material – ceramic Terracotta, raku, stoneware	Material samples of each and research and testing of their characteristics and properties.
Consideration: Hand-built or formed on a pottery wheel	Trialling of both construction methods to be photographed and documented.
Secondary research	**Research method**
Constraint: Surface decoration – tropical theme	Refer to paintings by Henri Rousseau in the school library and on the internet.

Table 3.2 Example of primary and secondary research for a terracotta garden pot

Figure 3.7 Clay pots being painted

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ACTIVITY 3.1

1 Plan your team's roles and responsibilities for this unit according to each team member's strengths.
2 As a team, create a mind map or use another creative thinking technique to explore the situation or context of the end-user/s and the product or prototype to be produced.
3 Undertake qualitative and/or quantitative research.

- **Complete the primary and secondary research task on page 92 of the workbook, Activity 3.3.**
- **Complete the activity on how to identify the influence of historical and contemporary design movements, culture/s and styles in a product's design on page 94 of the workbook, Activity 3.4.**

3.3 Historical and contemporary design movements, cultures or styles and how they can inspire new product designs

A design movement or style is formed when designers have a shared philosophy and want to promote this philosophy through their design work. A design movement or style will last for a period of time and eventually evolve into another movement or style. This change could be driven by a number of factors.

Contemporary design has been influenced by the search for and implementation of new materials and technologies due to innovations in manufacturing.

When starting your research into a style or movement, investigate the following:

- Find out what was new at that time in manufacturing and technology, as it may have influenced the movement or designer.
- Research the movement or style that occurred before, as some designers could have reacted to a previous movement or style.

There are many different types of design movements, cultures or styles that can be explored. The influence of these can be seen in both resistant and non-resistant material products.

Historical design movements, cultures or styles

An example of a historical design movement that developed a certain style of design work is the Bauhaus school, which was founded in 1919 in Germany. Bauhaus was based on the principles of the Arts and Craft movement, which was founded by designer William Morris in 1861 in England. The Arts and Craft movement developed as a reaction to the Industrial Age and technological advances of the time that resulted in the production of machine-made products of poor quality. The Arts and Craft movement emphasised the importance of hand-crafted work. Designers from the Bauhaus school wanted to integrate the artist and craftsperson and bridge the gap between design and industry, so they embraced the machine culture of the twentieth century.

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Figure 3.8 Wassily Chair by Marcel Breuer from the Bauhaus school

Figure 3.9 The Kota Sustainable Style Fashion Awards at The Garage, New York, 2016

Contemporary design movements, cultures or styles

Contemporary design refers to design that is happening now. What is contemporary today will be history in the future, so contemporary design is forever evolving and transforming. In our technologically driven world, more designers are looking at sustainable ways of approaching design. Sustainable and biomimetic design are contemporary design philosophies that focus on contemporary issues in our technologically driven culture. Sustainable design is about designing with the environment in mind and removing the potential of negative environmental impact. Through natural evolution, nature has been solving problems, and biomimetic design involves designers, engineers and scientists designing and producing products that are developed using technology to mimic and recreate some of nature's inventions to improve our lives. Refer to Chapter 1 for more information on biomimicry.

A design movement or style has the potential to inspire you. Researching past designers is a traditional method, but it also allows us to see how other designers have tried to solve the same design problem that your team may be trying to solve. Be adventurous with your approach to research and use different inspiration points as your starting point.

To quote biomimicry pioneer Janine Benyus:

> When we stare this deeply into nature's eyes, it takes our breath away, and in a good way, it bursts our bubble. We realise that all our inventions have already appeared in nature in a more elegant form and at a lot less cost to the planet.' (J Benyus, *Biomimicry*, William Morrow, New York, 1997)

How does culture play a part in design?

Perhaps you have travelled to another country or your parents or grandparents were born in another country. What is different about the country you are thinking of compared to your home in Australia?

What kind of history does the country have and how has it shaped the people and their environment? What are their religious beliefs and what are some of their traditions? Is their food similar to Australian food or very different and what is the typical architecture found in urban areas? All of these questions will help you to consider and gain a broader perspective on the differences in cultures and how these differences inspire, influence and shape design movements and styles.

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Victoria's cultural history and its influence on contemporary design

The Eureka Tower in Melbourne is an example of how cultural history has influenced contemporary design. At the top of the tower, representing the gold rush, is a 24-carat gold-plated glass "crown" that spans 10 storeys. In 1854, goldminers in Ballarat, Victoria, rebelled against the colonial authority of the United Kingdom. This rebellion resulted in the battle of the Eureka Stockade against the colonial forces of Australia.

White lines that run over the surface of the tower represent the markings on a ruler and the blue glass covering the tower represents the blue background of the Eureka Flag. A red strip running down the crown symbolises the blood spilt during the rebellion. Melbourne has been referred to as the design capital of Australia.

Significant events in history and how they influence contemporary design

The world first experienced space travel in 1957 when Russia launched the satellite *Sputnik 1* into space. Eventually, in 1968, astronauts left Earth on the US mission *Apollo 8*. This was a time of great technological and scientific achievements. Space-age design was born, influencing clothing, furniture and architecture.

With this new enthusiasm for the future and technological developments, fashion designers were interested in technologically advanced materials, such as plastic, vinyl and metal. Go-go boots were created by space-age designer André Courrèges, and Pierre Cardin designed skin-tight catsuits, tubular dresses, high leather boots and space helmets.

Figure 3.10 Cultural history – dominating the high-rise skyline of Melbourne is Eureka Tower, a 297-metre (975-foot) skyscraper. The Eureka Skydeck is the highest public viewing platform in a building in the Southern Hemisphere.

Figure 3.11 Go-go boots, circa 1968

Historical and contemporary design movements

Some historical and contemporary design movements include:

- American kitsch
- Art Deco
- atomic-age design
- Bauhaus
- biomimetic design
- biomorphism
- futurism
- Gothic
- Memphis
- minimalism
- modernism
- organic design style
- Orientalism
- postmodernism
- space-age design
- sustainable design.

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Areas of focus for your research on historical or contemporary design movements could include:

- specific designers
- technological themes
- brands
- fashion houses
- subcultures
- resistant/non-resistant materials.

Table 3.3 contains a list of historical and contemporary product, industrial and furniture designers.

Product, industrial and furniture designers – resistant materials	
Marc Newson	Christopher Dresser
Greta Magnusson-Grossman	Wells Coates
Grant Featherston	David Mellor
Michael Marriott	Ross Lovegrove
Jasper Morrison	Ben Wilson
Florence Knoll	Philippe Starck
Assa Ashuach	Karim Rashid
Sebastian Bergne	Buckminster Fuller
Achille Castiglioni	Lloyd Groff Copeman
Cini Boeri	Nolen Niu
Douglas Snelling	Adam Savage
Roger McLay	Peter Behrens
Tom Dixon	Raymond Loewy
Eileen Gray	Takeo Kikuchi
Arne Jacobsen	E Fay Jones
Ernest Race	Tom Barker
Charles Rennie Mackintosh	Ron Arad
Charlotte Perriand	Naoto Fukasawa
Verner Panton	Piet Zwart
Brodie Neill	Norman Bel Geddes
Oki Sato	Luigi Colani
Mathias Bengtsson	Deutscher Werkbund
Antoni Gaudí	Maarten Baas
Marcel Breuer	Jonathan Ive
Charles Eames	Martí Guixé
Ray Eames	Pascal Anson
Frank Lloyd Wright	Tord Boontje
Mario Bellini	James Dyson
Ettore Sottsass	David Mellor
Marcel Wanders	Todd Bracher
Matali Crasset	Neri Oxman
Konstantin Grcic	
Isamu Noguchi	
Lina Bo Bardi	
Johnny Chamaki	
Paul Schuitema	
Marco Zanuso	
Pierre Paulin	

Table 3.3 Product, industrial and furniture designers – resistant materials *(Continued)*

Table 3.3 Product, industrial and furniture designers – resistant materials

Innovative designers and their classic designs – resistant materials

Date	Product	Designer/s
1903	Harley-Davidson Motorcycle	William S Harley and Arthur Davidson
1907	Hill House Chair	Charles Rennie Mackintosh
1909	Handpiece for sheep shearing	David Unaipon
1917	Red and Blue Chair	Gerrit Rietveld
1924	Red Telephone Box (United Kingdom)	Sir Giles Gilbert Scott
1932	Anglepoise Lamp	George Carwardine
1933	Ford Model T	Childe Harold Wills
1945	Hills Hoist	Lance Hill
1954	Fender Stratocaster	Leo Fender
1970	Marilyn Sofa	Studio 65
1981	Super Lamp	Martine Bedin
1986–93	Well Tempered Chair	Ron Arad
2009	KeepCup	Abigail Forsyth

Table 3.4 Innovative designers and their classic designs – resistant materials

Australian designers in the 2015 Rigg Design Prize at the National Gallery of Victoria

The Rigg Design Prize recognises excellence in contemporary Australian object and furniture design and exhibits a combination of new and existing purpose-built works. This triennial exhibition gives people the opportunity to not only view some of the best work from Australian designers that expresses current issues and values, but engage in inspiring and innovative contemporary design, marvel at the different skills involved in each work's production, learn about the background of some of Australia's best designers, and their inspiration and

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Figure 3.12 Adam Goodrum, *Unfolding*, Rigg Design, 2015

reasoning behind their choice of original design style and materials used.

Sydney designer Adam Goodrum, the winner of the 2015 Rigg Design Prize, was interested in designing something to do with houses constructed using hinges so they could be folded (flat-packed). As a result, he developed a range of shelters titled 'Unfolding', produced using transparent acrylic sheets overlaid with dichroic film. His choice and application of materials caused visible light to split into different wavelengths and reflect a range of beautiful luminous colour.

The seven 2015 Australian designers invited to exhibit were:

- Adam Goodrum
- Korban/Flaubert
- Khai Liew
- Brodie Neill
- Kate Rohde
- Koskela
- Daniel Emma.

Researching designers

Non-resistant materials

The Bendigo Art Gallery in Victoria regularly holds fashion exhibitions and is a great resource for historical and contemporary fashion. Some of the gallery's past exhibitions include an extensive list of notable designers who you may be interested in researching.

Fashion exhibitions – Bendigo Art Gallery

The Golden Age of Couture: Paris and London 1947–1957	The White Wedding Dress: 200 years of wedding fashions	Modern Love: Fashion visionaries from the FIDM Museum LA
Designers	**Designers**	**Designers**
Christian Dior	Charles Frederick Worth	Jean-Paul Gaultier
Cristóbal Balenciaga	Charles James	Gianni Versace
Hubert de Givenchy	Zandra Rhodes	Valentino
Pierre Balmain	Vivienne Westwood	Ralph Rucci
Norman Hartnell	Vera Wang	Prada
Hardy Amies	Christian Lacroix	Zac Posen
	Jeanne Lanvin	Hiroaki Ohya
	Philip Treacy	Thierry Mugler
	Stephen Jones	Moschino
		Issey Miyake
		Alexander McQueen
		Louboutin
		Monique Lhuillier
		Helmut Lang
		Patrick Kelly
		Betsey Johnson
		Carolina Herrera
		Tom Ford
		Ferragamo
		Comme des Garçons
		Coco Chanel
		Thom Browne

Table 3.5 Examples of Bendigo Art Gallery's fashion exhibitions

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Notable twentieth-century fashion design and styles

Time	Culture and world events that influenced fashion design	Notable designers	Silhouette and styles
1900–19	• World War I	Paul Poiret Mariano Fortuny Charles Frederick Worth	• 'S' shape silhouette for women • The Ballets Russes
1920s	• Known as the Roaring Twenties or the Jazz Age • Dancing to the Charleston in speakeasies	Coco Chanel	• Tubular silhouettes for women • The 'flapper' • Styling, hair and make-up – 'la garçonne', women influenced by masculine traits
1930s	• The Great Depression • Hollywood glamour • Surrealism	Madeleine Vionnet Elsa Schiaparelli	• Bias cut, and long, languid dresses
1940s	• World War II	Madeleine Vionnet Claire McCardell	• Military silhouettes and fabric restrictions, such as L-85 guidelines • 'Make do and mend' • Hair styles and accessories for women dictated by safety, such as a pompadour with turbans and snoods
1950s	• The birth of rock 'n' roll • The baby boom	Balenciaga Givenchy Chanel Dior Balmain Vionnet	• Christian Dior's 'New Look' of 1947 was highly influential, featuring a narrow waist, round shoulders and a full skirt for women • Beatnik and teddy boy subcultures
1960s	• The Space Race • The rise of the model (Twiggy, Jean Shrimpton) • London as a cultural influence – music (the Rolling Stones, the Beatles) as well as fashion • Pop art and Andy Warhol	Mary Quant Pierre Cardin Biba André Courrèges Yves Saint Laurent	• Miniskirts and babydoll dresses • Hippy aesthetic (late 1960s) • Mod and rocker subcultures • Space-influenced fashion
1970s	• Dissatisfaction with Western lifestyle and Vietnam War	Vivienne Westwood Ralph Lauren Yves Saint Laurent Zandra Rhodes	• Continuation of the hippy movement – natural aesthetic, interested in Eastern influences • Glam rock and David Bowie • *Saturday Night Fever*, flared trousers and platform shoes • Punk subculture led by Vivienne Westwood and Malcolm McLaren in London • Abba
1980s	• Wall Street and financial prosperity	Christian Lacroix Thierry Mugler Issey Miyake Rei Kawakubo Donna Karan	• As women entered the corporate arena, they required new workwear, including masculine-style shoulders in garments • Power dressing • Bubble skirts • Excess – think Madonna and the 'Material Girl' • Japanese avant-garde
1990s	• The rise of the 'supermodel'	Versace Continued rise of Japanese designers The Antwerp Six Calvin Klein Helmut Lang	• Youth and subcultural influences included grunge, hip hop and rave culture • The rise of streetwear • Underwear as outerwear • Minimal fashion as a reaction to the excessive 1980s

Table 3.6 Some notable twentieth-century fashion designers and styles

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Fashion designers	Shoe designers	Bag designers	Milliners
Azzedine Alaïa	Manolo Blahnik	Hermès	Philip Treacy
Giorgio Armani	Christian Louboutin	Prada	Piers Atkinson
Dolce & Gabbana	Sophia Webster	Pashli	Noel Stewart
John Galliano	Charlotte Olympia	Coco Chanel	William Chambers
Marc Jacobs	Emilio Pucci	Givenchy	Lock & Co. Hatters
Karl Lagerfeld	Jimmy Choo	Louis Vuitton	House of Flora
Madeleine Vionnet		Kate Spade	J Smith Esquire
Jean Patou		Proenza Schouler	
Mary Quant		Alexander McQueen	
Donna Karan		Longchamp	

Table 3.7 Other designers to research

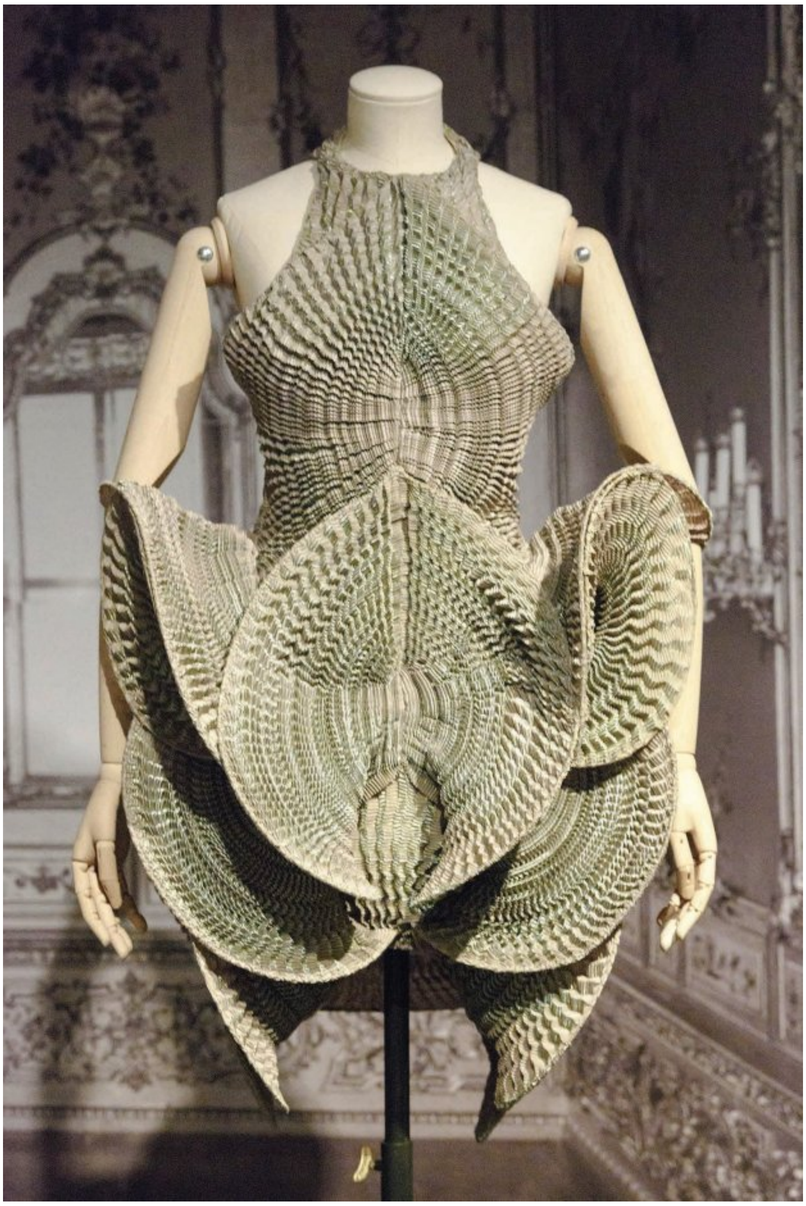

Figure 3.13 Iris van Herpen, 'The Vulgar: Fashion Redefined', an exhibition at the Barbican, London, 2016

ACTIVITY 3.2

Non-resistant materials

Reflect on your own buying behaviour and discuss these points with your team:

- How many clothes do you have in your closet that you have only worn a few times? Will you ever wear them again?
- What items of clothing do you wear regularly? Describe them to your team. What makes them your favourite items?

ACTIVITY 3.3

Resistant materials

1 In your team, reflect on your own buying behaviour in relation to similar products. Choose three product design factors and discuss with your team what you look for in a product in relation to each factor.
2 Have someone record or take notes of the team's discussion. This information will be a great resource to refer to and it will help you get an idea of what your other team members think are important factors in a product.

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3 Discuss your team designs with your team. Are you designing something that is currently on trend or reflecting timeless design?

Presenting research in a team environment

Design does not occur in a vacuum. We are influenced by every interaction we have with a product, place, person or environment.

Design has always been part of our lives. Since the dawn of time, humans have wanted to find solutions to problems that they encounter. We are all designers and inspiration can be found all around us. Don't narrow your inspiration and research focus to only similar products, as this can create a false sense of limits on your design.

An idea for a great product can be sparked from the unexpected. Have you ever walked down the street and stopped to look at a garment or product in a shop window that for some reason caught your attention? Why did it catch your attention? Was it the colour or shape, or was it a particular part of its design? Start taking photos of things that catch your eye in your everyday life. It might seem pointless initially, but there is a reason why particular things catch your eye. A simple observation or inspiration from any source could be the starting point of an improved design.

Allow yourself time to research because there might be a key moment that will make your product more creative and innovative. The more ideas you initially visualise, the more likely you will capture an idea that will spark creative thinking and guide you along the design process towards successfully meeting the end-user/s' need.

When presenting your research about historical and contemporary design movements, cultures or styles, refer to Chapter 1 on design thinking and, with your team, discuss and apply relevant creative thinking and critical thinking techniques.

In the investigating and defining stage, creative thinking techniques can help spark and expand ideas within the team, and critical thinking can help team members understand the expectations of the product/s and help refine ideas, ensuring that all team members

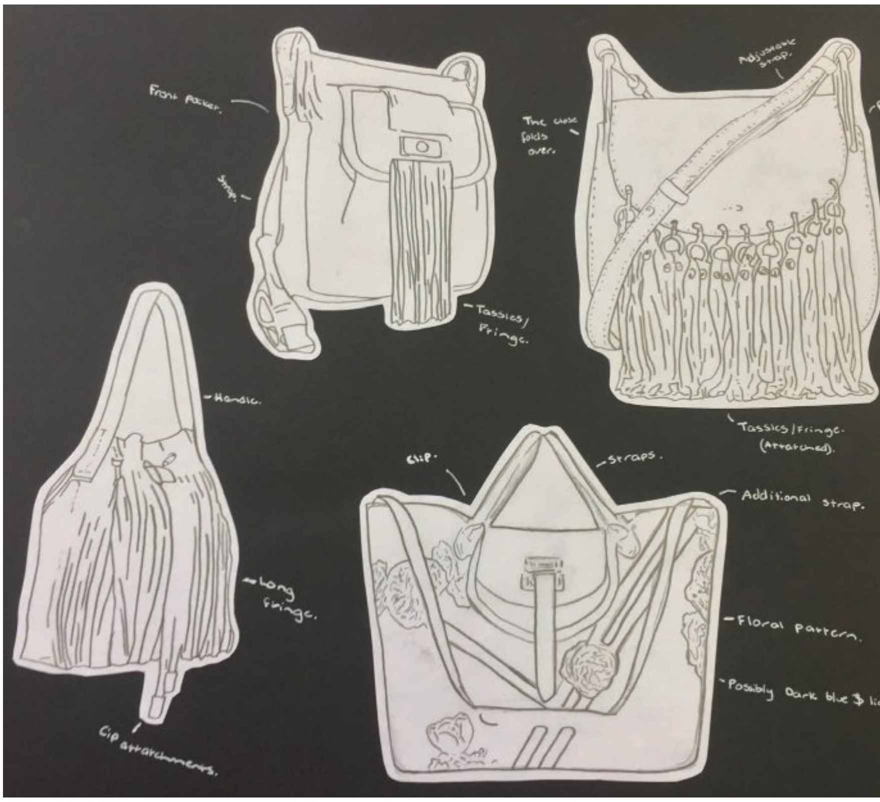

Figure 3.14 Bag designs for a festival by a group of students at Hoppers Crossing Secondary College inspired by the 1960s hippie movement

have the same goal and understanding of what is to be achieved. Using both these thinking techniques the team can progress from viewing the product as something typical to creating a unique product.

When researching other work, make sure you recognise the intellectual property of the designer. Most information about designers, design movements or products will be from a secondary source.

Any information (text, images) that is not your own must be acknowledged within your folio. List the owner of the intellectual property beside the information; for example, (Designer: Karl Lagerfeld for Chanel, Summer 2016 Collection).

It must be clear the idea/image/text is not your own. You can also include the publication in which you accessed this information and the date.

Below are some methods to present research of historical and contemporary design movements, cultures or styles in a team environment. All these activities can be altered to suit how you have defined the roles in your team. Your teacher may have created a short list of movements to research according to resources available at your school.

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DID YOU KNOW?

In Australia, copyright is automatically given to the work's creator, which means that the copyright symbol © does not have to be placed on an image or body of work in order to protect it. However, if you create something as an employee, your employer will hold copyright of that creation. Copyright can protect many creative outputs, such as illustrations and photographs.

Research methods

Quantitative research – how people think, feel and behave

A typical way to undertake this kind of research would be to create a structured questionnaire. For example, 'Is the chair comfortable to sit on?' The end-user/s you are questioning might then have to select an answer from three options: not comfortable, comfortable, very comfortable. At the end of the survey, tally up your results to determine the success of your product or prototype and how well it meets the requirements of the design brief.

Qualitative research – how people think, feel or do

This kind of research does not seek statistical information. Qualitative research requires you to develop open questions that encourage an end-user/s to explore reasons for their responses. Qualitative research can be audio or video recorded and your end-user/s' thoughts and feelings about the product can be used to reflect on the success of your work.

More than ever before, consumers have the ability to use reviews and data to make informed choices about products they may want to purchase, as well as sharing their own thoughts and reviews on products. There are countless blogs, YouTube channels and apps dedicated to comparing and reviewing products and services. Consumers can compare prices and specifications of similar products without leaving the house.

Mood board

A mood board is a collection of images placed together that visually provide a sense of your end-user/s' style and taste and so on. Images on a mood board can be chosen for many reasons, including shape, texture, colour, style and material. Your team could refer to the design elements and principles or product design factors to help establish areas of focus for this visual research method.

The following are steps taken to create a mood board in a team setting:

- Step 1: Team members select a combination of three or four product design factors or design elements and principles to investigate and research images for a small mood board each (up to 10 images) of what each team member thinks is their end-user/s' need as outlined in the design brief.
- Step 2: In a team meeting, present your mood board and discuss your choice of product design factors and design elements and principles and the images you selected for your mood board as a result.

OR

- Step 1: Create a mood board with images from different design movements/styles that your team has been researching. As a team create a short list of images that you will all use as your points of inspiration.

Mind maps

Mind mapping and brainstorming are great for connecting ideas. They encourage deeper and more empathetic thinking about an end-user's need and are a great way of undertaking primary and secondary research. Mind maps open up thinking to see what else can be explored.

As a team, use the product design factors as a starting point and discuss what product design factors the team needs to focus on during the research stage. You could even divide these into primary and secondary research categories.

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Keep these mind mapping or brainstorming sessions short, as the more time spent on these activities the less productive they will become.

Research reports

A research report can be used to create an overview of different design movements to help you clarify your team's inspiration. Each member of your team might choose to create their own report or create an overview of design movements and historical references for your team.

You could undertake your research report in the following way:

- Step 1: Each team member completes a short research task on one historical or contemporary design movement, culture or style and finds two products designed within that movement that are similar to the product their team is going to design and produce.
- Step 2: Each team member presents their report. The team then discusses what movement or number of movements should be the starting point for their visualisations and analyses the two products each team member has researched.

Research from multiple sources can help you picture how the design problem can be solved in many different ways. Research is a time to gather lots of ideas from existing products, possible materials, both resistant and non-resistant, and textures, among other things, and also user experience and your own experience of particular products. When starting to research, it may seem like a massive task, but breaking it down into smaller blocks

Figure 3.15 Exploring the ideas of 1980s fashion and Madonna song 'Material Girl' by student Natasha Darbisi

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will help the direction of the research. Looking for inspiration from historical contexts is one part of this, and it is a great starting point.

Ensuring that your research is clear and logical will help the team understand the goal and its limitations and set a clear direction. It may prompt a team member to research a particular aspect in greater detail.

ACTIVITY 3.4

Discuss with your team ways that you can undertake research. You might want to give individual members research tasks and create a:

- brainstorm/mind map
- mood board.

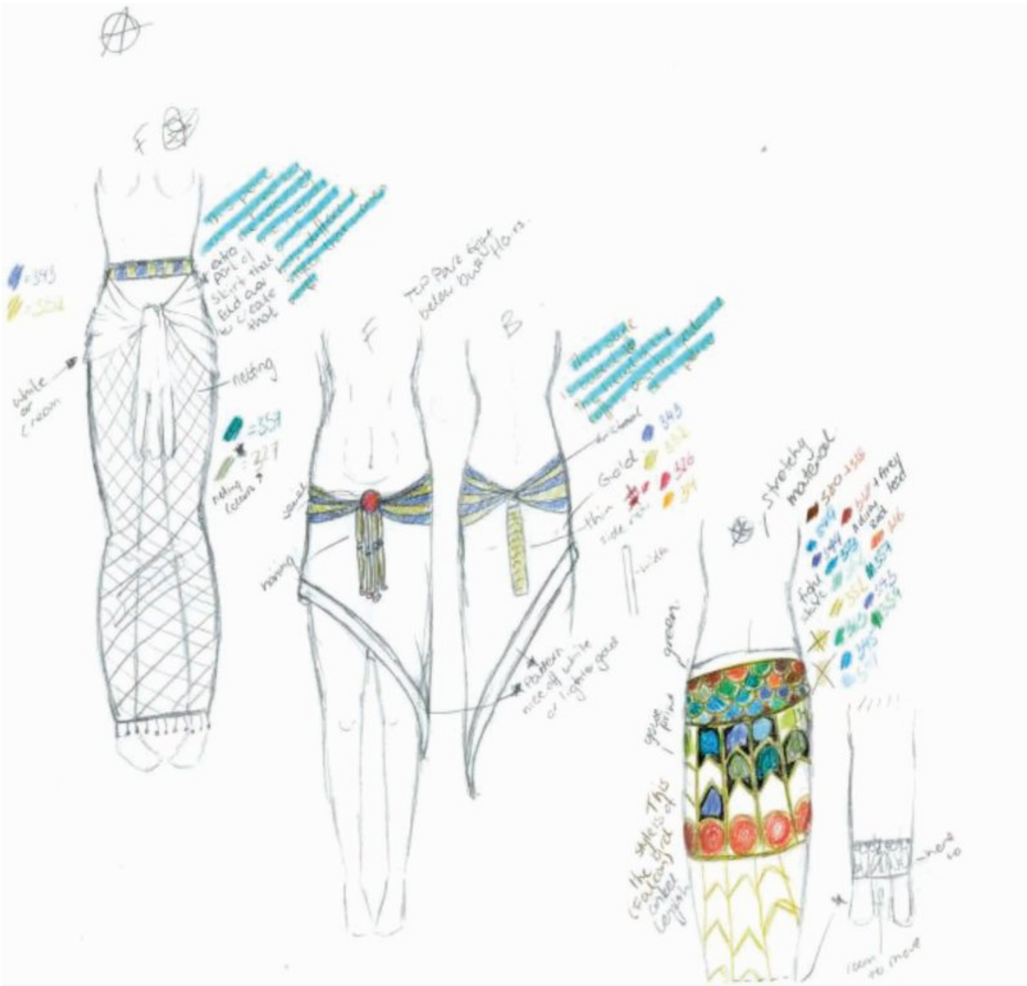

Figure 3.16 Ancient Egyptian fashion was the main inspiration for student Willow Follett.

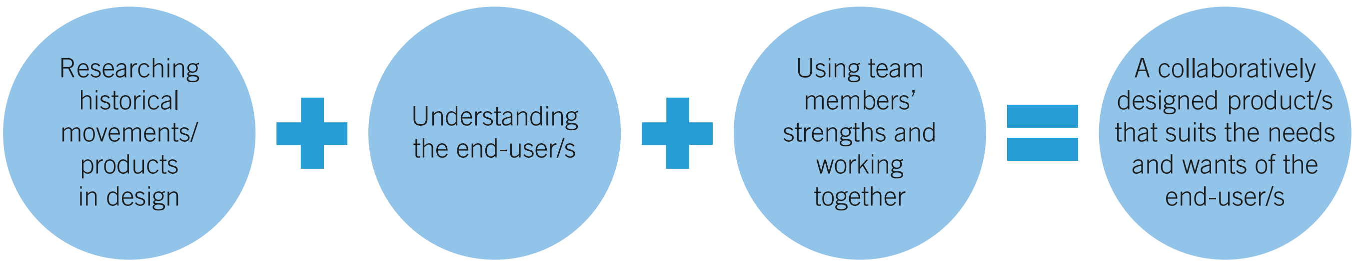

Figure 3.17 Understanding your end-user/s and working collaboratively will result in a product that suits the needs and wants of the end-user/s.

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ACTIVITY 3.5

Research design movements or styles other than the ones listed that you might find inspiring.

ACTIVITY 3.6

What other Australian design exhibitions and competitions can you find to inspire ideas? Research two other exhibitions and/or competitions and look at inspiring ways designers have approached design.

3.4 Social, economic and environmental issues of sustainability related to design

Including sustainability in design is becoming increasingly important and all designers should consider designing with sustainability in mind. The activities we do as humans have an impact on the environment, economy and society. The level of impact is what we need to consider when we design products. Our world is not an endless source of raw materials; nor is it sustainable for a person to be making clothes in an unsafe work environment for minimal money so a consumer can buy a T-shirt for $4.

As discussed in Chapter 1, sustainability can be broken into three main areas: social, economic and environmental. As designers, we need to adapt our design thinking and consider and implement as appropriate these areas in our designs rather than seeing them as a challenge or problem.

Questions to consider as a team

As a design team, how will you create a product with sustainability in mind? How will your team adapt their thinking and make sustainability a vital factor in the investigating and defining and design and development stages while still being innovative?

Environmental

As our modern world grows, and with it the increased consumption of materials, environmental sustainability has moved from a consideration to a key focus in product design. It is important to think about this key point when choosing materials for a garment or product.

> [At] a global growth rate of 3% per year we will mine, process, and dispose of more stuff in the next 25 years than in the entire history of human civilization. (M Ashby and K Johnson, *Materials and Design*, 3rd edition, Butterworth-Heinemann, Oxford, 2014)

Designers need to be aware that all their choices have an impact socially, environmentally and economically in some way, and they need to constantly adapt their thinking to find sustainable solutions to design problems.

An important question for a designer is how can a product's sustainability be improved?

Ways a designer can increase a product's sustainability include:

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- using recycled materials
- designing a product so parts or components can be recycled
- reducing the amount of material needed to produce a product
- extending the product's life by increasing its quality
- incorporating replaceable parts
- reducing the energy needed to produce, use and dispose of the product
- changing how the product is transported to the end-user
- creating instructions for how the end-user can dispose of the product
- creating a producer buy-back scheme.

There are many different sustainability models, as discussed in Chapter 1, including:

- design for disassembly
- life-cycle analysis
- cradle to cradle
- extended produced responsibility.

Environmental issues in textile design

One environmental issue in textiles is style obsolescence. The fashion world is highly competitive and a designer will want to have the edge over other designers by creating a new style to entice the consumer to buy their product. The consumer sees the new style of clothing and buys it from the store, while the old garment will be left in the closet until it is thrown out or donated to the second-hand store. This leads to many garments being discarded well before their use-by date. Users see textile garments now more as a commodity than a necessity.

To increase sustainability, the easiest way is to increase the life of the garment or the length of time the user wears the garment. It is important to design something that will still be in style when these short trends come and go. Good design is timeless.

Another environmental issue in textile design is the ongoing care requirements of the garment. A garment washed regularly in warm water will take more energy than if it is washed in cold water or does not need regular washing. Reflect on your group design. Are you designing something that could be dried on a line or dry-cleaned only?

How will your group look at these issues and incorporate these ideals in your design thinking? Sustainability is becoming ever more important in design. Even a small change in your design and the product's life cycle can minimise their impact.

For product obsolescence, refer to Chapters 1 and 6.

Figure 3.18 Hand wash instructions on a clothing care label

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ACTIVITY 3.7

It is important that every time you design, you consider the sustainability principles. Think of ways your collaboratively designed product can address sustainability. It might be socially, economically, environmentally or all three.

Complete the three pillars of sustainability Activity 3.5 and your final design on page 98 of the workbook.

3.5 Purpose of feedback to inform the selection and justification of viable design solutions

You should gather feedback in your design team in deciding which design options best meet the design brief. It is important to give constructive feedback to your team members, and help decide how you will all continue to progress in the product design process. Digital technologies can also be used during this decision-making process to assist with collaboration.

Feedback is important throughout the product design process, and by asking relevant questions throughout the product design process it will be useful and meaningful and ensure that a successful solution to the need will be found. In production, feedback could be used to ensure that the product is produced on time.

Evaluating your work by using different methods, such as checking how the product meets the end-user/s' needs, wants and expectations while staying in budget, is also a way to obtain relevant feedback.

Designing without feedback is like throwing a ball at a hoop with a blindfold on – we can keep throwing it by ourselves, but it may take longer to get it in the basket on our own. If we have someone next to us, giving us guidance and clear feedback – a little more to the left, a little more to the right – every time we throw the ball, we have an improved chance of getting the ball into the basket, quicker and more efficiently.

Instead of throwing the ball at a hoop, replace this action with your product's design options. Designing on our own, we could satisfy

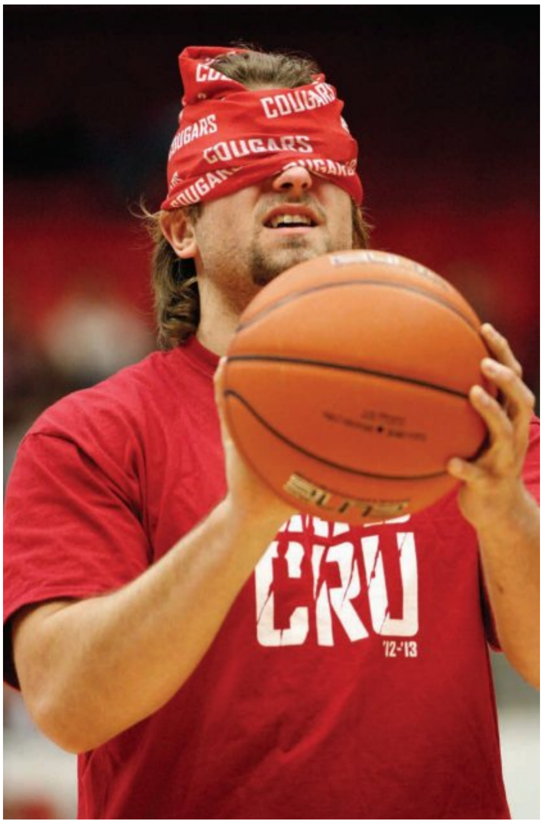

Figure 3.19 Designing without feedback is like throwing a ball at a hoop with a blindfold on.

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the brief with our own ideas – it may just take longer to find a suitable design. If we use the guidance and advice from people around us (team members, our teacher, family or end-users), our design could be a better solution and completed in a shorter period of time. Feedback helps us hit the target in a shorter period of time, while helping us with critical design thinking.

Critical feedback is just as important as constructive feedback. As a team working through the product design process, we need to ensure that all types of feedback are occurring. Timely feedback is also important; if we ask for feedback, others should return it in a timely manner. If feedback takes too long, we may just move on with the idea or throw the idea away.

Feedback should be from multiple and diverse sources – your team members, classmates, teacher, family and friends. The more feedback you receive, the more you can refine your ideas.

Here are some ideas on sources of feedback:

- Show your designs to potential end-user/s.
- Simply ask, 'What do you think?' when showing a team member.
- In a team meeting, talk through why you created certain designs.
- Pitch your ideas to the class.

When receiving feedback, remember to note down ideas or comments made. Write down details about why a design will or will not work. This will be useful when you are redesigning or altering ideas and will help your critical thinking about your designs.

Understanding the importance of feedback is a great start, but what is the next step?

We need to act on the feedback we receive. Some feedback might not be useful, but it should still be reflected upon before being dismissed. You may ask someone to answer questions about your design or perhaps ask them to reply to a statement during a discussion. These are all valuable types of feedback.

Negative feedback can be hard to take on, but you should see it as a chance to improve. As designers, we may think that our designs are perfect, but when they are presented to the end-user they may not meet their expectations or the end-user/s might not like any of the designs! Perhaps one vital constraint was missed and a team member may pick up our error.

Negative feedback can be taken personally and you might feel that you have not completed your required tasks correctly as part of the team. You don't want to waste time, materials and resources, so look at negative feedback as a way of moving forward by helping you to reflect on what you have been doing and then make necessary changes to move closer to meeting the need of the end-user/s.

When you have been given negative feedback, think carefully about your designs. Further research or investigation of the end-user/s, materials or products may be needed.

Good feedback starts by asking the right questions. Use the following questions to help you understand how you could improve your design:

- Applying an empathetic approach, have I understood why my end-user/s don't approve my designs?
  - Have I asked open-ended questions?
  - How can I use the end-user/s' answers to my questions to improve my design?
- Did I not identify what their expectations of the product would be?
  - If you are unsure, refer back to user-centred design factors and how they influence the design of products.
  - Do I need to look at the end-user/s in greater detail?
- Have I been creative and innovative, or does it look like every other product on the market?
  - Do I have something unique in my design?
- Do I need to research more areas related to this product?
  - Have I understood the situation in which the product will be used?
  - Do I understand the expectations of the product I am designing?

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ACTIVITY 3.8

Do you understand the importance of feedback?

1 What is feedback?
2 How is feedback useful when creating designs?
3 Why is critical feedback just as important as constructive feedback?

ACTIVITY 3.9

In your team, create your own feedback questions.

DID YOU KNOW?

Critical feedback should be taken positively. It is not a reflection of you personally, nor do you have to take the advice on board. It can be hard to hear criticism about something you have worked hard on, but sometimes taking on feedback can help to improve your product or even give you new ideas.

- **Refer to the folio checklist on page 99 of the workbook, Activity 3.6.**
- **Complete the team design option feedback Activity 3.7 on page 100 of the workbook.**
- **Complete the team testing of properties Activity 3.8 on page 102 of the workbook.**

3.6 Methods of construction used to determine appropriate, efficient and effective production processes to make a product

Completing a team product or product range

Reflect on how you constructed your product if you undertook Unit 1, the tools, equipment and machines you used and the materials and production processes you selected. What worked well and what could you have done differently?

Discuss your experience with the team and plan production roles that focus on individuals' areas of strength. Through discussion you might find that someone is particularly accurate at measuring and marking out, while someone else is skilled with hemming or drilling.

Allocating team members production roles that suit their individual strengths will help in the production of a quality product. Other team members will be able to observe better ways of undertaking particular production processes and how to do others not yet tried. This way of working collaboratively as a team will support a way of learning that will encourage each other to build on current knowledge and skills, increasing the degree of difficulty with production processes.

Refer to the materials you researched and used if you undertook Unit 1. Is your team using similar materials and can you share

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Figure 3.20 A product range – jewellery

knowledge of particular materials and their properties? If you are making one product, ensure that all members have something to do during production. If members of your team are sitting around, your team is not being effective and efficient with their time.

- **Complete the team review of Unit 1 scheduled production plans on page 104 of the workbook, Activity 3.9.**
- **Complete the team production skills digital activity.**

3.7 Role of scheduled production plans

In Unit 1, you are required to develop a scheduled production plan, a materials and equipment list, risk management, quality measures and estimated time needed for each production step. Refer to Chapter 1 for more details on how to complete the above components.

Your team could approach the production plan in one of the following ways:

- a team production plan if individually making a component of the team's one product
- a team production plan if individually making a part of each product from the team's product range
- an individual production plan if producing a product from the team's product range.

If you undertook Unit 1, refer to your work and share your production plan with your team. After reviewing each other's production plans, whether you are working on individual production plans or a team production plan, adapt and build upon what your team members think are the best examples shown.

Perhaps someone in your team developed clear and concise risk-management strategies, while someone else has demonstrated a thorough approach in applying quality measures to produce a quality product.

Team members can be selected to review the evaluation criteria and make a note of quality measures that need to be addressed for each evaluation criterion question written.

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Review of team strengths from Unit 1 scheduled production plans

	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6
Timeline		Accurate and timely				
Production steps	Sequential and detailed					
Materials and equipment list				Thorough research on materials with good knowledge of school workshop equipment		
Risk assessment			Clearly presented with relevant and well-researched information			
Quality measure						Quality measures were thorough
Estimated time needed for each step					Estimation was accurate and allowed for a consistent flow of production steps	
Conclusion As our team is making one product, after reviewing each team member's scheduled production plan from Unit 1, we have identified each member's strength and have allocated a role to each team member for our team's Unit 2 scheduled production plan.						

Table 3.8 Scheduled production plan – review of team strengths from Unit 1 scheduled production plans

Note: there is no requirement as to how many students can make up a team.

- **Complete materials and equipment list Activity 3.11 on page 106 of the workbook.**
- **Complete team risk assessment Activity 3.12 on page 107 of the workbook.**

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Chapter summary

- Creating a clear understanding of the end-user/s' needs, wants and expectations will help your team and yourself create a product that will be the best solution to your particular design problem.
- Inspiration can come from many sources. Don't just use the internet; instead, broaden your research areas. Modern design is traditionally an evolution of an old design to improve its user-centred factors.
- Sustainability is an increasingly important aspect of design, and all aspects of the product design can be made more sustainable.
- Working in groups to produce a product has its positives and negatives. Good communication and job roles will ensure that the product will be finished with the highest possible quality.

Short-answer questions

1 Discuss what it means to work collaboratively.
2 Explain how user-centred design influences the design of products.
3 Identify three ways that historical design has influenced current design.
4 Explain why sustainable design might be considered a contemporary design movement.
5 Describe how you have used formal feedback to support the development of your product.

Extended-response questions

1 You are collaboratively producing a chair or dress. List three types of primary research that will help in the development of your product and three types of secondary research that will help in the development of your product. Explain why they are suitable.
2 Describe three ways you could use ICT appropriately to support collaboration in the product design process.

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Figure 4.1 This design team, husband and wife Ray and Charles Eames, evaluate their finished product in their studio, 1974

4

Area of Study 2: Producing and evaluating within a team

INTRODUCTION

This area of study requires you to work collaboratively in a team situation and produce a product or product range inspired by a historical or contemporary cultural design movement or style. The production process and any modifications made will be logged individually. The final product or product range will be checked and evaluated on how well it meets the requirements of the design brief, including how materials, tools and equipment were used during production.

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KEY KNOWLEDGE

- production techniques for the use of materials, tools, equipment and machines, including risk management, to make a product safely
- digital and manual methods of recording progress through production, including any modifications to the production plans
- methods to evaluate the suitability of the product or components of a group product/s as a solution to the design brief:
  - checking the product in relation to evaluation criteria
  - the extent to which the product was influenced by an historical or a contemporary cultural design movement or style with consideration of user-centred design factors and sustainability
  - observations and feedback from others
  - suggestions for improvements.

KEY SKILLS

- work individually and as a team member to make a product or components safely
- use risk management strategies and safely use materials, tools, equipment and machines
- individually record progress, decisions made and modifications to the preferred design option and production plans
- evaluate the finished product or components to determine how they satisfy the design brief.

4.1 Production techniques for the use of materials, tools, equipment and machines, including risk management to make a product safely

In Chapter 3, you and your team members would have established your roles within the design team, and planned your production accordingly using the workbook support material. This could involve:

- individually making a component of the team's one product
- making a product from the team's product range
- making a part of each product from the team's product range
- utilising the strengths of the design team, allowing each group member to perform specific tasks; for example, one group member cuts out materials, and another member works on surface decoration techniques.

Refer to Section 3.6 in Chapter 3 for more information.

At the end of Chapter 3, your team completed a scheduled production plan by drawing on the strengths of each team member after reviewing scheduled production plans completed by those who undertook Unit 1.

TIPS

A team's scheduled production plan should rely on the individual strengths and talents of each member, clearly identifying who is completing which task, aiming to have everyone working at all times. A variety of materials, tools, equipment and machines should be used to create product/s that meet your team's quality measures previously written.

Risk management

Risk management is vital during production. This is even more important with students working together. How will your team manage the risks associated with creating your product/s? What risks will your team need to manage?

Have a clear understanding of what risks and hazards there will be when creating your product/s. If new tools, equipment or machines need to be used, then all team members must know how to use them correctly and safely. Your teacher will be watching how you apply the strategies listed in your risk assessment when undertaking production as a team and individually.

As a team member and class member, it is also your role to make sure others are being safe at all times. If you see unsafe behaviour, even if you think it is a minor issue, let the teacher know and/or show your team member the correct procedure.

Figure 4.2 Know where the emergency stop button is on the machinery in your workshop

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As mentioned in Chapter 2, if you are unsure of how to use something or how to complete a production process, it is vital that you inform your teacher, who can demonstrate the correct way to use the tool, equipment or machinery or production process safely. Your teacher may have set rules and safety expectations of how each tool, equipment or machine must be used, and you will need to follow them.

Risk management and communication are especially important when working as part of a team. Your risk assessment written in the previous outcome should identify who is completing what steps during production, as well as manage risks in the following steps:

1. Identify the hazards:
   - What are potential hazards of your resistant materials workshop and non-resistant materials classroom?
   - What could be a hazard?
2. Assess the risks:
   - What could happen from these hazards?
   - What is the likelihood they will occur? (unlikely, possible, likely)
   - What harm could occur?
3. Control the hazards and the risks:
   - How can you minimise the risks?
4. Check the controls:
   - Regularly review your controls and procedures.
   - Ensure that you are practising your suggested risk management.
   - Inform your teacher of any machine faults or risks.

During production, it is up to you and your team to continue to action your risk-assessment strategies and to continually check the controls suggested, each lesson. More detail on risk assessment specific to your materials can be found in Chapter 1 (pages 40–2).

Creating a product or product range as part of a team

Creating a product in a team has its positives. Everyone can share their individual production skills and work towards producing the best quality product.

The length of time a team's product or product range takes to make will depend on how the team decides to approach production. If each member is making a component of one product, it might take less time than if each team member has the role of one specific production process for a product range. Team collaboration is important to ensure that everyone has clear goals and expectations during the production stage.

What production skills can I bring to the team?

As a team member, think about how you can effectively apply your skills to your team product. Reflect on the skills you have learned in Unit 1. Here are some questions to start discussions in group meetings:

- What skills can I bring to the team?
- What did I do well in my last product?
- What techniques did I use when creating my product?
- What did I learn about creating products from my own design?

Figure 4.3 Mood board by student Baptist Zacharia

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As a team, you will all need to agree on all aspects of the production. Agreeing on all aspects will be vital if your team is creating a range of products. If all materials and techniques are the same, the products will be of similar style/look and quality.

Here are some questions for group discussions:

- What materials will be used for the product/s?
- Is the quantity of materials needed available?
- What techniques will you be using to construct and decorate the product?
- Will one student complete each step of a product or will each student create their product individually?
- How will your team work collaboratively?

Review of team members' prior production experience and skills

Ask each team member to fill in a review about their level of experience and skill working with the tools, equipment, machines and materials that your team will need to complete the product or product range.

In this way, your team can decide who is best for a particular production step or who will be best at demonstrating a step or particular skill to the team.

Table 4.1 shows an example of a review of the level of team members' skills in the production of a range of ceramic tableware inspired by the Arts and Crafts style. **This range of ceramic tableware would be part of other components made from materials in category 1 (see Table 7.13 on materials categories).**

Identifying team members' production skills

	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6
Pottery wheel	My parents are potters and I have a lot of experience making plates and bowls.	I don't feel confident using a potter's wheel. I don't think I would do a good job.	I have used the potter's wheel on camp before and at summer school in year 9.	I have never used a potter's wheel and I will need to be shown how.	I made a vase on a potter's wheel in year 10. I like using the potter's wheel.	I don't like clay. I would rather glaze the finished pieces.
Joining using slip	I don't have a problem with this and I am happy to demonstrate a good technique.	I have no idea how to do this.	I know how to do this, but I am not sure if my technique is that good.	I am happy to be shown how to do this.	I think I am skilled at joining clay pieces using slip.	I don't like clay. I want to glaze the finished pieces.
Glazing	I am okay with glazing.	No comment.	I think I would be able to do the glazing well.	I enjoy painting with acrylic paint, but I have never painted with glaze before.	I have only glazed a vase, but I am happy to glaze our work.	I enjoy painting and think this is one of my strengths. I have not painted with glaze before, but if someone demonstrates I think I can do an excellent job.
Conclusion The results of the review have been discussed and the following students will undertake these production tasks: Student 1 will use the potter's wheel. Student 2 will glaze. Student 3 will use the potter's wheel. Student 4 will join additional pieces using slip. Student 5 will join additional pieces using slip. Student 6 will glaze and demonstrate this skill to student 2.						

Table 4.1 Identifying team members' skills for production of ceramic tableware

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Figure 4.4 A bowl being made on a potter's wheel

Team meeting to reinforce production goals and expectations

Once you have established what production steps each team member will undertake, it is a good idea to discuss the other important areas of the scheduled production plan to make sure all team members have the same goals and expectations.

Your team will need to hold meetings throughout production to make sure everyone is working to the timeline and quality work is being carried out. Remember to log all decisions from the meetings during production.

Recording a production team meeting

Team meeting	Meeting discussion points	Team notes	Team signatures
Meeting 1	• Production timeline • Materials	• Production timeline must be followed. If a team member is falling behind, the team must be notified. • The team will use materials available in the classroom. • Roles have been agreed upon.	
Meeting 2	• Modifications • Process	• A team member will need extra assistance in completing a join. All team members agreed to help.	

Table 4.2 Production team meeting

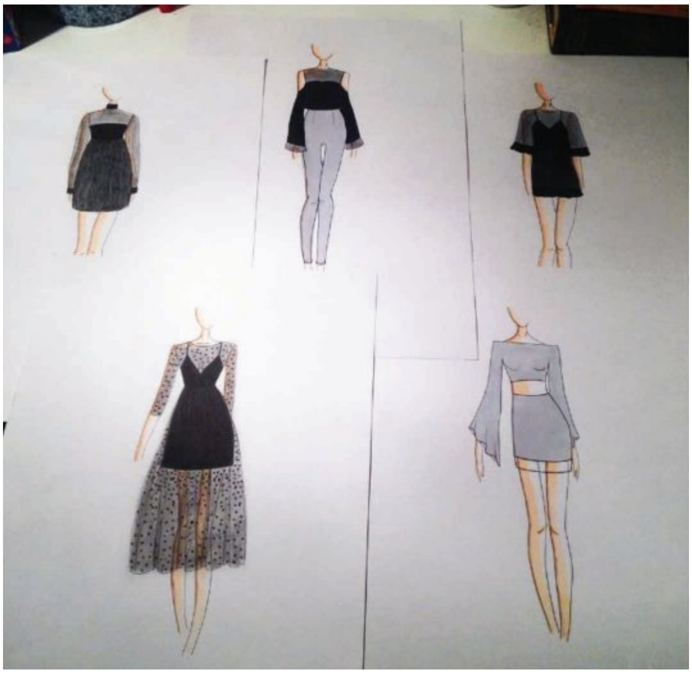

Figure 4.5 Student Madeleine Rosenbrock contributing her design skills to a team

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Production – choice of tools, equipment, machines, materials and modifications

Your materials, tools, equipment and machines should have been selected during your production planning in the previous outcome. As challenges arise during production, you may need to explore alternatives to tools, equipment, machines and materials previously selected.

It would be a good idea to hold a team meeting if this occurs to make sure everyone knows about, understands and agrees on any modifications. (Refer to Section 4.2.)

When choosing production techniques for the team's product/s, remember that if it is made from a range of materials, the production processes that are required when working with one particular material may differ for another, and this needs to be understood by all team members.

Production processes for a range of materials may differ depending on:

- the material's components and properties
- the quality of the particular material
- how the material will be used as part of the product
- care requirements of the particular material.

Refer to Chapter 2 and Chapter 7 for more information on tools, equipment and machines.

Production

Once your team knows their role in the production process and the materials and techniques, tools, equipment and machines needed, the next step is to start creating the product.

As your team begins production, different issues may arise, and when this happens the team will need to meet to establish an alternative approach to the production step that will achieve the result needed. This modification to the production process will need to be trialled and then decided on by the team and recorded.

Team work happens when team members demonstrate and share skills and experience with their team members.

The following points should be discussed with your team before you start production:

- Can team members help each other complete certain aspects of each product?
- Will one person complete different components of each product?
- Will team members show others how to complete different production techniques?
- If a team member finishes their production stage early, will they help others?
- Will you have a team leader who will be checking up on team members' progress?

It is important your expectations of each other are the same and understood. Remember to log all changes and let all members know of changes.

DID YOU KNOW?

Managing members of a team and working well as a team member are valuable skills to a potential employer.

How to make sure all team members are being efficient and effective with the time allocated

During the production stages, no team member should be idle while waiting for another person to complete something. If a team member is sitting around, the team is not being efficient and effective with the time allocated. Below are some hints to make sure that the team is using production time efficiently.

If you are making one product:

- Break the product into components. Each component can be created by one student and then the components assembled to form the product.
- Members can be doing quality control checks on other students' work.

If you are making a product range:

- Each student can create one of the products in the range.
- Each student can compose a part of each product.
- Members can be doing quality control checks on other students' work.

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Example of some quality measures for team members producing a garment

Quality measures	Checklist	Date checked	Team member signature when step/ checking is completed (if required)
Material is prewashed	Fabric washed as per care instructions		
Material cut out to correct measurements	Another member to check measurements		
Seams pressed after every production step	Team members remind each other to iron fabric		
Seams/joins completed with high quality	Another member to check seams/joins		

Table 4.3 Example of quality measures for team members producing a garment

Figure 4.6 Student production work – spiral tie-dyeing

ACTIVITY 4.1

1. Describe the production skills that will be needed to produce your product or product range.
2. List important quality measures that your team needs to consider to make a product or product range that meets the end-user/s' needs and wants.

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4.2 Digital and manual methods of recording through production, including any modifications to the production plan

In this outcome, students must create their own individual production record. Students can also use digital collaborative methods to facilitate communication. There are many types of digital and manual methods of recording production, some of which are discussed in detail in Chapter 2 (pages 63–4) and Chapter 9 (pages 279–81). Methods include:

- taking pictures each lesson
- completing a blog or setting up a social media account and posting the pictures with the information listed below
- putting the pictures into a Word document, PowerPoint or OneNote, updating an ongoing production record
- printing out your pictures and collating them into a handwritten record
- creating production videos.

Your production record needs to include:

- images of production and the date
- a description of what steps you are completing in the production plan
- any modifications to the production plan
- discussions and feedback from team members.

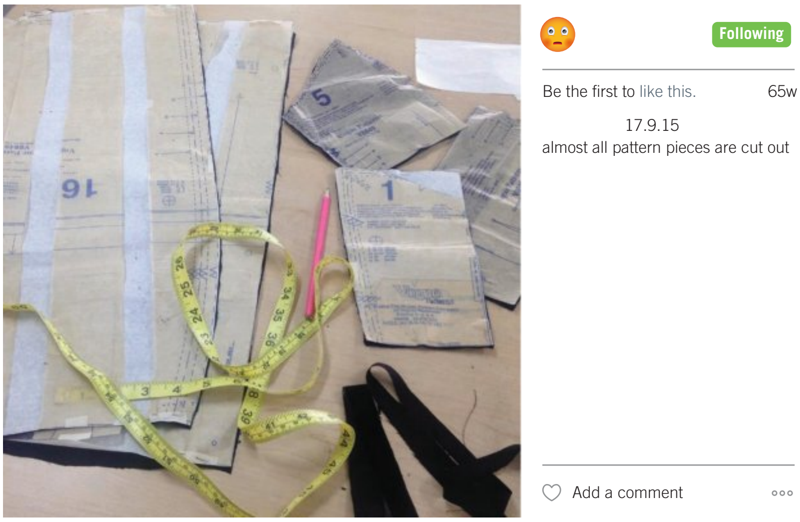

Figure 4.7 Student production journal using social media, allowing for group feedback

Reflecting on previous methods used to record production

If you undertook Unit 1, ask yourself some of the following questions and share your reflections with your team.

- Did I record every time I worked on my product? Why/why not? What could be done better?
- Should I trial a new method of recording or modify the type I have already used?

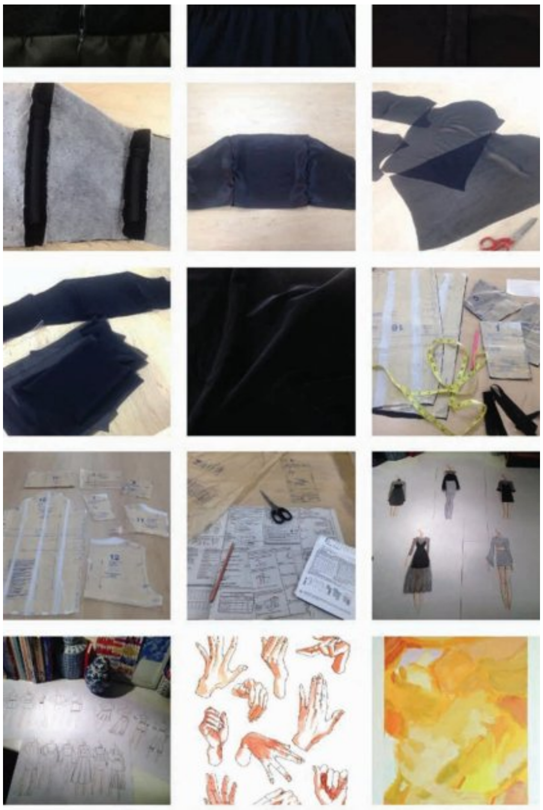

Figure 4.8 Overview of a student group blog using social media

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- Did I write enough detail in my record?
- Did I mention modifications and changes in the production plan?
- Did I follow my production plan?

As a part of a team, each member will need to be clear on how they are recording their production. Your teacher may choose which way they would like you to log or may ask that you inform them of your choice.

You might decide to hold a team meeting and discuss how you are going to record your production within your group:

- Will all team members use the same recording style or each use their own preferred style?
- Will you create an online version of a record so all members and your teacher can see your record?
- What are the expectations for the production record? How much detail? How many pictures per record?
- How will modifications be recorded? As an effective team member, creating a detailed record will help your team in reflecting how well you have worked together in creating your product/s.

Remember to:

- record all production processes and production steps
- create a new record every time you start working on your product
- let your team members know if some production steps are taking longer than expected
- keep your production record somewhere safe – back up files or print out records regularly.

Modifications during production are part of the product design process. Materials may not be available or some production processes may be taking too long. As a team, you will need to create a clear outline of how you will tackle these challenges. Below are some questions that your team can use as starting points for discussing recording any modifications of the product:

- Will all modifications need to be discussed in a team meeting?
- Will modifications occur if a majority of members agree or only if all agree?
- If a small modification is needed, will a note in the production plan be required or will a quick discussion with a team member be sufficient?
- In a range of products, if one product needs modification, will the other products need modification?

Team modifications log

Modifications	Team meeting date	Team notes	Team signatures
Material colour changed due to material no longer available	August	Team agrees that colour will change to a similar colour in stock	
Finishing technique changed	August	Team has agreed to use a similar finishing technique due to time constraints	

Table 4.4 Example of how to log modifications completed in production

The key point in production records with a team is to ensure that everyone knows how each member is going in the production. Be honest in your production record and communicate with your team.

- **Complete a weekly production record on page 110 of the workbook, Activity 4.1.**

ACTIVITY 4.2

1. Why is it important for each team member to create a production record?
2. Explain what happens when modifications are needed during production.
3. How can a team work together to create a product?

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4.3 Methods to evaluate the suitability of the group product/s as a solution to the design brief

Checking the product in relation to evaluation criteria

In Outcome 1, your team developed criteria to evaluate your product/s. Checking your product against these evaluation criteria can help the team understand if you have met the requirements of the brief. It is key to give both constructive, honest and helpful feedback at this stage of the product design process.

The extent to which the product was influenced by an historical or contemporary cultural design movement or style with consideration of user-centred design factors and sustainability

You must also gather feedback as to how well your product reflects its influence of your chosen cultural movement. This could be done by

- asking members of your team
- comparing your product to your previous research
- surveying friends and family members.

You must also reflect on the sustainability of your product. Consider how successful you were at incorporating sustainable design thinking in your product, as well as the product's environmental impacts, in both producing the product, and how the final product may be used. For example, a silk dress may need dry-cleaning, increasing its environmental impact. A life cycle analysis/assessment (LCA) provides a structure to assess the impact. (See Chapter 1 for more information on sustainability.)

Observations and feedback from others

Working in a team is a great opportunity to gather feedback from others on your own effectiveness in the product design process, as well as give helpful feedback to others, with the aim of improving your design skills.

Activity 4.3 shows how you can gather feedback from your design team.

Suggestions for improvements

Finally, you must reflect on your own evaluation, plus feedback gathered from others, to make a summary of areas for improvement. Identifying your strengths and weaknesses both as an individual and as a team is suitable. Ideas to respond to could include the following:

- If you were to complete this process again, what would you change in your design?
- What production processes could you improve on?
- What steps in the stages of the product design process could you improve on if you did this again?
- In what ways could you improve as a team?

ACTIVITY 4.3

Using your evaluation criteria to gather team feedback

1 Get your pre-written evaluation criteria from Outcome 1 (Chapter 3). Add new columns to the right for yourself and your team members (see Table 4.5). Delete the justification and ways to achieve columns.

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2 Get your end product/s, and team members, and work through each criterion. For example, is the finished chair comfortable to sit on? This requires an end-user/s to sit on the chair and find out.

3 Collate all this information into a table similar to Table 4.5.

Team member evaluation of a dress

A question	How the finished product could be tested or checked	Myself	Team member 2	Team member 3
How effectively was a 1960s theme incorporated in the design?	Compare the finished product with our 1960s research and discuss as a group	The inspiration, Mary Quant, Twiggy and the swinging sixties, is reflected in the babydoll style and short hemline of the dress.	The miniskirt style of the design is very sixties, yet the design is modern.	The dress is very on trend and looks both 'festival ready' and sixties inspired. The fabric print could have been more inspired by the sixties.

Table 4.5 Sample evaluation by team members of a dress

CASE STUDY

Working in a team at Peter Alexander

Your team and role

I am a product manager in the Production team. The Graphics team will develop prints and artwork, then we get to design the shape of the product and get it made. It's a fun product and it is rewarding to see product you have designed in a store – as well as to see how much people love the brand!

Roles in the team

There are three major teams, Graphics, Production and Quality Assurance, as well as planning, allocation and visual merchandising staff. In the Production team we have:

- Supply coordinators: These guys are responsible for raising the purchase orders and liaising between factory, distribution centre and head office – ensuring that product gets from the supplier to our stores on time. They also oversee important aspects of social compliance (ensuring that all our factories meet standards and are safe places to work).
- Product coordinators (also known as design assistants): They assist the product managers in range development, do all the production tracking, chasing suppliers, manage the flow of samples, coordinate shoot samples, do approvals with the manager.
- Product managers (also known as designers): That's what I do! In a nutshell, we develop the range, liaise with suppliers to get it made, negotiate prices, approve all the elements like lab dips, fabrics, prints, fit, etc., work with our planners to ensure that we have the right mix of options and quantity.
- Creative director (that's Peter!): Peter creates the range concepts and works with the graphics team to create the prints that reflect this. He then hands it over to the production team.
- Head of production: Oversees the production team, suppliers and quality assurance. Works on sourcing new suppliers and ensuring that all production runs smoothly so everything gets to store on time.

Communicating with your team

We communicate face-to-face with the office team, and mostly email offshore suppliers (who we also talk to face-face when completing factory visits).

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Your product design process

It is a six-month process, involving:

- Creative director (sometimes others) comes up with the range concept.
- Graphics team is briefed on the concept, and develops prints and graphics.
- Production team design the range and begin the production process, including many rounds of fitting and fabric testing.
- Suppliers send goods to the distribution centre, then goods are distributed to stores. This also involves the stock allocation, marketing and visual merchandising teams.

What inspires you?

Lots of things! As Grace Coddington famously said, 'Always keep your eyes open. Keep watching. Because whatever you can see can inspire you.' This is true! I can be inspired by fabrics, photos, movies, a certain piece of clothing or a sample I might find that can spur different ideas. I can be inspired by different trends or even by wanting to evoke a certain emotion in the wearer. As I design for a certain brand, what inspires me a lot is the Peter Alexander customer – what does she want/like/need? What do I want her to feel?

Intellectual property

Unfortunately, my work has been copied; it seems to be the nature of the beast in this industry. Peter Alexander are leaders in sleepwear and we often develop quite innovative product. It is good motivation to keep things new and keep moving forward!

Steps to ensure a quality product

We work together with the quality assurance team, who work really hard to ensure that the Peter Alexander quality is maintained. This includes:

- Fitting the garment (first fitting, second fitting, third fitting if required, pre-production sample and shipment sample): The garment is measured and we do fit sessions to ensure that it all looks and sits right.
- Ensure a soft hand feel and quality fabrications: This is achieved through print, knit, weaving, brushing, washes and softening techniques.
- Have fabric tested: All our fabrics must be tested to ensure that they meet our standards. They are tested for things like colour fastness, pilling, shrinkage and seam slippage. We also do wash and wear tests to ensure that the product not only looks and feels great but is comfortable and durable.

Figure 4.9 Product managers and coordinators can also manage photo shoots for the marketing of a product

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Extent to which the product was influenced

One of the main design constraints of your team product is that it must be influenced by a historical or cultural design movement. During the design and investigating stage, your team would have found a historical or contemporary design movements, cultures or styles that inspired your team's designs.

There are many ways to check if your final product clearly reflects this inspiration.

Compare designs to the final product

During the design and development stage, your team created a design for the product/s you will be making. Place the designs and final product together.

As a team, reflect on these areas:

- What similarities and differences are there between the design and the final product?
- What key ideas worked well in the product?
- What ideas looked great in the design but didn't turn out as expected in the product?

Design elements and principles and product design factors

You can choose to use design elements and principles and/or product design factors when your team members reflect on the designs and the final product. This will help you focus on the specific aspects of each design and clearly identify the similarities and differences.

This page should be filled with information. You can write the similarities and differences in columns (see Table 4.6), or you might choose to draw arrows and provide relevant and clear annotations.

Historical and contemporary design movements, cultures or styles

How does your team's final product or product range reflect historical or contemporary design movements, cultures or styles with considerations of user-centred design factors and sustainability?

Your team designed with a focus on historical or contemporary design movements, cultures or styles. Does your final product or product range show this?

Comparing the similarities and differences of a design to a final product

Picture of design	Similarities	Differences	Picture of final product
Garden stool	• Made from recycled metal • Both have a compartment for holding three garden tools • Both are lightweight and easy to carry • Both fold away	• The seats are covered in a different fabric • Only one seat has a back support	
	You can refer to the product design factors and/or design elements and principles when discussing the similarities and differences of the design and final product.		

Table 4.6 Example of how to compare the similarities and differences of a design to a final product

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Using the design elements and principles to determine historical influence on a product's style

Arts and Crafts inspired tableware – how it has influenced the design in relation to design elements and principles	
Design elements	**Design principles**
Influence can be seen in the following ways: • **Line**: The lines on the organic surface decoration curve and swirl in varying thickness. • **Texture**: The surface of the fired clay with glaze is smooth with prickly textured leaves. • **Colour**: The colour of the glaze is a calm subtle green reflecting nature.	Influence can be seen in the following ways: • **Space**: The decorative leaf and petal feature lining the rim of the bowls and plates is evenly spaced. • **Pattern**: In the centre of each bowl and plate is a decorative pattern of swirls and circles.

Table 4.7 A historical influence on a product's style with reference to the design elements and principles

You could list how you think your final product or product range reflects this with reference to the design elements and principles.

User-centred design factors

Your team designed with an end-user/s in mind. Looking at the final product, how does your product fit the requirements/expectations of your end-user/s?

As a team, how have you met the user-centred design factors according to your end-user/s' needs and wants?

DID YOU KNOW?

You may choose to interview your end-user/s while planning your product or product range. The more information you can get beforehand will help reduce the number of changes you may need to make later on.

Sustainability

Considering sustainability was an important part of your Unit 2 collaboratively designed product, how successful were you in producing a product or product range that is sustainable?

Table 4.8 provides an example of how your team members could reflect on these key aspects of your Unit 2 collaboratively designed product. You could ask team members to fill out the reflection sheet first and then compare and discuss their responses, or you might choose to discuss the questions in your team and have someone fill in the responses.

DID YOU KNOW?

Furniture style – the way it looks – stems from social and artistic influences of the time. In Britain during the Victorian period (1837–1901) there was a large range of Victorian styles that influenced furniture design. These styles reflected different groups of people who wanted to show off who they were and how much money they had. Victorian furniture was based on a wide range of styles that developed from architecture and past furniture design.

Victorian furniture styles included:

- Medieval and Tudor
- Japanese
- Arts and Crafts
- Liberty.

Furniture during this period was usually made from ebony, mahogany, burr walnut and rosewood. Typical features of Victorian furniture were elaborate carvings, exaggerated curves, lush upholstery, dark finish and heavy proportions, with influences from Gothic, Rococo and Louis XV styles.

Today we no longer have to show off our social status and wealth by filling our homes with pieces of elaborate furniture. There are many other products we can purchase to do this.

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Figure 4.10 Victorian walnut breakfast table with carved central support, 1850, United Kingdom

Identifying how well the end product or product range demonstrates user-centred design, sustainability and historical and contemporary design movements, cultures or styles

How did our team achieve the following aspects in our final product or product range?		
Historical and contemporary design movements, cultures or styles	**What needed to be achieved?**	**Has this been achieved?**
The end-user/s wanted a range of Arts and Crafts inspired ceramic tableware (bowls and plates).	The end-user/s asked that the tableware reflect the Arts and Crafts movement, be glazed in colours typical of that style and have decorative features on the surface.	This has been achieved with all six bowls and six plates. William Morris's wallpaper designs were a big inspiration for the surface decorations.
User-centred design factor	**What needed to be achieved?**	**Has this been achieved?**
The tableware needed to create a sense of well-being in the end-user/s' home, something elegant and beautiful to look at that would be used for special occasions.	The design of the bowls and plates needed to respond to the end-user/s' sensory appeal and reflect elegance and beauty that would be used for special and memorable occasions.	The end-user/s was involved throughout the product design process. She was shown examples of existing Arts and Crafts ceramic tableware and during the design phase had a lot of input into the surface decoration and choice of glaze. On seeing the finished bowls and plates, she was elated and overjoyed at how much beauty she saw in the pieces. She couldn't wait to take them home and use them for her mother's upcoming 50th-birthday dinner.
Sustainability	**What needed to be achieved?**	**Has this been achieved?**
The end-user/s wanted a range of Arts and Crafts inspired tableware (bowls and plates) that were made from clay we dug ourselves and fired using an alternative firing technology that is sustainable.	The clay used to make the Arts and Crafts inspired tableware needed to be sourced locally and fired using a sustainable firing technology somewhere local.	As the town has a number of local potters, it wasn't too difficult to find a potter who was able to fire the Art and Crafts inspired tableware using a sustainable firing technology and provide information on where clay could be sourced.

Table 4.8 Example of a team reflection sheet to identify how well the end product or product range demonstrates user-centred design, sustainability and historical and contemporary design movements, cultures or styles

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ACTIVITY 4.4

1 Compare your product/s to your team design/s. List the similarities and differences.
2 Discuss with your team how well your historical or contemporary cultural design movement or style influence is reflected in the final product or product range.
3 Could you have considered using sustainability in another way?

Observations and feedback from others

During the product design process, your team needs to gain feedback from end-user/s as identified in your team's design brief. This works best if the feedback is genuine and constructive, from typical end-user/s of the product or product range.

As designers, sometimes we can get carried away during production and the final product may differ from our designs and no longer meet the requirements of the brief. The product or product range might match our designs, but when created may not be as functional as intended.

Feedback will help us ensure that, if the product or product range is made again, these issues will not occur.

Gaining feedback from others is vital when creating products for end-user/s. As designers, we might not see issues in the product design until they are pointed out to us.

If the feedback you have received in Chapter 1 was not as useful as you wanted, then you could arrange a team meeting and discuss how your team might improve feedback quality.

Here are some ideas on how to improve feedback:

1 Check your questions are clear and easily understood.
2 Ask feedback from others when they have enough time to answer the questions in the detail you require.
3 Ask open questions.
4 Let the person talk openly and don't dismiss their points.

Figure 4.11 Feedback is important and should be from multiple sources.

There are many ways to evaluate how successful the product is as a solution to the design brief:

1 Place the product in the context it will be used.
2 Observe the end-user/s using the product.
3 Ask the end-user/s to talk through what they like about the product and what they think needs improving.
4 Ask the end-user/s to judge if the product matches the design.

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Logging end-user feedback

Logged feedback from end-user/s of the Arts and Crafts inspired tableware	
Questions related to the product design factors	**End-user/s' response**
How do you think the tableware looks in the context it was designed for? Do you think the tableware does what it was designed to do? Do you think the tableware functions well?	The tableware looks elegant on my dining room buffet and the colour matches the room decor. The bowls and plates are a good size. The bowls are deep and suitable for my favourite desserts and the plates are large enough for the main meals I like to cook. The plates and bowls are not too heavy, are easy to carry and are easy to clean.
Does the tableware meet your sensory need?	The tableware is beautiful and elegant and its calm green colour makes it a special centrepiece in the dining room.
Do you think the decorative surface features and glaze colours reflect the Arts and Crafts movement?	I am very happy with the surface decoration and glaze colour. It is what makes the bowls and plates reminiscent of the Arts and Crafts style.
Are you happy with the visual/aesthetic look of the tableware?	Visually, the tableware looks beautiful and elegant on my buffet in the dining room. The bowls are deep and this makes them look quite large against the plates. Perhaps their size detracts from the overall elegance of the tableware a little.
Does the tableware satisfy your sustainability concerns?	I am very impressed that you sourced the clay from the earth yourselves and used an alternative method of firing the clay that is less harmful to the environment.
Are you happy with the length of time it took to make the tableware? Are you happy with the final cost of the tableware?	I was a little disappointed that the firing and glazing process took longer than you anticipated and as a result it was not ready in time for my mother's 50th-birthday dinner. I am very happy with the final cost of the tableware. Even though the glazing and firing process took longer, you were able to stick to the allocated budget.
Are you happy with the clay sourced?	Yes, I think the tableware is fairly durable. The decorative leaves and petals around the rims of the bowls and plates have the potential to chip or scratch if not handled carefully.
Do you think the production processes chosen were the best methods?	I wanted clay to be sourced from the earth and made using a potter's wheel (traditional production methods) and the end result is beautiful pottery with a natural elegance.

Table 4.9 Logging end-user/s' feedback

ACTIVITY 4.5

1. Create a questionnaire that you can give to others to gain feedback about your product.
2. Why is feedback important in design?
3. Why is it important to log end-user feedback? Provide two important reasons.

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Suggestions for improvements

A product or product range might be a satisfactory solution to the design brief, but what else could have been altered to create an even better solution?

That is the question a designer should always be asking themselves. Use all the information you have gathered from the start of the design process to the feedback you obtained from the end-user/s and in a team meeting discuss where the product could be improved.

Where to improve in the product	Ideas for improvement
Parts of the product do not fit together seamlessly.	Take more time when cutting out materials.
The fabric is puckering in the seam lines.	Check seams before moving on to the next production step.

Table 4.10 Examples of improvement ideas

Below are some questions that can help your team discuss improvements during the production stage:

- Did the team complete all components of the product/s?
- Did all members follow the sequential production steps?

How will you use the information gathered on improvements for the product/s? How will it make you a better designer?

TIPS

Create some personal goals to focus on.

- I will use feedback to improve my designs.
- I will listen to the end-user/s and understand their expectations.
- I will create a design brief that includes many product design factors.
- I will follow my production plan so I can finish my product.
- I will work safely in production.

ACTIVITY 4.6

1 Identify aspects of the final product that could be improved.
2 Explain why products are always being improved.

- **Complete an end product evaluation with team feedback on page 112 of the workbook, Activity 4.2.**

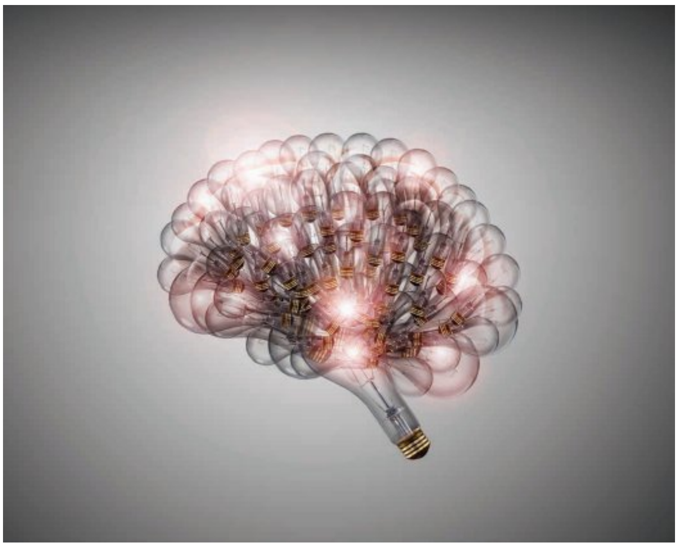

Figure 4.12 Feedback helps give designers ideas on what needs to be improved.

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Chapter summary

- Working in a team means continual communication between all members to ensure continuity.
- Working effectively as an individual is vital in team work.
- Inspiration from sources needs to be clear from design to the final product.
- Production record is a vital part of the product design process, as it helps designers keep on track during production.
- Evaluation criteria are used to evaluate the final product.
- Feedback is important to judge the success of a product in relation to the design brief.

Short-answer questions

1 Explain how you can compare your finished product to the end-user/s' expectations of the product.
2 Explain why feedback is important when the product is completed.
3 Outline the methods you can use to determine the sustainability of your finished product or product range.

Extended-response questions

1 Explain why evaluating the finished product is an important part of the product design process.
2 Reflect on how the end-user/s affect the final product design.

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Unit 3
Applying the product design process

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Figure 5.1 Denise Lasprogata, Braille clothing designer, in her home office with two blind end-users

5 Area of Study 1: Designing for end-user/s

INTRODUCTION

This area of study requires you to refine skills in the initial stages of the product design process and develop a design brief to find viable solutions for end-user/s. You will consider the needs and wants of the end-user/s and explore how to solve the design problem.

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KEY KNOWLEDGE

- the relationship between designer and end-user/s and their respective roles
- stages and steps of the initial stages of the product design process
- product design factors that influence the designer
- use of appropriate market research methods to explore product design factors identified for an end-user/s
- methods used by a designer to create a design brief, including collecting, recording and developing relevant information about the design problem and the specific requirements of the end-user/s, and reference to product design factors
- the purpose and structure of evaluation criteria
- relationships between the design brief, evaluation criteria, research and product design development activities.

KEY SKILLS

- describe the stages and explain the goals of each step of the product design process
- develop a design brief and identify aspects that require research
- outline research to explore and develop creative design ideas to meet the requirements of the design brief
- develop evaluation criteria based on the design brief.

5.1 Relationship between designer and end-users and their respective roles

Chapter 1 discussed the importance of empathising with your end-user/s to understand their needs and wants. The better your ability as a designer to empathise with your end-user/s, the more successful your end product will be. The designer and end-user/s should be in continual contact throughout the product design process so that you as the designer are able to identify what steps are working well, and what steps need to be improved or changed, and then be able to communicate this information to your end-user/s clearly, ensuring that any misunderstandings between you and the end-user/s are minimised and resolved.

Below are some simple ways a designer and an end-user can create an open dialogue.

Roles of the designer and end-user/s in the product design process

The role of the designer

- Have an empathetic understanding of the end-user/s' needs and wants for the intended product.
- Continually seek feedback from your end-user as you work through the steps in each of the stages of the product design process.
- Arrange meetings frequently with your end-user/s and provide examples of the progress being made.
- Design a safe product.
- Create a product that meets the end-user/s' requirements.
- Create a product that considers contemporary design thinking and is sustainable.

The role of the end-user/s

- Clearly state your needs and wants for a product to the designer, including economic needs.
- Communicate honestly with the designer when asked questions throughout the product design process.
- Attend arranged meetings with the designer and provide honest timely feedback.
- Use the product as intended.

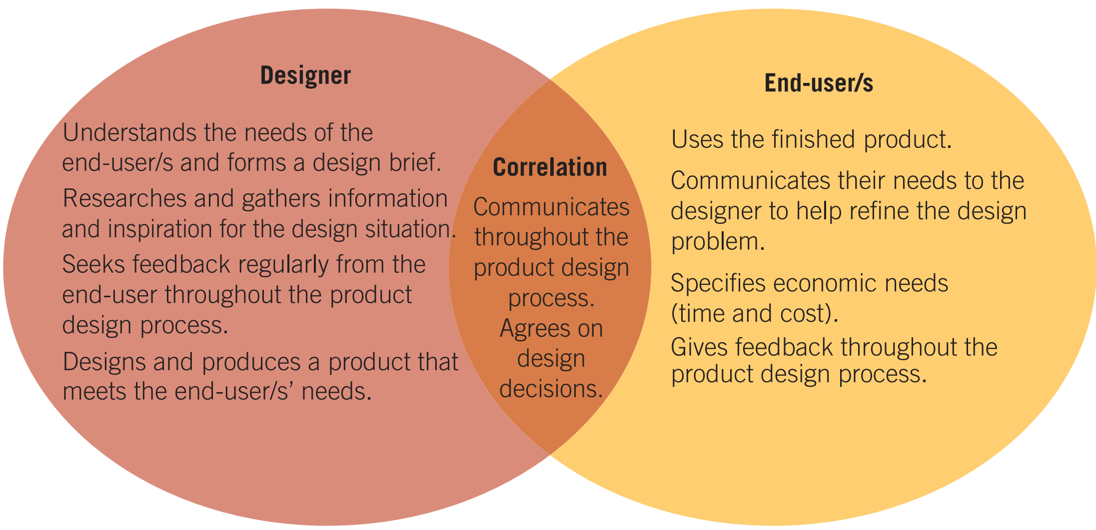

Figure 5.2 The designer and end-user/s and how they correlate

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Roles of the designer and end-user/s in industry

The roles of designers and end-user/s can differ greatly in industry, depending on the scale of manufacturing. Often designers will have to consider the needs of a group or **target market**, rather than work to the needs of an individual. This requires a designer to consider the product design factors of the group. For example, a children's furniture designer will need to consider ergonomics and user-centred needs (such as the height of a child) and economics (for example, how much a parent is willing to pay). Scenarios that product designers could find themselves in include:

- a product developer working as part of large company who mass-produces lunch boxes and plasticware to be sold nationally at supermarkets
- a costume designer working for a theatre company designing costumes for a range of chorus performers
- a jewellery designer who designs and manufactures their products themselves at a low volume, selling them at markets and online
- a custom furniture maker who advertises their services online and creates custom pieces for individual customers.

target market
a group of potential customers of the product

ACTIVITY 5.1

Discuss with a classmate how the designers in the above scenarios could acquire more information about their end-user/s.

CASE STUDY

Jeremy Scott and Katy Perry

Figure 5.3 Jeremy Scott and Katy Perry

Figure 5.4 Katy Perry at the 2015 Superbowl half-time performance wearing a costume designed by Jeremy Scott

Quirky American designer Jeremy Scott has an ongoing designer–client relationship with pop star Katy Perry. As well as being a friend, she is considered a muse to the designer, and this dynamic allows them to collaborate together on designs for events, such as her performance at the 2015 Superbowl, that both reflect the designer's aesthetic and suit the pop star's persona.

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The Superbowl performance (a highly televised event) provided a new challenge for their designer–client relationship, with extra considerations for the live show, including lights and costume changes, as well as the designer taking inspiration from each of her songs to suit the performance, as well as being appropriate for a family audience.

Jeremy Scott has a less personal relationship when designing for ready-to-wear label Moschino, catering for a wider range of end-users who can buy garments, produced on a low-volume scale, in-store. His designs are often seen on other pop stars and he is known for his eye-catching and humorous aesthetic.

User and designer expectations and product design factors

How we use and rank the importance of product design factors and apply them when creating products is left up to the designer. End-users usually believe that designers know how to create something that functions as we intended.

In the ideal design world, the end-user/s' and designer's idea of a product should match. Yet, we know as designers that some end-users may have an unrealistic expectation of the product and don't understand the product design process and what is possible, particularly when a product has various constraints that need to be met.

A designer and end-user/s must reach mutually agreed expectations about the product. Once agreement is reached, a realistic, achievable product can be created to improve the end-user/s' quality of life.

The nine product design factors

Product design factors	Parameters
1 Purpose, function and context	The need for a product The primary and secondary functions of a product Where the product is going to be used
2 User-centred design	How to improve the quality of life of end-user/s and meet their needs through design, including: • ergonomics and anthropometrics • social and cultural considerations • age and budget • emotional appeal • physical needs and comfort • fashion and trends
3 Innovation and creativity	The implementation of creativity, innovation and originality in design, through (but not limited to): • improving and modifying existing ideas • use of new materials and technologies • experimentation and invention • research and development
4 Visual, tactile and aesthetic (design elements and principles)	The look, feel and style of products and consideration of the design elements and principles The elements are the building blocks, including point, line, shape, form, texture, tone, colour, transparency, translucency and opacity. The principles complement the elements, and include balance, contrast, repetition, movement/rhythm, pattern, proportion, asymmetry/symmetry, negative/positive space and surface qualities.

(Continued)

Table 5.1 The nine product design factors with parameters

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Product design factors	Parameters
5 Sustainability	The consideration of the product's social, environmental and economic (the three pillars) impacts, and the use of models and systems to assess and promote sustainability, including: • life-cycle analysis/assessment and life-cycle thinking • use of renewable energy and resources • carbon footprints • models of sustainability, including EPR (extended producer responsibility), DfD (design for disassembly) and cradle to cradle
6 Economics – time and cost	The time and cost to make a product
7 Legal responsibilities	The legal considerations of a product and its manufacture and use, including: • intellectual property • safe products and OHS • standards, including Australian and International standards and mandatory labelling standards
8 Materials and properties	The materials used in product design and their characteristics and properties
9 Technologies – tools, processes and manufacturing methods	The available and emerging technology, machinery and processes used to create products, from raw materials to products ready to use (for example, a drill, a sewing machine)

Table 5.1 The product design factors with parameters *(continued from previous page)*

Complete the relationships between designers and end-user/s Activity 5.1 on page 114 of the workbook.

ACTIVITY 5.2

Develop questions you can ask your end-user to gain an empathetic understanding of their needs and wants.

ACTIVITY 5.3

What are some ways you could address contemporary design thinking and consider sustainability for an end-user's product?

Figure 5.5 The designer and end-user/s should be in continual contact throughout the product design process

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5.2 The stages, steps and goals of the product design process

Figure 1.21 on page 20 provides a diagram of the product design process steps and stages. Chapters 7 and 9 provide examples of student work at various stages during the product design process. These steps and stages can be revisited and repeated and are described below.

Investigating and defining

Step 1 – Identify the end-user/s

In this first step, you identify the end-user/s and establish one of the following:

- Need: Does an end-user/s have a need for a product?
- Problem: Is there a design problem that needs to be solved?
- Opportunity: Is there a niche market that is not being catered for?

Step 2 – Design brief

Once you have established the need, problem or opportunity, the goal is to gather this knowledge and develop a design brief, including:

- an outline of the context
- constraints (aspects about the product you can't change) and considerations (aspects you need to consider as a designer)
- the expected quality of the product.

You must also annotate your design brief as part of the school-assessed coursework (SAC), identifying the product design factors and potential areas for research.

Step 3 – Evaluation criteria

It is important that you are able to identify how well you have achieved a successful product that satisfies the design brief. To do this, you develop a set of criteria in question form that focus on different aspects of the product and are developed from the design brief and link to product design factors.

For example: Question 1 Material for a footstool cushion – How durable is the cushion's material?

Step 4 – Research

Once you have identified your end-user/s and the need, problem or opportunity and have written a design brief and evaluation criteria, you are then able to research factors related to the design brief, such as suitable materials and production processes, as well as gather inspiration. Getting this research right is vital in creating a product that meets the needs of the end-user/s.

Design and development – conceptualisation

Step 5 – Visualisations

Concept sketches and drawings

These are quick thumbnail sketches that are informed by your research. In Units 3–4, you must gain feedback from an end-user/s on your visualisations, and document this in your folio. This gives you guidance as to which ideas you should develop into design options. Your visualisations should show a development of ideas. These ideas should happen quickly and not be a stage of drawing that is slow and time-consuming. Ideas can happen quickly and spontaneously, and you want to sketch them onto paper while they are fresh in your mind. Your concept sketches might be as basic as simple stick drawings using ballpoint pen or more expressive using a 2B pencil. Whichever method works for you is fine.

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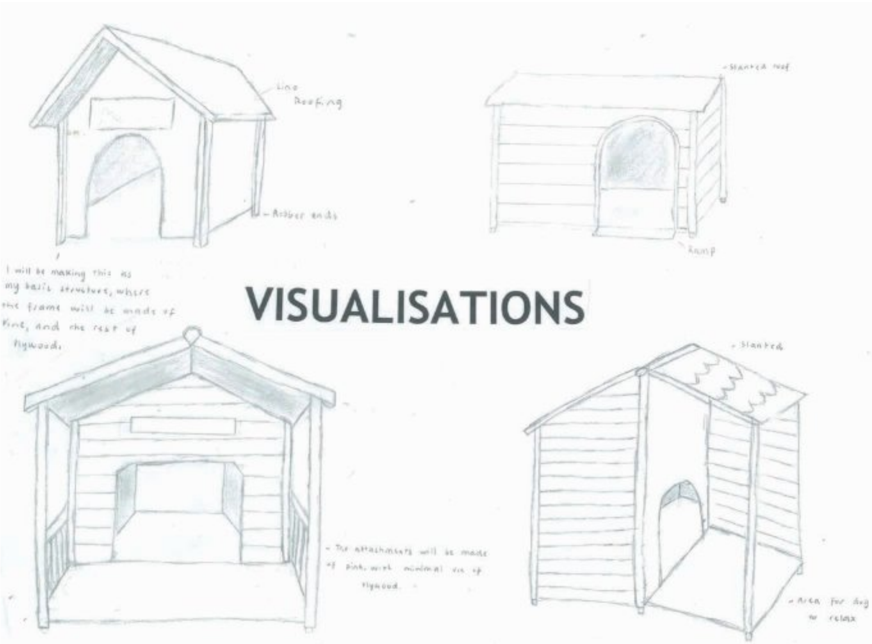

Figure 5.6 Visualisations for a dog kennel by student Dylan Vella

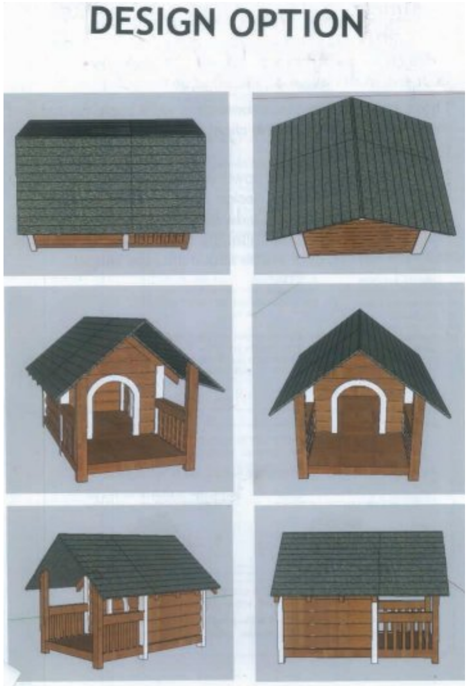

Figure 5.7 SketchUp design of student Dylan Vella's preferred design option for a dog kennel

Mock-ups and 3D modelling

If you choose to create mock-ups or 3D models of the whole or part of your ideas, this process will help you understand what aspects of your product transfer easily into 3D and what aspects do not. This allows you to then make the necessary modifications to your ideas, bringing you closer to creating a product that will satisfy the requirements set out in the design brief. This form of research can be suitable for various stages of the product design process.

Step 6 – Design options (presentation drawings), selection and justification of preferred option

After gaining feedback from the end-user/s, you can select the visualisations (concept sketches) or mock-ups/3D models that you will further develop and draw as design options (presentation drawings). These drawings are skilled, coloured and annotated drawings that show what the product will look like, and help the end-user/s decide on the preferred option.

For resistant materials, you might choose to use 3D drawing techniques, such as isometric or oblique drawing, or computer-aided design (CAD), such as SketchUp.

Step 7 – Working drawings

Working drawings help you communicate how the preferred option should be made, including the size, measurements and construction methods that will be required for production planning, and are drawn to scale.

For more detailed information on working drawings, refer to Chapter 1 (pages 32–5) for both resistant materials and non-resistant materials, and Chapter 7 (pages 239–40) for more examples.

Planning and production

Step 8 – Scheduled production plan

This step of the product design process prepares you for production, with the development of a sequenced production plan and timeline that lists all the tools, equipment

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and machines you have researched and intend to use as well as the amount of time you predict your steps will take. You will also develop a materials list, write quality measures to ensure a quality product, and, to support safe working practice, develop a risk assessment that aligns with the tools, equipment and machines you have researched and intend to use.

Step 9 – Production

Once you have a scheduled production plan, timeline and risk assessment, you will be ready to produce a product or prototype, refining and modifying your work as you go. This process needs to be recorded in a production record.

Evaluation

Step 10 – Product evaluation

This is the final stage of the product design process, during which you reflect on your production work and determine its quality and how successfully your product meets the requirements set out in the design brief. To do this, you use your evaluation criteria and end-user/s' feedback and establish possible recommended improvements.

Refer to Figure 1.21 on page 20 for the product design process diagram.

Stages and steps		Goals
Stage: Investigating and defining		Refine and research your design problem to help you best meet the needs of the end-user/s.
Step 1 – Identify end-user/s, need, problem or opportunity		Work out the design problem you will resolve in the product design process.
Step 2 – Design brief	Outline of the situation, constraints and considerations	Clarify your design problem and the end-user/s' needs in a written statement.
Step 3 – Evaluation criteria	Development of criteria to evaluate how well the finished product satisfies the brief	Generate questions that help ensure that the design and product meets the brief.
Step 4 – Research	Research into factors related to the design brief: materials and process investigations	Begin gaining inspiration and information to assist design development.
Stage: Design and development (conceptualisation)		Creatively develop design ideas through inspired research that meet the needs of the end-user/s, completing drawing styles appropriate for each step's purpose.
Step 5 – Visualisations	Concept sketches and drawings, mock-ups and 3D modelling of whole or part of potential ideas to meet the requirements of the brief	Quickly generate ideas from research that meet the brief. Explore all possibilities for the design.
Step 6 – Design options (presentation drawings), selection and justification of the preferred option	A series of potential solutions evaluated to determine which best suits the requirements of the design brief	Create refined, detailed drawings (CAD or manual methods) that illustrate potential solutions to the design brief. Discuss and decide which design option is most suitable.

Table 5.2 Goals within the product design process stages and steps

(Continued)

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Stages and steps		Goals
Step 7 – Working drawings	Drawings, including technical drawings, showing product specifications (sizes and construction methods) needed for production planning	Create a detailed drawing of the preferred option that will assist in production and planning.
Stage: Planning and production		Safely plan for, and safely produce the preferred option for the end-user/s, as well as document your progress.
Step 8 – Scheduled production plan	Sequenced plan and timeline, listing tools, equipment and machines with risk assessment and a materials list	Plan for the safe and accurate production of your preferred option within your time frame.
Step 9 – Production	Product/prototype and production record; refinements and modifications, including pattern drafting, may be added throughout production	Produce the preferred option safely and with accuracy.
Stage: Evaluation		Critically reflect on how well your product meets the design brief and discuss areas for improvement.
Step 10 – Production evaluation	Evaluation of the product/s' quality using evaluation criteria and end-user/s' feedback; recommend improvements	

Table 5.2 Goals within the product design process stages and steps *(continued from previous page)*

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CASE STUDY

Philippe Starck

Figure 5.8 Designer Philippe Starck holds his Louis Ghost chair at Kartell Talking Minds during Milan Design Week, 2016.

Philippe Starck is a designer who places great importance on innovation, humanity and the environment and is widely respected for his approach to design. This focus as a designer has led him to not only transform the interiors of buildings but also to create various products, including furniture. Starck prefers mass-produced consumer goods over exclusive pieces and seeks ways to make them more affordable. His iconic Louis Ghost chair, originally inspired by eighteenth-century Louis XV wooden armchairs, is an example of a product that is mass-produced.

This chair was first marketed in 2002 and has become one of the most widely bought chairs in the world. It is unique in its design and its function and is made from a single injected polycarbonate mould. This material is clear (hence the reference to 'Ghost') and the production process means that the chair has a uniform appearance, is light and durable, and can be used indoors or outdoors. The historical influence in the chair's design means that it has an elegant appearance and can be positioned anywhere in the home, from a study to a dining room. The chair's transparent material allows it to blend in to any other interior style, and small rooms that would feel cluttered with solid furniture feel larger.

- **Complete the A3 fold-out steps of the product design process Activity 5.2 on pages 116–7 of the workbook.**
- **Complete the A3 fold-out stages and steps of the product design process Activity 5.3 (parts a and b) on pages 118–21 of the workbook.**

ACTIVITY 5.4

List the four stages of the product design process.

ACTIVITY 5.5

List the 10 steps of the product design process.

ACTIVITY 5.6

Describe the goals of the four stages of the product design process.

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5.3 Product design factors that influence the designer

As designers, our role is to design products that find the best solution to a design problem. We have a wealth of knowledge about how to design and produce products. The challenge is to use this knowledge and product design factors to create a product that suits our end-user/s.

All product design factors come into the design of a product. Depending on the product type and scale of manufacturing, some factors may be more important than others. It is our job as product designers to know which factors play the most important roles when we want to create a certain product.

If you undertook Unit 1, in Chapter 1 it was suggested that you focus on the following product design factors for your product:

- purpose, function and context
- innovation and creativity
- sustainability
- materials
- economics.

If you undertook Unit 2, the product design factors you focused on may have varied because your end-user/s had different needs and wants and required a completely different product. As a result, the ranking of the product design factors (with parameters) would have differed.

How to establish a list of influential product design factors for an intended product

Points to reflect on and note down

- What are the most important aspects of the product I am designing?
- How can I use the factors and their parameters to solve the design problem?
- How do each of these product design factors relate to my end-user/s' expectations?
- What product attributes will I need to consider?

You could use your reflection notes and the product design factors to create a survey for your end-user/s to complete, as shown in Table 5.3. This will help to establish what factors are most influential and will lead to a successful product.

If you were going to design a range of recycled paper bracelets for resistant materials or men's scarves for non-resistant materials, what might a list of influential product design factors look like?

Survey – end-user/s' ranking of a product against the product design factors

The survey in Table 5.3 asks two end-users to rank the importance of each product design factor in relation to their design problem. One end-user needs a range of recycled paper bracelets and the other a range of men's scarves.

This example focuses on the three highest ranked factors only.

The three product design factors that are of most value to the end-user who needs a range of recycled paper bracelets are:

1. purpose, function and context
2. innovation and creativity
3. sustainability.

The ranking of these factors is influential in providing the designer with a greater awareness of what the end-user values as important factors in the development of a range of recycled paper bracelets: bracelets that are functional, suit the environment in which they will be worn, are innovative and creative in their design, and are a sustainable product.

The three product design factors that are of most value to the end-user who needs a range of men's scarves are:

1. purpose, function and context
2. visual, tactile and aesthetic appeal
3. innovation and creativity.

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Ranking system used to show two end-users' design problems and the value they place on each of the nine product design factors

Product design factor	Range of recycled paper bracelets – ranking (1 = most important, 9 = least important)	Range of men's scarves – ranking (1 = most important, 9 = least important)
1 Purpose, function and context	1	1
2 User-centred design	7	6
3 Innovation and creativity	3	3
4 Visual, tactile and aesthetic appeal	5	2
5 Sustainability	2	7
6 Economics – time and cost	9	4
7 Legal responsibilities	8	9
8 Materials – characteristics and properties	6	5
9 Technologies – tools, processes and manufacturing methods	4	8

Table 5.3 Survey – ranking system showing the value that end-users have placed on each of the nine product design factors in relation to their design problem

Figure 5.9 A bracelet made from recycled paper is worn by Camilla, Duchess of Cornwall, given to her when she visited Mahis School, Jordan, in 2013.

Once you have established what factors each end-user values the most, you can use this information to develop a relevant and detailed design brief based on the results.

Figure 5.10 A model wearing a man's scarf walks the runway at the Maharishi show during London Fashion Week, 2017.

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How do designers consider the product design factors?

Purpose, function and context

Purpose

The main purpose of a product is its primary function. A secondary function can be added to create appeal, but it is only an added feature.

Function

The function of a product refers to its intended performance. The product must be designed with the expected quality and durability. If the product does not function or perform as expected, the designer has not completed their task of solving the design problem.

Context

The context refers to where the product will be used by the end-user/s. It is vital that the designer understands this, as it directly relates to what materials the product will be constructed from and production processes that will be used. For example, a designer may not want to use a material that is not resistant if worn or used outdoors.

User-centred design

A designer's empathetic understanding of the end-user/s is paramount in improving well-being and quality of life through insightful and clever design solutions. There are many parameters within the product design factors that explore how the user interacts with the product. Depending on your end-user/s, some of the parameters may hold greater value than others. As a designer, you need to incorporate the important aspects into your designs.

Ergonomics

Ergonomics relates to products meeting physical and human needs, such as a computer mouse that fits the size and curve of a hand. Ergonomics should be the first factor that a designer considers before creating a

CASE STUDY

Memphis Group furniture, 1981–87

Memphis Group furniture was all about function following form. This meant the style of a piece of furniture was more important than its function. This focus on style was driven by one of the main designers/artists from the group, Ettore Sottsass, who wanted to break away from the restrictions of functional furniture.

An example of Sottsass' design style, and his most identifiable piece of furniture, is his Carlton bookcase, sometimes referred to as a room divider or dresser. His bookcase is a great example of a style that defined 1980s furniture design. Made from medium-density fibreboard, it was laminated in bright colours. Its design is not typical of a traditional bookshelf, as it has unusual placement and direction of shelving sections based on a system of equilateral triangles, making these aspects of the bookshelf more graphic and stylistic than functional.

Figure 5.11 An Ettore Sottsass 'Carlton' bookcase, Memphis Group, 1981

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design for human use. It will help generate a better user experience and the product will be safe, comfortable and easy to use.

The ergonomic factors required in a design for an adult male will be different for a child or for a person with a disability. Ergonomic design considers human limitations and abilities (anthropometrics) that might alter how the end-user interacts with a product.

Anthropometrics

Anthropometrics is an element of ergonomics. It is a collection of data concerning static and dynamic measurements relating to size and shape of a human body. It is important to think about a typical end-user/s and use anthropometric data to produce a product that fits their body shape or hand size, for example (see Figure 5.12).

You can find information from various sources about anthropometric data. It is easy to design a product that works for us because we are making it, but what if you had to design a product for a child, such as the garden tools pictured in Figure 5.12? The measurements of a child's hand are different from those of a teenager's or adult's hand.

Ways to use anthropometric data when designing:

- Determine the end-user/s. What body dimensions will be important?
- The length of a dress or the height of a table will be different depending on age.
- Determine if you are going to design for the average, adjustable or extreme.
- Will a specific end-user/s or everyone be using your product?
- Find anthropometric data relating to who you are designing for.
- Have this data as a reference point when creating your designs.
- Write down the important data for your reference throughout the design process.

User expectation

Positive and negative feelings about a product can alter how the end-user/s views the product in the future. These feelings relate to the memories created by using products. End-users have vast historical experiences of a variety of products.

They have expectations about how the product should look and work. These expectations can be explored and researched by conducting market research. Understanding the needs and wants for a product will allow the designer to create a product that fits the user's expectations.

Figure 5.12 Children's garden tools are smaller than adult gardening tools.

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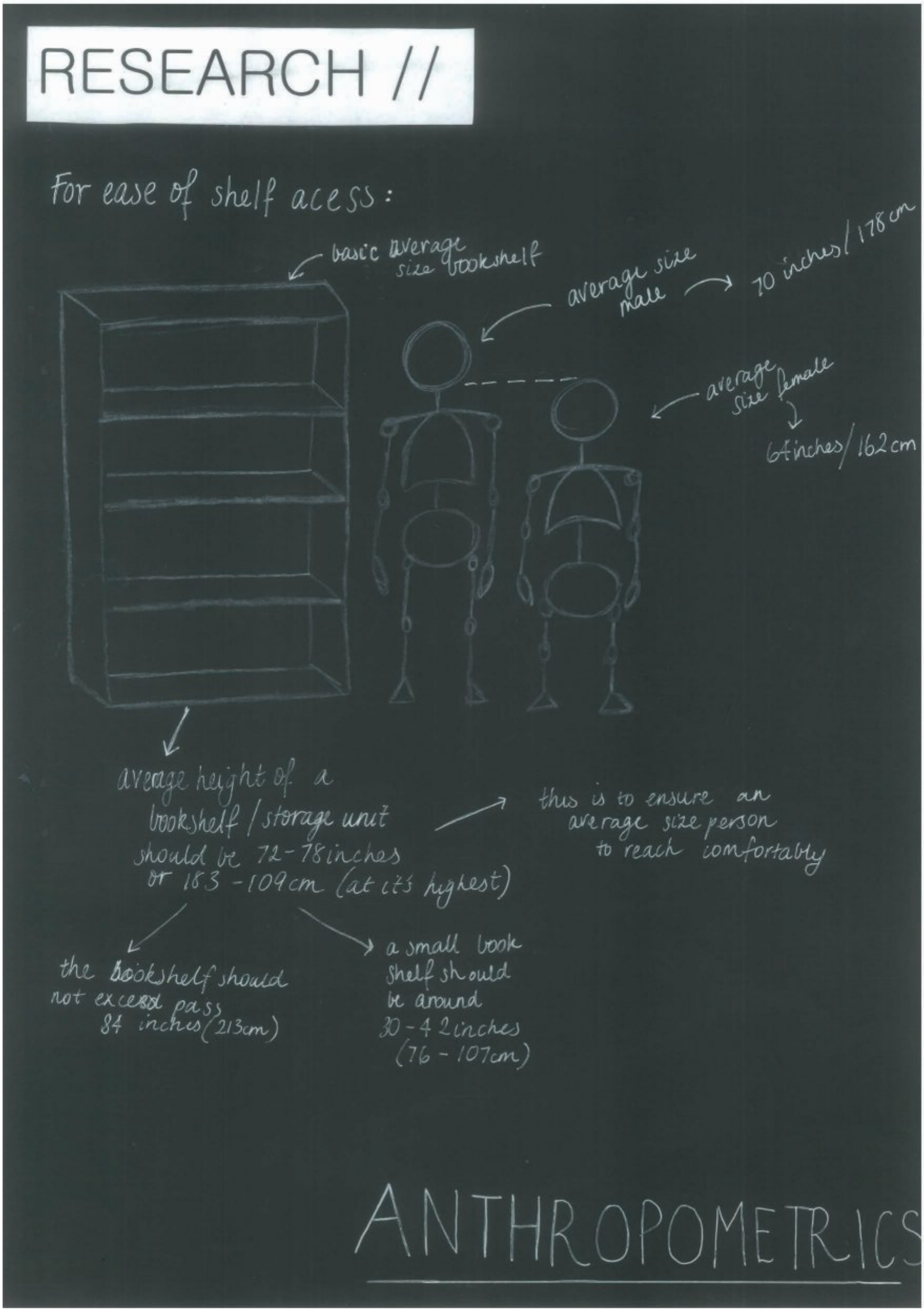

Figure 5.13 Anthropometric research by student Thanh Thy Tran

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Emotional attachment to products

Do you have a product that you can't throw away? Is it a toy that you have had since you were a child, or a family heirloom that's style is obsolete and doesn't appeal to you but has great sentimental value? This is an emotional attachment to a product, and it can be a stronger influence on the end-user/s than they may realise.

A designer needs to understand how emotions can change how the end-user/s views a product. The product could be the best designed product on the market, but if the end-user/s cannot see themselves using it and connect to it, the product will remain on the shelf or be disposed of before its function becomes obsolete.

Figure 5.14 A teddy bear. Do you still have a toy from when you were a baby? Why won't you throw it away?

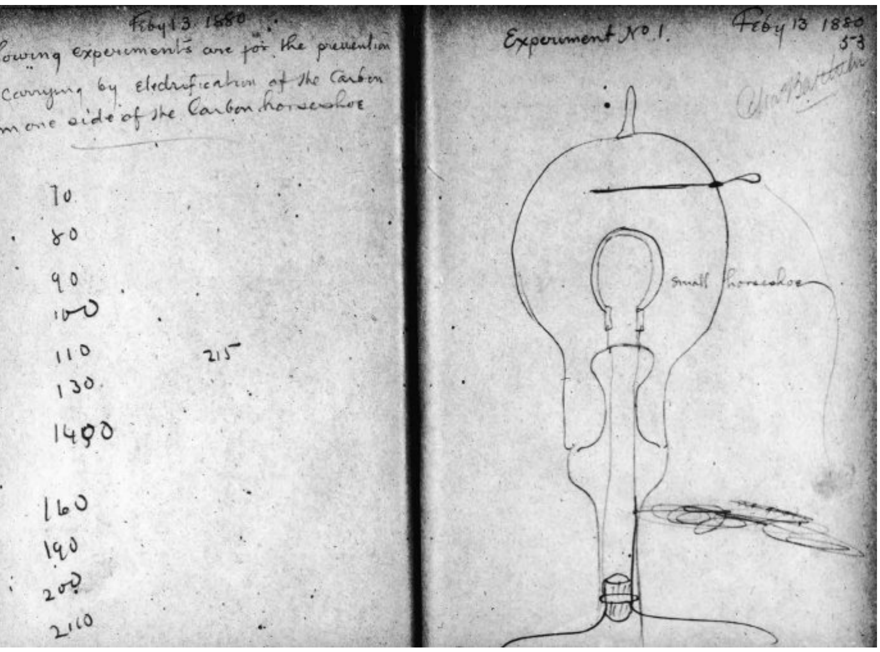

Figure 5.15 Early sketch of a light bulb by Thomas Edison, 1880

Different products that end-users choose to use can give us a sense of their taste and style. We can draw on that information and create a suitable product for an end-user/s.

Some questions to consider are:

- Does the end-user/s want something that will start a conversation because it is different but hard to use?
- Does the end-user/s want a product that may not function as well as others on the market but is aesthetically more appealing?

Market research and understanding the current trends or styles will help us as designers to create products that our end-users will not only purchase but also use.

Innovation and creativity

Innovation

Creating an innovative product that becomes a part of everyday life is the dream of every designer. Thomas Edison succeeded in this way with his light bulb. It is an invention that has become such a part of our everyday life that we take it for granted.

Edison's sketch, shown in Figure 5.15, is a good example of how a great idea doesn't necessarily start from an accurate detailed drawing.

DID YOU KNOW?

Many people now believe it is wrong to credit Edison with inventing the light bulb. He was one of many working on such an idea, but Edison was far better at self-promotion and ultimately wound up being credited, wrongly, as the sole creator. He even had a development team to help him.

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Another innovative product that was ahead of its time is the Polaroid Instant Camera invented by Edwin Land (founder of Polaroid) in the 1940s.

Photos taken with a traditional camera needed to have the film sent off for developing before prints could be made and viewed. Film for the revolutionary Polaroid Instant Camera incorporated the developing chemicals, so the camera itself created the print. Early versions required the photographer to separate the print from the negative, but by the 1970s the camera ejected the print, and the photographer could watch the image appearing.

How would you react if the products we take for granted, such as the light bulb, suddenly no longer existed? It is interesting to consider how products have become ingrained in our lives, and often as end-users we don't remember what it was like without them.

As designers, we need to think innovatively in the way we try to solve our end-users' problems. End-users usually don't know exactly what they want in a product until we offer a solution – a solution that they then cannot live without.

Innovation can happen in two ways:

- by redeveloping an existing product, as in the case of Edwin Land's Instant Polaroid Camera
- by creating a new product, as in the case of Thomas Edison's light bulb.

Each type of innovation has its own challenges. We cannot ask an end-user/s what factors they value in a particular product if they have not seen it, used it or have a memory of it, whether it be a positive or negative one.

Creativity

Taking a creative approach during the product design process will support the development of a product that will stand out from similar products. Perhaps you enjoy the visual arts, perhaps you are studying VCE Art or Visual Communication Design, perhaps some of the creative ideas, research or use of materials in these subjects can be transferred over to product design, keeping in mind you are designing for an end-user/s who has particular needs and wants.

Visual, tactile and aesthetic – design principles and elements

The visual, tactile and aesthetic factor relates to the product attributes. Designers want to design a product that looks amazing but is still functional. It is a balance that you will have to find when creating your product.

For more detailed information on product attributes, refer to Chapter 8 (pages 263–6).

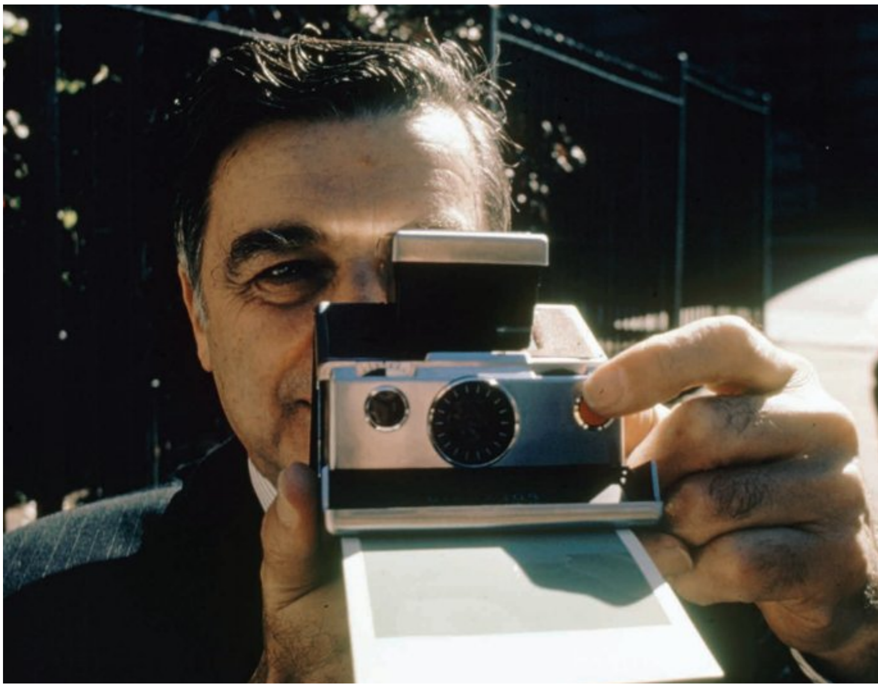

Figure 5.16 Edwin Land taking a picture with a Polaroid Instant Camera, model SX-70, 1972

Figure 5.17 A Polaroid 300 Instant Camera at the world's largest innovation event, Consumer Electronics Show (CES), Nevada, 2014

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Aesthetic

As discussed in Chapter 3, aesthetics and how we view products is purely personal taste. One person may view the product as the most beautiful thing they have seen, while another may think the product is the ugliest thing they have seen. This is a challenge if you are designing for end-users with different personal views or designing a product that goes against the designer's aesthetic.

Visual

How a product looks can be the most important factor to the end-user/s, and as the designer you need to ensure that you design a product that meets this need. Your product may function better than others on the market, but if the end-user does not like it visually, they won't buy it.

Have you ever not bought something because it didn't come in the colour you wanted?

Tactile

The tactile aspect of a product is how it feels. How a product feels can play a large role in how an end-user/s judges a product. Have you ever worn a jumper that is itchy? Did you wear that jumper again? Probably not. Perhaps it was visually appealing and warm, but because it was uncomfortable it did not function effectively and is no longer useful.

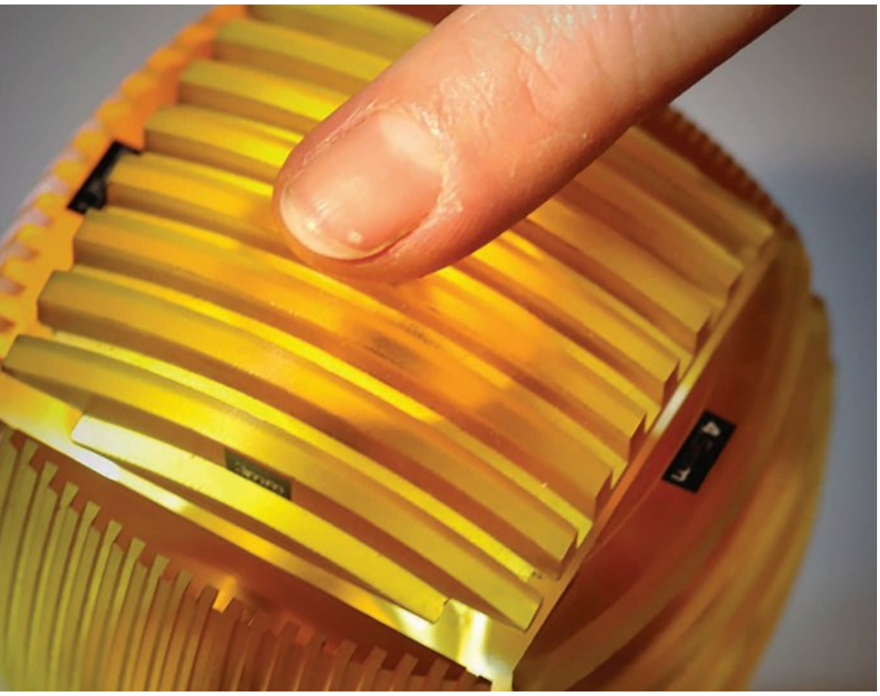

Figure 5.18 How a product feels can change how an end-user/s relates to the product.

As designers, we need to think about how the end-user will interact with the product. We need to explore the tactile aspects of different materials to ensure that we use the correct material to meet the expectations of the end-user. The feel of a product directly relates to how we judge its functionality.

DID YOU KNOW?

Some products are designed specifically for the sensations they cause when touched. Sensory items, such as zipper bracelets, weighted blankets or vests and play dough, are used for children (and even adults) with sensory issues. For some people, a gentle hug could be painful while a firm hold could be pleasant.

Design elements and principles

A designer uses the design elements and principles to create a product that is visually appealing. Users connect certain colours and forms to different meanings about products. How can you use your end-user's perspective and what is inferred when they look at a product?

- Design elements: point, line, shape, form, texture, tone, colour, transparency, translucency and opacity. Natural forms, patterns and structures along with geometry and mathematics can also be employed to create aesthetic appeal.
- Design principles: balance, contrast, repetition, movement/rhythm, pattern, proportion, asymmetry/symmetry, negative/positive space and surface qualities. They are used to combine and arrange the design elements.

How we use these elements and principles in our design changes how the end-user views our product. A designer wants the end-user to buy their product, and so will design a product that appeals to the user's aesthetic style and taste.

Refer to Chapter 1 (page 30) for examples of the design elements and principles.

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Sustainability

As discussed in other chapters, sustainability has an increasingly important role in product design. It is our role and responsibility as designers to create sustainable products, to understand and include the three pillars of sustainability (social, economic and environmental), the life-cycle analysis/assessment (LCA) and apply life-cycle thinking to lessen the negative impacts of products.

Economics – time and cost

Time

In production, the biggest factor is how much production time you have to complete the product. The time constraint may affect what can be achieved in a production process and alter what is possible. Time is important throughout the product design process; it runs from the moment you have a design problem until you have completed your product. As you work through the steps and stages of the product design process, time will be your biggest limiting factor. It may seem like you have plenty of time, but if you spend too much time on a particular step, such as research, you may run out of time for concept sketches or a detailed scheduled production plan. The worst part in production is running out of time and not completing your product. This can be avoided by writing a detailed scheduled production plan and following it, and designing a product that can be made within the time frame.

Cost

The cost of production or materials required to make a product could change what is achievable. An end-user may have a limit on how much they are willing to spend on the product, or perhaps you as the designer want to create a product that will fit into the price range as the production and material costs will be more than the end-user/s has specified they are willing to spend. It is a good idea to start factoring in costs when you are designing.

How will you meet the challenge of creating a functional product with minimal cost?

Legal responsibilities

When creating a product, it is the legal responsibility of the designer to create a safe product. No end-user/s should be harmed when using the product. A designer also has the expectation of not stealing other designers' intellectual property. Legally, the product must also meet standards in the country it is to be sold in.

Intellectual property

We need to respect the intellectual property (IP) of others. IP covers anything that is produced by a designer throughout the product design process, from images to names.

A designer may use patents and trademarks to protect against others using their ideas.

In your SAT, you will need to make reference to IP.

Refer to Chapter 1 (pages 26–8) for more information on intellectual property.

Safety of products

It is a legal requirement of product design to create a product that meets all expected standards (international and Australian), regulations and legislation throughout the product design process. A product cannot be sold within Australia or the world without meeting standards. Textiles products also fall under mandatory labelling laws in Australia. See Chapter 10 (page 292) for more information.

Another aspect of safety is ensuring that the end-user/s uses the product without harm. A designer can decrease the risk of harm to the end-user/s by using ergonomics to predict how the end-user/s will use the product and prevent injury. If the product is designed to have reduced chance of human error, accidents can be prevented.

If your product does not meet the standards or has been found faulty, it can be recalled. Recall is bad for the designer/manufacturer, as it means loss of money due to lack of sales and associated costs. It can also damage the end-user/s' view of your products, and they may not buy them in the future.

Materials – characteristics and properties

It is the role of the designer to understand a material's characteristics and properties and know how to use this knowledge effectively to create a product that functions as intended. Materials need to be researched early in the product design process, as they will affect the tools and processes that will be used.

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There are many approaches to choosing a material or materials for a product. You can choose a material by:

- establishing the material requirements specified in the design brief
- knowing how the product needs to look (form and shape) and sourcing material/s that will achieve the desired result.

Figure 5.19 The chairs pictured are made from different materials, but all have the same primary function.

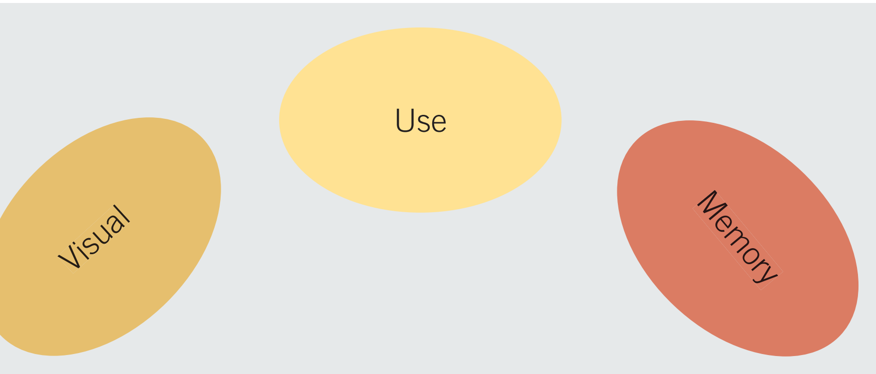

Figure 5.20 End-users experience a product visually and through use and memory.

As would have been the case with the range of materials used in the chairs pictured in Figure 5.19, you will need to test the properties and characteristics of materials you might use. Testing these is important, as it will help you to select suitable materials and plan appropriate production processes.

If you were making one of the chairs pictured to be used outdoors on a front porch, you might decide to test the materials' properties for durability and strength, heat and waterproofing to ensure that you source the most suitable materials and produce a chair that can handle the varied weather we can experience in Victoria.

Technologies – tools, processes and manufacturing methods

Designers need to think about suitable technologies to use in the production of a product. The technologies you choose will depend on your end-user/s' needs and wants. It is important to use the correct production process for the material/s selected.

As new technologies are created, designers are very keen to trial and implement them because they could mean that a design that was not possible before is now possible.

User interaction and useability of a product in relation to visual, use and memory

An end-user/s interacts with a product in three ways:

- Visual: An end-user/s will first see a product and make judgement on how it looks.
- Use: The end-user/s will use the product and make judgement on how well it functions.
- Memory: The end-user/s will reflect on the product and create memories (positive or negative) about the product.

A designer must think about the useability of a product. If a product is not easy to use, the end-user/s may change to a product that is easier to operate. A designer must get it right the first time to create a positive interaction.

Once the end-user/s has started using a product, they are still making positive or negative judgements about it. A product that once appealed to the end-user visually

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and functioned as intended and was judged positively may be seen in a less positive way over time as its style or function becomes obsolete. A negative memory about a product is hard to remove from the end-user/s' mind.

- **Complete the product design factors ranking survey Activity 5.5 on page 125 of the workbook.**
- **Complete a product design factors activity matching each factor to its parameters on page 122 of the workbook, Activity 5.4.**

ACTIVITY 5.7

Complete a ranking of product design factors to determine what value your end-user/s places on each of the nine factors.

ACTIVITY 5.8

How have you related to a product visually – through use and memory? Think of a product that has positive memories and one that has negative memories. What happened to create these differences in memory?

5.4 Use of appropriate market research methods to explore product design factors

Market research is a very important part of product design. We need to know if there is a market out there for our product and how we can attract users to buy the product. Market research helps us gain a greater understanding of the users' experience of a product.

When market research is undertaken correctly, it can help designers refine their ideas to create a successful product. There are many factors that influence why end-users buy certain products, and market research helps us decode and explore them.

If you undertook Unit 2, you explored how to design a product with an end-user/s in mind. To complete market research, you will need to know who your end-user/s is and their needs and wants. This information will help you determine their demographic and provide more information about their points of view on products.

Market research can be undertaken using both quantitative and qualitative data.

The following are some activities to complete when doing market research for your SAT.

Interviewing typical end-users

Once you know your target market, create questions that you can ask your end-users. Keep them simple, but do not use closed questions that lead to a 'yes' or 'no' answer. For example, if you were designing a raincoat, you might ask typical end-users how much they would be willing to pay for one rather than if they use raincoats.

Gaining feedback on existing products

If you have access to a group of typical end-users, let the group chat about what they like and don't like in existing products. It is a great chance to see how viewpoints can differ in a target market. Using audio or video to record your end-users is valuable, as you will have the information for future reference.

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Figure 5.21 What can market research show?

Questionnaires

Create simple questionnaires that can be filled in quickly by your end-user/s. Make the questions short and easy to understand. Questionnaires can be printed or emailed. There are even applications that let you create them online: after building your questionnaire, you send a link to the end-user/s, who complete it online, and you can go back into the application to view the results.

Researching similar products on the market

A designer can research similar products that are currently on the market to determine what factors of a product are valued by end-users.

As designers, it is our role to be inquisitive observers, constantly asking questions to find out more information. Undertaking market research may seem quite time-consuming, but it means you will be able to establish the market for your product before design and production begin, and produce a product that is successful in the marketplace rather than one that does not sell or is marketed to the wrong audience, failing to meet the end-user/s' needs.

Complete the market research Activity 5.6 on page 127 of the workbook.

ACTIVITY 5.9

Find similar products that are currently on the market. Using the product design factors, ask your end-user to talk through what they like and don't like about each product.

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5.5 Methods used by a designer to collect, record and develop relevant information about the design problem

Design problem

Establishing an empathetic understanding of a design problem that an end-user/s faces by asking the end-user/s questions to determine their needs and wants and what factors they value in a product can be seen as the first step for a designer to collect, record and develop relevant information about a design problem. If the designer is able to develop clear communication with the end-user/s, a successful working relationship will result and the end-user will feel confident that the designer is able to solve their problem and produce a product they want and need.

Ways a designer can collect information about a design problem

There are many ways to collect information about design problems and the needs of end-user/s, and for designers this is a continuous process. In industry, methods include (but are not limited to):

- market research
- surveys
- visiting stores and looking at existing products
- identifying and predicting trends
- researching end-user/s
- identifying niche markets
- developing databases of end-user information.

In the product design process, when an end-user/s is clear with a design problem that needs to be solved, this information is formatted into a design brief and end-user profile.

Establishing an empathetic understanding of the design problem that faces an end-user/s is the foundation for a successful product.

End-user/s profile

This is a gathering of relevant information about the end-user/s of the product to complement the design brief. This is used to assist you in the product design process and can include images and text.

If you are designing for one person, this information will be specific to them, such as their budget, aesthetics, and need for the product. If you are designing for a larger group, market research is required to gather a variety of information.

Design brief

A design brief contains an outline of the design problem/situation that needs a solution and constraints and considerations. It makes reference to the relevant product design factors and describes the expected quality of the finished product.

Example design brief

The design brief in Table 5.4 has highlighted product design factors and three factors listed for constraints and considerations.

Design problem

An end-user/s needs a flat-pack stool with a small detachable travel bag that can hold necessities. The stool must be easy to assemble and disassemble and be made from sustainable materials.

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Design brief – outline of the situation

My end-user Ella is a first-year university student studying Environmental Science. She is very concerned with the issues surrounding sustainability and is inspired by biomimetic and Bauhaus design. As part of her course, she will be studying in Europe for one semester and reconnecting with her British and European heritage. Ella's taste in furniture reflects modern Bauhaus design and she would like an innovative, stylish and modern flat-pack stool that is unique, easy to assemble and disassemble and has a small detachable travel bag that can hold necessities, including a travel guide, water bottle and energy bars. The flat-pack stool with its detachable travel bag needs to be constructed from lightweight sustainable materials. As Ella will be backpacking around various countries, the flat-pack stool and detachable travel bag will need to be durable and able to cope with some rough handling, so quality production processes with limited use of traditional joining methods using sustainable materials are important. Ella is not concerned with how much it will cost to produce, as her parents will be paying. She will need it completed by September.	1 Purpose, function and context 2 User-centred design 3 Innovation and creativity 4 Visual, tactile and aesthetic 5 Sustainability 6 Economics – time and cost 7 Legal responsibilities 8 Materials – characteristics and properties 9 Technologies – tools, processes and manufacturing methods

Product design factors	Constraints and considerations
1 Purpose, function and context	• Must be a flat-pack stool that can be assembled and disassembled • Must include a small detachable travel bag • Must be able to hold a range of necessities • Height and weight of stool and bag need to be suitable for Ella
2 User-centred design	• Could use biomimetic design philosophy in its construction • Could apply Bauhaus design aesthetics • Stool must be easy to assemble and disassemble
3 Innovation and creativity	• Could include a unique method for carrying and storing both the stool and detachable travel bag when not in use

Table 5.4 Example of a design brief for a flat-pack stool with detachable travel bag

- **Complete the design brief activity on page 154 of the workbook, Activity 7.4.**

ACTIVITY 5.10

Create an end-user profile of your typical end-user.

5.6 Purpose and structure of relevant evaluation criteria

Evaluation criteria are used to help ensure that the designed product meets the design brief, by suggesting research and design methods, as well as providing a structure to evaluate the end product at the end of the product design process.

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Each criterion has four parts, including:

- a question
- justification and relevance to the brief
- the process used to evaluate the success of the product
- how the finished product could be tested or checked.

The evaluation criteria must come from the design brief. You can turn your constraints and considerations into the questions.

The previous section looked at a design problem and design brief based on a flat-pack stool with a detachable bag. Table 5.5 is an example of four-part evaluation criteria for the flat-pack stool with detachable bag.

Complete the product evaluation activity on page 160 of the workbook, Activity 7.5.

ACTIVITY 5.11

1 Why is it important to determine relevant evaluation criteria?
2 Why do you complete four-part evaluation criteria for the product?

Evaluation criteria for a flat-pack stool with detachable travel bag

Constraint or consideration	A question	Justification and relevance to the design brief	The process used to evaluate the success of the product	How the finished product could be tested or checked
The flat-pack stool must be easily assembled and disassembled	Is the flat-pack stool easy to assemble and disassemble?	The end-user will be carrying the stool around Europe and needs to assemble and disassemble it with ease and without the use of hand tools	Ensure non-traditional joining methods, such as strong and durable wood pieces that slot together	• Have the end-user/s test the ease of assembly and disassembly by assembling and disassembling it a number of times. • Have the end-user sit on the stool to determine its strength and durability.

Table 5.5 Evaluation criteria for a flat-pack stool with detachable travel bag

5.7 Relationships between the design brief, evaluation criteria, research and product design development

All stages of the product design process are explicitly linked and related to each other. This ensures that the product reflects the design brief and meets the end-user's needs.

Knowledge about your end-user/s' need is of primary importance and should be established early on through good communication between you and your end-user/s and demonstrated within a detailed and well-researched design brief. Successful products happen because designers initially develop an empathetic understanding of their end-user, leading to a detailed design brief that clearly specifies the product's requirements.

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Refer to Table 5.4 on page 140 for an example of a design brief written for a flat-pack stool with a detachable travel bag.

As you work through the design process and continue to refer to your design brief and the considerations and constraints, the knowledge you have established about what your end-user/s wants will be clear throughout all the steps and stages you work through.

Your four-part evaluation criteria should contain questions carefully developed from the design brief and product design factors. Refer to Table 5.5 on page 141 for an example of evaluation criteria written for the flat-pack stool with a detachable travel bag.

Your research needs to be relevant, thorough and drawn from various types of research. You can also separate your research

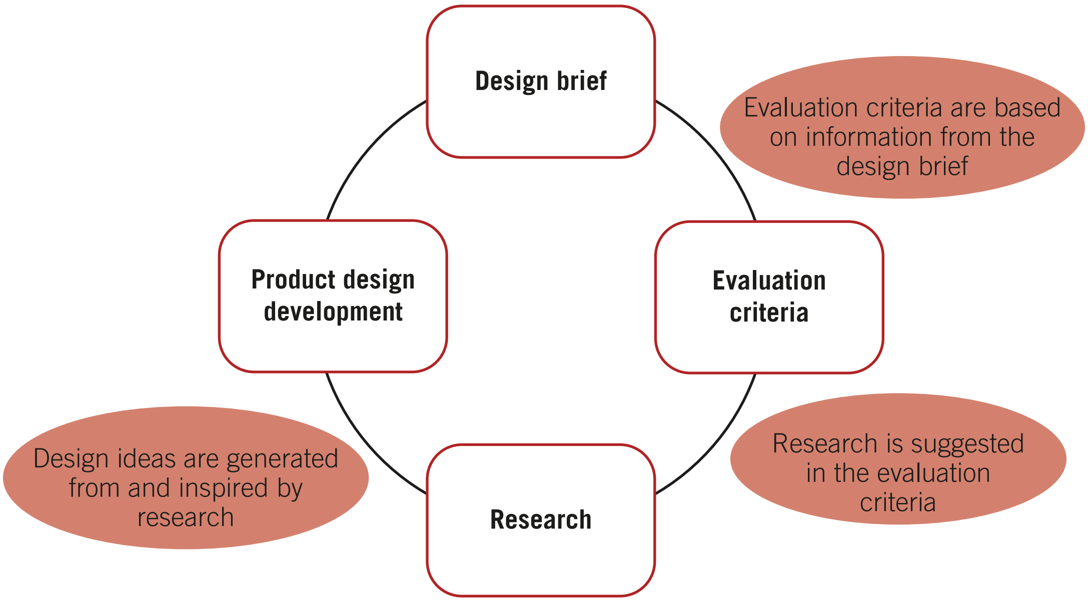

Figure 5.22 The relationship between the initial stages of the product design process

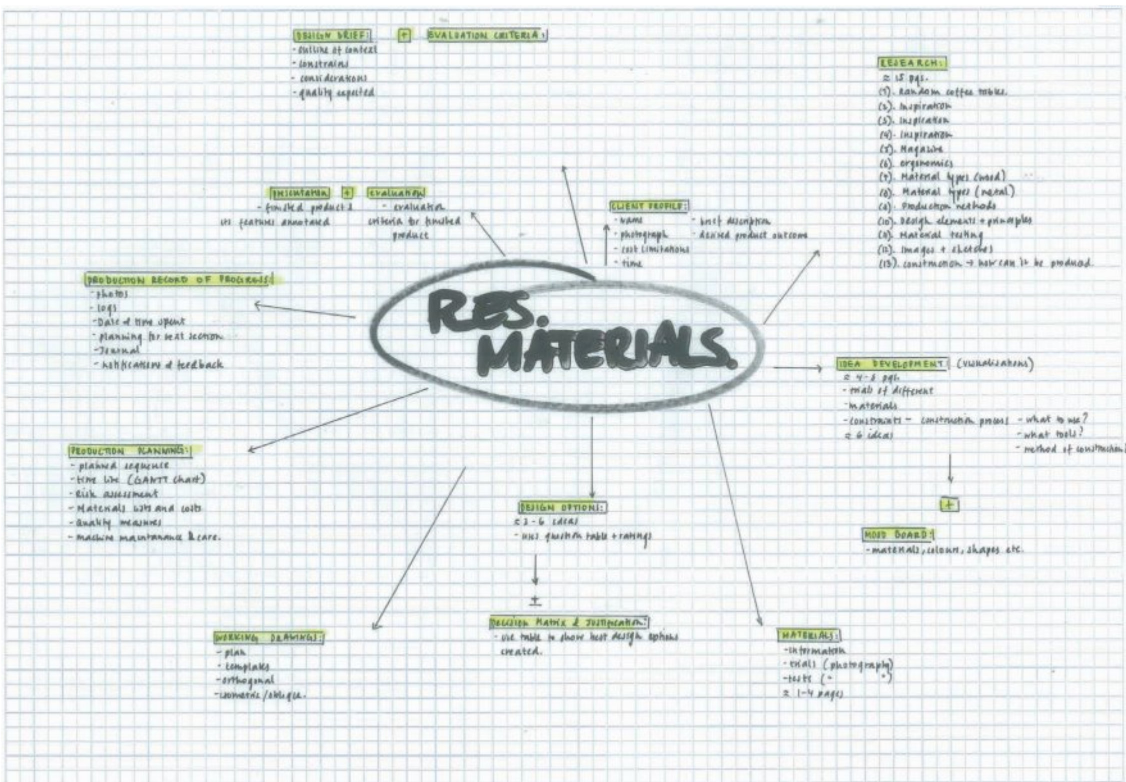

Figure 5.23 A brainstorm in the form of a spider diagram by student Natalie Dubinski

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into primary and secondary research developed from the design brief, as discussed in Chapter 3 (page 75).

You can brainstorm ideas in the form of a spider diagram against the product design factors and/or the stages and steps in the product design process. This is an effective way to start thinking about the design problem and all the possibilities of the design task. Do not restrict yourself when you write down ideas by overthinking what you should and shouldn't include. The more ideas you have, the more potential you have to successfully solve the design problem.

Planning your research

A research plan developed using the product design factors will help you establish what exactly you need to research, how relevant each area of research is for the design problem, how you will gather and apply the research and how it will support your work as a designer, resulting in a quality product that meets the end-user/s' need.

Before you develop a research plan, refer to Table 5.3 on page 128, which demonstrates how to establish a list of influential product design factors for an intended product by ranking them according to the end-user/s' needs determined through either an interview process or a survey completed by the end-user/s. This process helps you to establish the level of value the end-user/s places on the factors. If a material is ranked highly, this means it is important that you meet this need and there is very little room for alternative materials. If production processes are not ranked as highly as materials, this gives you room as the designer to make decisions about the most efficient and effective production processes to use with the end-user's preferred materials.

Figure 5.24 American architect and furniture designer Florence Knoll Bassett in her studio among her research, 1961

When you develop your research plan, you can apply the results of this ranking to a level of importance section. Table 5.6 provides an example of a research plan developed for the flat-pack stool with detachable travel bag with reference to a product design factor with a high rating of importance.

Research plan

As you research materials for the flat-pack stool and detachable travel bag, you might find that a particular wood or fabric is not available or suitable and you will need to revisit this with your end-user/s and repeat that section of your evaluation criteria.

Thorough research on materials and production processes suitable to your end-user/s' product and meeting their needs and wants is vital for success. The better you know and empathise with your end-user/s, the more suitable your material choices and production processes will be. Chapter 1 covers this research in detail and it is important that you are aware of what can be achieved in your school classroom and workshop according to the facilities they provide.

It should be evident that the research you have undertaken has influenced your design. Your research needs to be clearly annotated with relevant information of the design task you are undertaking and you need to acknowledge IP. Refer to Chapter 1 (pages 26–8) for information on annotating and IP.

Visualisations should meet the requirements of the design brief and be developed from your primary and secondary research, leading to a series of design options that are carefully evaluated to determine which most closely reflect the requirements of the design brief. The working drawing of your preferred design

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Research plan for a flat-pack stool with detachable travel bag

Product design factors	Areas for research – secondary and primary	Level of importance (1 = high importance, 9 = low importance)	How will this research support my work?	How will I apply this research?
1 Purpose, function and context	• Primary research – look at existing products on the market and visit travel supply stores • Secondary research – refer to books in the school library on travel bags and ways of designing compartments to hold necessities	1	Primary research: • See functionally what works well and not so well, the way the modular concept is applied • Measure height of stools to determine a suitable size • Sit on stools to determine a level of comfort according to the design and material/s used • Use examples of travel bags to inspire ideas and draw concept sketches	• I will be able to produce concept sketches based on construction methods using modular pieces. • Measurements taken of the stool will support the development of the working drawing and provide necessary ergonomic and anthropometric information for the design and development stage. • Travel bag research undertaken from books in the library will provide ideas for the design and development stage.

Table 5.6 Example of a research plan for a flat-pack stool with detachable travel bag

option will be accurate and clearly express the product specifications.

Concept sketches/drawings need to be clearly annotated and link to the research you have undertaken. For example, your concept sketches of modular stools researched in stores for the flat-pack stool with detachable travel bag should show a range of modular ideas inspired by these stools and address ergonomics and anthropometric factors also researched. Parts of your sketches may be dissected for further exploration and development of ideas through concept sketching.

Design options are presentation drawings of those visualisations that best meet your end-user/s' needs and wants. Presentation drawings will best meet their need if you have understood the relationship between the design brief, evaluation criteria and research, resulting in design options that your end-user approves of.

Once a final design has been determined, working drawings/patterns drafting can take place in preparation for production.

Refer to Chapter 1 (pages 32–5) for information on working drawings for resistant and non-resistant materials.

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Research plan

Design Factors	Area of Research	Importance	How will you gather the info and apply it	How will this research support work
Innovation: stool designs	Various previous design furnishings (stool chairs) and past/present designer's pieces and inspirations or distinct style.	For inspiration and gain more understanding on modern design/ concept.	Research online sources/ magazines and design publications and take into account the features that appeal to me, a source of inspiration.	Help generate ideas and construct various visualisations to potentially come up with the ideal design.
Sustainable and characteristic of materials/pricing	Sustainable (life cycle analysis) and resistible materials and its characteristic (properties/aesthetic) plus pricing.	The materials need to have these qualities in order for the product to last longer but would also satisfy the client. Pricing also would have great attention as I would have to be able to stay in budget and restrict myself to only buying the highest quality with a moderate price tag.	Source out different sample materials and do testing/trials to find compatibility, weakness and strength. Research on each of their properties and sustainability.	Confirm what materials are going to be used to form the piece and its price tag. It would help in advance to compare prices from different suppliers.
Sourcing materials	Where to source the material. Material availability.	Need to know where these materials/parts can be found and whether I am able to get access to it. In addition, alternatives that are similar in comparison (qualities but cheaper in price.	Search around online and local stores, from scrap yards to junk sales.	Know where to access these materials and what I would have to do in order to get my hands on them.
Inspiring designers and their designs	Famous past and present designers and products that have similar sense of styling to my own.	Exposure to different concepts of design. Gain further knowledge on the different style and field of these famous/popular designers and products.	Research conducted online as it's far easier to access and contain large resources. Get inspiration from these people and know what makes as design admirable.	For inspiration and to help generate ideas.
Production method	The sequence of production and different method approaches to be efficient with time and produce the perfect piece.	Preparation made before production is highly important in order for me to be able to be prepared and organised when it comes to the production stage. Distinguish the process/tools that are best suited to follow on with during the production process.	Construct a clear design concept and plan so that time is used efficiently.	This would allow me to stay on schedule and make evaluations in order to potentially construct the highest quality furnishing/ finishes.
Technologies and machinery	The functionality of the potential tools that will be used and each of its safety requirements.	Need to be well informed of the functionality of each tool/machine so that I can find which tool/ machine would help in producing the look and quality that the client would expect.	Research on various tools/machinery and its functionality in order to find the most productive and fitted to produce the design version.	Help identify what tools and machinery are needed, plus the best approach (what tools are better to produce my vision) during the production stage to build/ put the product together.
Legal responsibilities/ Safety	Australian legal responsibilities (IP,IOS, OH&S)	It is a requirement to oblige with the Australian legal responsibilities.	Research on the rights and responsibilities of a designer, safety and patients/copyrights.	Be aware and constrain to the Australian legal responsibilities, so that the product can be sold/ put in the market.

(Continued)

Figure 5.25 Research plan by student Tina Tran

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Design Factors	Area of Research	Importance	How will you gather the info and apply it	How will this research support work
Economic: cost	Costing of a product – materials, labour and use of plant (equipment and machinery)	To be efficient with the budget and identify what needs to be prioritised and invested in.	Know beforehand what to purchase and its price. Collect all the receipts and have a tab.	Stay in budget.
Human-centred	Identification of needs to improve wellbeing and the client quality of life. Consideration of their cultural and religious considerations, age, economic status, emotional and sensory appeal, universal design, social and physical needs, fashion and trends in response to these needs.	The client is the target consumer, which means the piece needs to be formed around the needs of the client and please/meet their request.	Client and design brief and frequent interactions with the client so that we are on the right track to potentially produce a piece that would ideally be perfect for the user.	Address the needs of the client to their satisfaction.
Functionality	The context and environment of its use. Its operation, performance, reliability and quality. Primary and secondary functions and features that support its use. Safety, accessibility, comfort, ergonomics and anthropometric data.	The furnishing must be functional and in working order, so that it will appease the client and meet its purpose.	Identify through the client: • The context and environment in which the product is to be placed • Ergonomics and anthropometric data research • Its primary and,if applicable, secondary function	Know the location that it will be placed in so that I am able to select the right materials to fit into its environment (indoors or out, kitchen or living room, etc.). Identify what its functionality and purposes are and if possibly a second function.
Finishes	What needs to be done in order to achieve a high standard (product).	Finishes must be high quality as expect by the client.	Research and perform testing on how to produce a piece with highly clean and polished finishes.	Construct a high quality piece of furnishing.
Special features	A unique feature that can be adapted into the design.	Make a mark (my own iconic feature) and be able to stand out from all other furnishing. Something different, brand new from the market and specially produce only one of a kind for this client, as requested.	Collect information on the client and design brief that can be a source of inspiration that can merge into the design, and in addition, put my own mark on it.	Consumers and future client can identify and point out my pieces through iconic feature – make a mark. Authenticity.

Figure 5.25 Research plan by student Tina Tran *(continued from previous page)*

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Charles-Edouard Jeanneret,

Known a Le Corbusier, was born at La Chaux-de-Fonds, in the Swiss Jura, in 1887; he died in France, at Cap Martin, in 1965. He is an internationally influential Swiss architect and city planner, whose designs combine the functionalism of the modern movement with a bold, sculptural expressionism.

Early in his career his work met with some resistance owing to its suspected revolutionary nature and the radical look it acquired from its traditionalist experiments, however in time it won the recognition it deserved and it is still widely admired. His message is still being assimilated by an ever increasing number of people in the profession, but his far-out avant-garde attitudes should be interpreted with due consideration for the use of rational systems in his planning methods, evidenced by extremely simple modules and forms based on the functional logic.

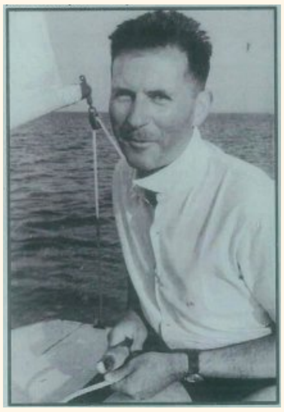
"Functionalism tending not so much to an exaltation of the mechanical functions at the expense of the symbolic, as to the rejection of symbol that he now considers outmoded and insignificant and the restoration of the practical function as a symbol of new values."

His experiments with furniture began in 1928 working with Pierre Jeanneret and Charlotte Perriand, and found form in 1929 with the "Grand Confort". Later known as the "Le Corbusier Collection" this chair solidified his legend in seating almost as strongly as in buildings.

Armchair with two arm-rests and armchairs with left or right arm-rest, two- or three seater sofas with polished trivalent chrome-plated (CR3) or semi-gloss grey, light blue, green, brown, mud, ivory or black enamel steel frame. Loose cushions with polyurethane foam and polyester padding or padding in feather with polyurethane core. Leather or fabric upholstery; the models with chrome-plated frame can also be upholstered with a technical fabric. An outdoor version is also available for this model.

Four cushions, free of connections, are held within a lacquered or chrome-plated steel tube cage making up the primary support of the object.

Figure 5.26 Research of inspirational designers undertaken by student Tina Tran



Jean Prouvé (1901–1984)

Born in: Nancy, France

Jean Prouvé was a self-taught architect and designer. Working primarily in steel, his designs are highly sought after on the contemporary auction market. He left his mark on architectural history again in 1971, when he played a major role in selecting the design of the Renzo Piano and Richard Rogers for the Centre Pompidou as chairman of the competition jury.

Prouvé's work encompasses a wide range of objects, from a letter opener to door and window fittings, from lighting and furniture to façade elements and prefabricated houses, from modular building systems to large exhibition structures – essentially, almost anything that is suited to industrial production methods.

Jean Prouvé Cité Lounge Chair 1930

Designed for a competition to furnish the student residence halls at the Cité Universitaire in Nancy, the Cité armchair is one of Jean Prouvé's early masterpieces. Prouvé himself used this dynamic looking armchair – with distinctive runners made of powder-coated sheet steel and broad leather belts for armrests – in the living room of his own home. Generous dimensions and inviting upholstery contribute to the great comfort of Cité.

Figure 5.27 Research page by student Tina Tran

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- **Complete research plan Activity 5.7 on page 128 of the workbook.**
- **Complete the market research Activity 5.6 on page 127 of the workbook.**

ACTIVITY 5.12

Develop a research plan that includes primary and secondary research.

ACTIVITY 5.13

What would be the most effective way to approach primary and secondary research to best meet your end-user/s' needs?

Figure 5.28 You will need to research different fabric types when designing a flat pack stool with detachable bag

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Chapter summary

- Designers will need to understand the end-user/s' needs and wants for a product to guide them when designing a product.
- The importance of product design factors will vary, depending on the product.
- Ergonomics is important in designing a functional product.
- Designers need to understand how the end-user views products to know how to create an effective product.
- The investigating and defining and design and development stages of the product design process can be revisited and repeated.

Short-answer questions

1 Recall the purpose of a design brief.
2 Describe how product design factors influence a designer.
3 Identify some appropriate market research methods.
4 Explain how a designer collects, records an develops relevant information about a design problem.
5 Describe the purpose of relevant evaluation criteria.

Extended-response questions

1 Explain the connection between the end-user's expectations of the product and how a designer may design a product.
2 Explain why ergonomics is so important when designing for multiple users.

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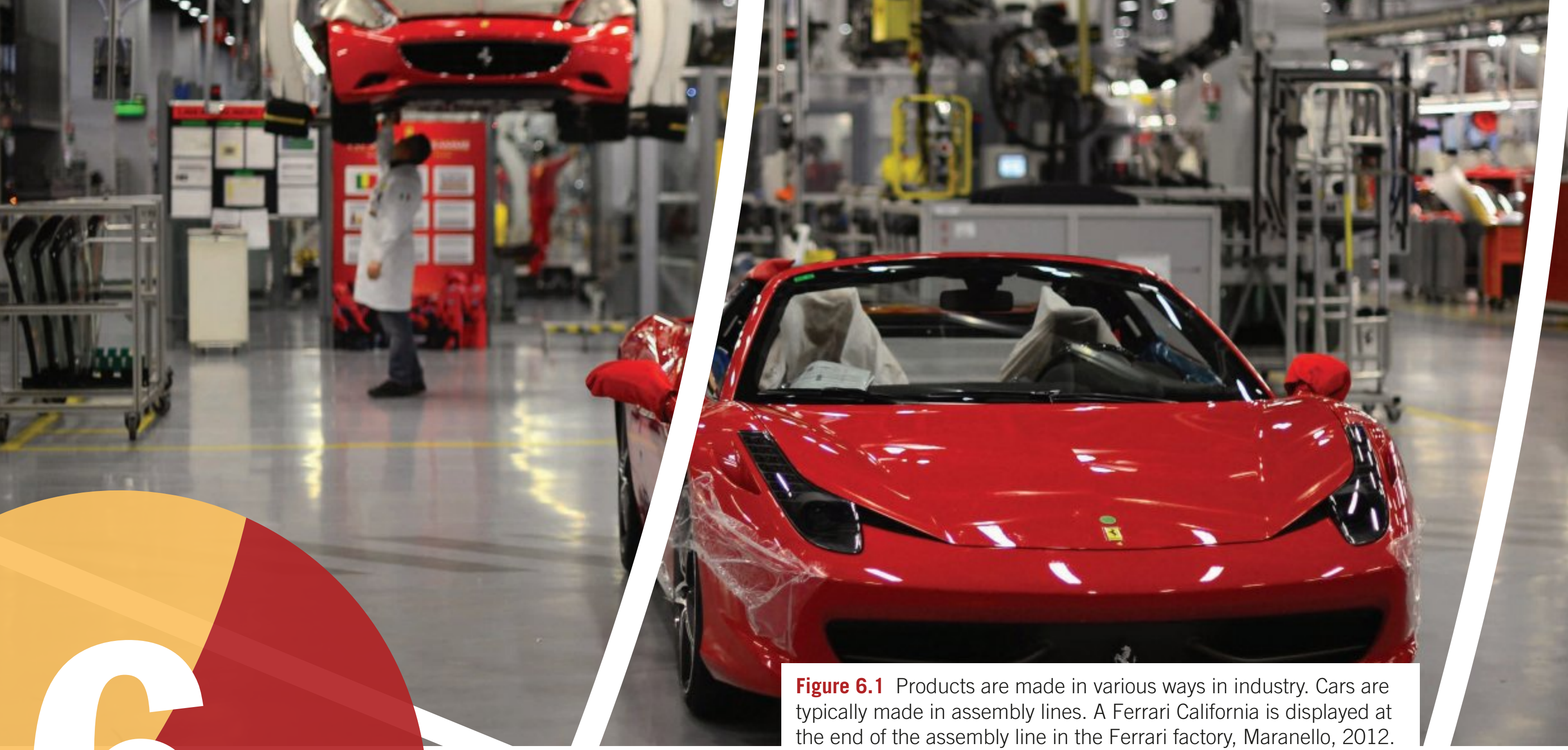

Figure 6.1 Products are made in various ways in industry. Cars are typically made in assembly lines. A Ferrari California is displayed at the end of the assembly line in the Ferrari factory, Maranello, 2012.

6 Area of Study 2: Product development in industry

INTRODUCTION

This area of study requires you to look at factors, processes and systems that influence the design and development of products within industrial settings. The importance of design, innovation, value adding to products and how companies respond to market demands and developments in technology is explored. Computer-aided design and manufacture and new and emerging technologies used in industry are investigated, including issues relating to marketing, innovation, design, research and development, obsolescence and sustainability in manufacturing and industry.

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KEY KNOWLEDGE

- the role of research and development (R&D) and their importance for industry
- the importance of new and emerging technologies, materials and processes and their influence on product design: laser technology; robotics; computer-aided design (CAD); computer-aided manufacture (CAM); computer numerical control (CNC); rapid 3D prototyping
- the importance of lean manufacturing as it relates to flexible and responsive manufacturing
- design and innovation and their importance in the product development process
- the relationship between market research and the product development process
- sustainability frameworks and strategies that influence design, production and distribution:
    - Life Cycle Analysis/Assessment (LCA)
    - cradle to cradle concept
    - design for disassembly (DfD)
    - extended producer responsibility (EPR) or product stewardship
- planned obsolescence in terms of style, technical and functional
- benefits and problems for the producer and consumer, and associated environmental issues with planned obsolescence
- methods and suitability of different scales of manufacturing systems, including one-off, low-volume, mass/high-volume and continuous production.

KEY SKILLS

- explain the importance of research and development
- explain and analyse the use of new and emerging technologies, including new materials and processes in an industrial setting
- graphically represent and describe the product development process in industry
- analyse the benefits and problems of planned obsolescence
- analyse the systems and models of sustainability that influence design, manufacturing and marketing in industry
- compare one-off, low-volume, mass/high-volume production and continuous manufacturing systems and the types of products that result from these production scales.

6.1 The role of research and development (R&D) and their importance for industry

What is research and development?

It is vital for an industry's success to continually power along competitively in the marketplace and invest in **research and development (R&D)**.

research and development (R&D) involves developing innovative ways to improve products and production processes

Research and development is a process used by companies to create new knowledge about products or processes on a systematic basis to increase their bank of knowledge and use it to develop new materials, products, devices, process systems and services, and to improve those already produced or installed.

It is beneficial for companies to research similar industries to:

- determine where change is needed
- adapt to new ways of doing things
- find similar or better ways of doing things
- improve what they already know and do.

A company's research might also involve developing strategies to increase employee productivity by improving and developing their skills and experience.

Other areas of research and development a company might consider for **design** and manufacture include:

design a drawing/sketch that shows the look, function and the way a product works before it is produced

- Design
  - developing and improving designs to better suit end-user/s' needs and wants
  - more effective use of computer-aided design (CAD) to achieve successful innovative results leading to product manufacture
  - innovation design that can involve the exploitation of a new market opportunity
- Manufacture
  - new and more efficient use of technology (tools and machinery) trialled and developed
  - research of new types of manufacturing processes, such as laser technology or rapid 3D prototyping
  - developing new or existing materials or searching a broader range of materials they could potentially use from various sources
  - material testing in ways that increase their overall potential.

Big industries in the global market – why are they so successful?

Big industries aim to remain competitive in a global market. Since 1955, each financial year Fortune Global 500 has ranked companies globally by revenue. Companies at the top of the rankings are most likely to be there due to sales success from new and improved products and services.

In 2016, three of the top 10 industries ranked by Global 500 were Walmart, Volkswagen and Apple (see Table 6.1).

Leading companies in the global market according to Fortune Global 500

Fortune Global 500 Ranking	Name of company	Type of product or service	Revenue in Australian dollars
1	Walmart	Chain of hypermarkets, discount department stores and grocery stores	$645.3 billion
7	Volkswagen	Automobiles	$316.7 billion
9	Apple	Technology	$312.8 billion

Table 6.1 Leading companies in the global market according to Fortune Global 500. These companies each provide a different service or product, but what they all have in common is they are leaders in the global market.

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What makes these companies leaders?

Walmart

The Walmart philosophy is low prices with great service. Through research and development, the company experimented with new in-store ideas, developing Walmart Supercenters and brought not only new approaches to retail but also new technologies to retail.

Research and development has a lot to do with why this US company is at the top of the global market. Taking risks and making those risks work and researching and applying new technologies allowed Walmart to rise above its competitors and do things more effectively and efficiently while still providing low prices with great service.

The owner of Walmart believes that to run a successful business you should go against the grain. If everybody is doing something one way or heading in a particular direction, then you should do it the other way and go in the opposite direction.

Walmart applies R&D to:

- target an end-user/s group who value low prices
- provide great service
- develop new approaches to retail
- bring new technologies to retail.

Volkswagen

Volkswagen was founded in 1937, manufactured the first Beetle in 1938 and has continually expanded, with automobile production growing quickly in the 1950s and the 1960s.

Since 1937, the company has increased its range of automobiles through research and development, addressing and applying new innovations and technology that have resulted in automobiles that are still commercially viable.

Volkswagen applies R&D to:

- address new innovations and technology
- apply new innovations and technology.

Apple

Apple is all about innovation and design. The company has researched, redeveloped, refined and popularised existing technologies in designs that have resonated with the end-user/s, which has led to competing companies following their

DID YOU KNOW?

Apple owns the patent to the 'rounded rectangle' shape used by most mobile phones. Apple was able to sue Samsung for nearly $1 billion for the latter's use of the 'rounded rectangle'.

Figure 6.2 A Walmart employee wears the company's customer service slogan on his jacket, United States, 2005

Figure 6.3 Douglas Engelbart's early design of a computer mouse, which was redeveloped by Apple

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lead. One product out of many that Apple has researched and redesigned is the mouse, which was originally invented by Douglas Engelbart at the Stanford Research Institute in the 1960s. (Refer to Chapter 1, page 19, for more information on the d.school.)

Apple applies R&D to:

- refine existing technologies to better meet end-user/s' needs
- popularise existing technologies.

When it comes to research and development, what do Walmart, Volkswagen and Apple have in common?

To be in the top 10 global industries of 2016, these companies would have invested a great deal of time and money in R&D. Because their revenue is so high, they can afford to do this. Smaller companies that spend less on R&D and are hoping to achieve the same kind of annual revenue have a big challenge ahead of them.

When Australian companies undertake research and development, they can apply for funding from the government. What companies choose to research can vary greatly.

Refer to Activity 6.1 on research and development on page 131 of the workbook.

CASE STUDY

Lego

Lego decided to undertake research and compile a study to determine the percentage of girls compared to boys who played with Lego. Their research revealed that only 9% of the primary end-users were girls. This was not too surprising, as the company had targeted their product towards boys for many years.

The company decided to act on these results by:

- developing and improving designs to better suit end-users' needs and wants
- applying innovative design to exploit a new market opportunity.

Figure 6.4 A Pakistani girl displaced by floods plays with Lego in a makeshift tent school in Mehmood Kot, 2010

Lego employed researchers to undertake a study of 3500 girls and their mothers over a four-year period. This research involved observing girls' playing habits and extensive questioning about what would make the product more interesting and aesthetically appealing.

In January 2012, Lego released a new range of toys as a result of its lengthy research. The new range of toys were called 'Friends'. The Lego product was developed in the following ways:

- The colours of the Lego bricks were made more vibrant.
- Figurines were included and enlarged slightly to allow for accessories such as hairbrushes.

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ACTIVITY 6.1

List four ways in which research and development is important in industry.

ACTIVITY 6.2

Identify some companies that have made significant changes to their products as a result of research and development, not including the ones mentioned above.

6.2 The importance of new and emerging technologies, materials and processes and their influence on product design

To have the edge over other designers, you need to be inquisitive, not afraid to take risks and be excited and inspired by the new, whether this be new technology, materials or processes that influence design, and be able to apply this to your work innovatively and creatively.

You want to meet an end-user/s' needs and wants, and often what an end-user/s needs and wants will be influenced by existing products, current styles, trends and new and emerging technologies.

Adapting your approach to new technologies, materials and processes will not only provide you with a great range of skills and experience, but it will allow you to develop your existing ideas and approach to design and find new ways of doing things.

Perhaps for resistant materials you are interested in creating a range of jewellery or for non-resistant materials a small decorative adornment that will attach to a collar. Why not try 3D printing or laser cutting if that technology is available to you at your school?

DID YOU KNOW?

Could 3D printing be yesterday's news and liquid printing the future?

Rapid liquid printing physically draws in 3D space in a liquid gel suspension and enables the precise creation of customised products. While 3D printing calls for layer-by-layer creation, rapid liquid printing works through direct injection into the gel, physically drawing the objects into existence. (www.wired.co.uk)

New and emerging technologies

Laser technology

Laser technology is the use of lasers and CAD programming to cut materials with extreme precision and accuracy. It is very efficient and can cut through a range of thicknesses quickly, resulting in better edge quality. It is a safer way to cut material than traditional methods. Laser technology is used in one-off, low-volume and mass/high-volume productions. Not all lasers cut the same way, with different types being used to cut different materials.

laser technology refers to machines that use a laser (light amplification by stimulated emission of radiation) to complete particular tasks

Laser technology in fashion and textiles

Laser technology can be used to cut fabric, prevent raw edges from fraying, and to create decorative lace-like work within a panel of a garment. A CAD design is drawn up (often on a vector-based program such as Adobe Illustrator) and fabric is laid on the laser bed, then cut as per the CAD design. Laser cutting is popular with underwear made of synthetic fibres, which results in a smooth cut edge and less bulky seams under clothing.

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Figure 6.5 This sign has been laser-cut.

Figure 6.6 Laser-cut leather shoes by Iris van Herpen (see case study on page 157)

Figure 6.7 A Fiat Chrysler Automobiles NV 2015 Dodge Viper vehicle is inspected by robots on the production line at the FCA US Conner Avenue assembly plant in Michigan, 2015

robotics
an area of technology that focuses on the design, production, operation and use of robots

computer numerical control (CNC)
the automation of machine tools operated by accurately programmed computer commands

Robotics

The use of **robotics** in industry has sped up production processes that would have taken longer in the past. Using robotics is very accurate and safe. Like laser cutters, robots are able to undertake a range of production methods, from welding to assembly and inspection, and are able to work efficiently with mass/high-volume production. An example of an area of industry that uses robots for high-volume production is the car industry.

Computer numerical control

Machines used in the computer-aided manufacturing process are **computer numerically controlled (CNC)**.

Machines that are controlled in this way include:

- CNC milling machine – carves out materials based on a pre-existing design and can machine solid materials such as wood and metal
- CNC laser cutter – uses a high-power laser to cut materials
- CNC plasma cutter – uses a jet of hot plasma to cut through electrically conductive materials such as brass, copper, aluminium and steel
- CNC router – a cutting machine used for cutting hard materials such as steel, plastics and wood
- CNC lathe – is similar to a manual lathe and is mainly used to machine round parts.

How does a CNC machine work?

The CAD/CAM program establishes the necessary movements of the tool head/laser and sends the data to the machine in numerical form. The machine interprets the numerical information and controls the movement of the tool head/laser.

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Computer numerical control (CNC)

Advantages

- Less chance for human error.
- Less need for specialised machine tools for each product, so production costs are reduced.
- The product can quickly be changed during production without the need for expensive retooling.

Disadvantages

- The initial purchase of machines is costly.
- The operators of the machinery and the programmers will need to be trained to use the machinery, which could also be costly.
- Purpose-built machines are more cost-effective than CNC machines if used for mass production.

Figure 6.8 The advantages and disadvantages of computer numerical control (CNC)

Computer-aided design

Once you have completed concept sketches and have selected design options, you can choose to use computer-aided design for these presentation drawings. Some computer-aided design programs include SketchUp and AutoCAD. These programs allow you to view your product in 3D. The more detailed the program allows your 3D drawing to be, the less need there is for a physical prototype. Unlike presentation drawings completed on paper, it is easy to make modifications to your work, which can be saved in the cloud, on a USB flash drive or portable hard drive and emailed.

Computer-aided manufacture

Computer-aided manufacture (CAM) is the successor of computer-aided engineering (CAE) and is often used with **computer-aided design (CAD)**. Modern CAM systems include real-time controls and robotics. Computer-aided manufacture is an application technology that uses computer software (such as SketchUp and AutoCAD) and machinery to facilitate and automate manufacturing processes.

Computer-aided design and manufacturing programs – textiles and fashion

A number of computer-aided design and manufacturing programs are used together to mass-produce textile items, including clothes, furniture and car seats. They can be involved in the design, pattern making and **production** of garments, allowing for quick, digital communication with manufacturers.

When designing

Adobe Illustrator, a vector-based CAD program, is used to generate working drawings to communicate how the product should look. Adobe Illustrator and Photoshop are also used to generate prints that are applied to fabric.

Figure 6.9 Design option for a kennel using SketchUp by student Luke Abella

computer-aided manufacture (CAM) the use of software to control machine tools/lasers in the manufacturing of products

computer-aided design (CAD) software used by designers, architects, engineers and artists to create accurate drawings or technical illustrations

production using tools, equipment and machines to produce a product from sourced materials

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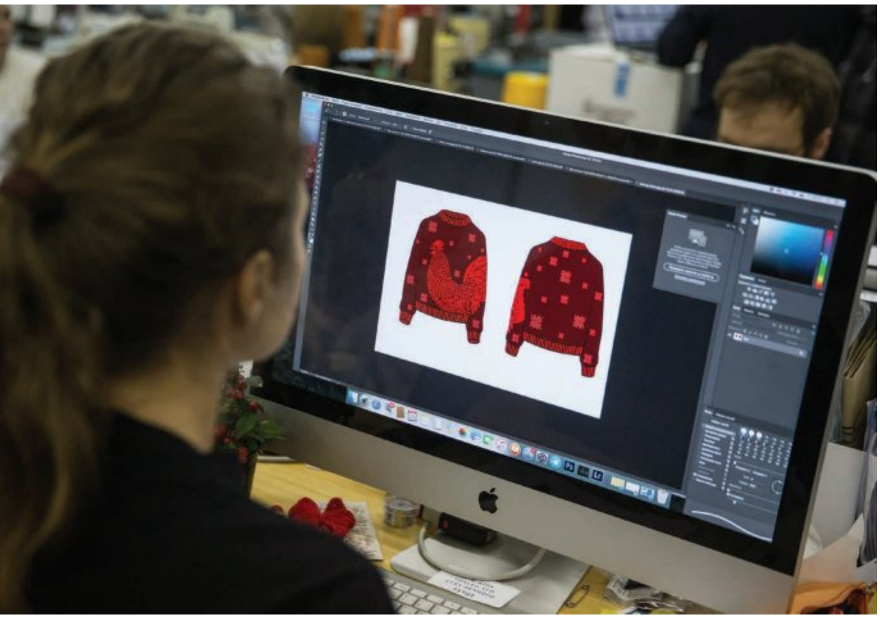

Figure 6.10 Designer using Adobe software

Such prints may be used both as a placement or as a yardage print that is repeated, and design option style drawings and mood boards can be generated to show how designs will look in potential fabrics, prints and colourways for buyers, much like your design options in the product design process.

rapid 3D prototyping requires CAD to fabricate a scale prototype of a part or assembly quickly

When pattern making

Programs such as Gerber and Lectra are popular CAD/CAM systems that are commonly used in the textiles industries, often following the work

Figure 6.11 Employees operate machinery, including 3D printing devices, as they manufacture automotive sensors inside Continental AG's powertrain division factory in Regensburg, Germany, 2014

generated in Adobe software. Physical garment patterns can be digitised into files, or patterns can be drafted using the CAD/CAM software. Information created in the pattern-making stage can be used to generate a digital rendering of what the garment will look like on a model, much like the graphics on a video game, as opposed to making a physical prototype of the garment.

Creating a marker

Patterns can then be graded (made into smaller or larger sizes) and laid out to create a marker (an economic cutting layout for patterns in multiple sizes and quantities). This can be used to predict how much fabric will be used, place patterns on the grain and match up stripes or prints accurately.

Creating a marker allows companies to respond quickly to trends by having a library of patterns and pattern blocks that can be easily modified, or sent to manufacturers quickly to cut out. It will also reduce waste.

Cutting out fabric

A CAM-powered spreader will roll out multiple layers of fabric (ply) on a spreading table, and a CNC fabric cutting machine will follow the digital marker previously generated to cut multiple layers of fabric in various sizes with blades specific to the type of fabric. This machine can also cut notches and internal drill holes in the fabric to assist the machinists in production. This technology allows the cutting of fabric to be completed safely, quickly and accurately on a larger scale, with minimal input from staff.

DID YOU KNOW?

3D printing has become increasingly affordable. It can be used to cheaply create parts of a product for testing, or even be used to make final products, such as toys, jewellery or costume pieces.

Rapid 3D prototyping

Rapid 3D prototyping produces scale models of a part or product and can be used to test the efficiency of a part or product design before it is manufactured in a large quantity.

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This saves material wastage and time, and testing may focus more on the shape or size of a design than on strength or durability because the prototype may not be made of the same material as the end product.

Refer to Table 2.7 on page 57 and 58 for the difference between rapid 3D prototyping and 3D printing.

DID YOU KNOW?

Many products can be 3D-printed in metal, from jewellery to medical products. There are three main methods for printing 3D metal. These are:

- metal binder jetting
- powder bed fusion
- directed energy deposition.

New materials

Manufacturing materials with new or improved properties has improved the functionality of products because these new materials increase their performance. The development of new materials has become a driving force of innovation in recent years, and as these new materials emerge and technologies used to create them develop, the way designers work is also changing.

As with emerging technologies, designers are excited and inspired by new emerging materials and are embracing all they have to offer. End-user/s are also changing the way they relate to products as more and more products are introduced to the market that function better and are more desirable.

What are some new materials available for both resistant materials and non-resistant materials?

Refer to Chapter 1 (page 18) for information on the Fastskin swimsuits from Speedo.

CASE STUDY

Iris van Herpen

Figure 6.12 Iris van Herpen designs, Fall/Winter 2016–2017

Dutch fashion designer Iris van Herpen is a leading figure in using emerging technologies in fashion, and is considered a pioneer for using rapid 3D prototyping in fashion. Her designs are often described as futuristic and sculptural. She combines the use of many emerging and cutting-edge technologies with traditional techniques in an innovative way, including:

- use of plastics, metals and other resistant materials in fashion
- creating flexible 3D-printed dresses
- laser-cutting materials
- use of hand-blown glass elements, coated in silicone
- weaving steel and silk together to make fabric
- using transparent synthetic materials and painting them via injection moulding.

Taking inspiration from Iris van Herpen, what other materials and technologies could you use in your design option to increase innovation?

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Complete the new technologies Activity 6.2 on page 133 of the workbook.

ACTIVITY 6.3

Research some textile companies that use CAM, and look at how they use this technology.

ACTIVITY 6.4

Research some companies that use rapid 3D prototyping or designers who use rapid liquid printing and investigate how these production processes best suit their needs.

ACTIVITY 6.5

What new materials exist for either resistant materials or non-resistant materials, and how do the properties of these materials improve the functionality of the product/garment?

6.3 The importance of lean manufacturing as it relates to flexible and responsive manufacturing

lean manufacturing the minimisation or elimination of waste within a production/ manufacturing system

muda Japanese word for waste

Lean manufacturing

Doing more with less is the concept of **lean manufacturing**, which is driven by lean thinking. Lean thinking involves constantly finding ways to eliminate **muda**, or waste, in the creation of a product or range of products. Applying this concept, whether you are a designer, manufacturer or distributor or involved in any other design and production activity that might consume resources and not add value, will improve the flow of the product design process steps and help to achieve a better end result.

Lean manufacturing looks at improving efficiency in:

- designing – using CAD
- manufacturing – types of machinery used
- distributing – from manufacturer to retailer/end-user/s
- time – needed for the production of a product or range of products
- labour – needed to design and produce the product or range of products.

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Lean manufacturing in the design, manufacturing and distribution of products

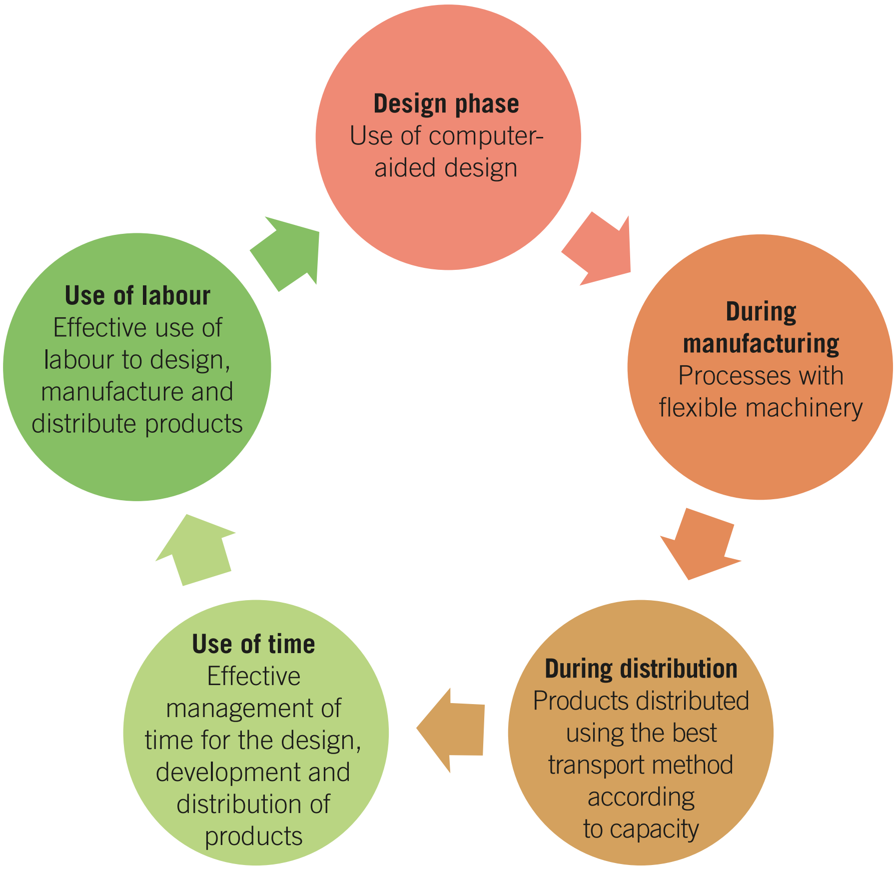

Figure 6.13 Lean manufacturing applied to eliminate muda, or waste, in the design, manufacturing and distribution of products

Flexible and responsive manufacturing

How does lean manufacturing relate to flexible and responsive manufacturing?

Flexible and responsive manufacturing involves:

- the flexibility of machines to produce different types of products
- the flexibility of machines to change the operational order of production processes
- the **routing flexibility** of machines so that more than one machine is able to undertake the same production process
- the flexibility of machines to adjust to capacity or volume changes.

Machinery that can undertake a variety of production tasks enabling it to produce different types of products, machinery that has the ability to change operational order with routing flexibility and machinery that can adjust if necessary to higher product volume or capacity will provide a lean manufacturing environment with less waste, less chance for human error at less cost because of efficiency in production processes.

Flexible and responsive manufacturing will enable a company to achieve lean manufacturing because machines are run:

- at constant speed
- under constant load
- under constant conditions.

Flexible and responsive manufacturing minimises the stopping and starting of machines and having to change them for retooling.

Lean manufacturing – machines

CNC machines, such as laser cutters, drilling and milling machines, are types of manufacturing processes that are lean. Products made using this machinery can quickly and efficiently be changed without expensive retooling. There is less cost involved, as individually specialised machine tools for each product are not generally needed.

flexible and responsive manufacturing manufacturing that allows a system/ machine to adapt to changes

routing flexibility when a manufacturing system is able to adapt to changes in manufacturing capacity; this capacity could be an increase in the volume of products being manufactured

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ACTIVITY 6.6

How can you apply lean thinking during the product design process?

ACTIVITY 6.7

List ways in which lean manufacturing has been adapted to and is used in current leading companies.

Complete the lean manufacturing Activity 6.3 on page 134 of the workbook.

6.4 Design and innovation and its importance in the product development process

product development process the evolution of a product from the designing phase to manufacture and distribution and, finally, into the marketplace

What is the product development process?

When products are produced, they all evolve from a similar **product development process**, from the designing stage to manufacture and distribution and finally into the marketplace.

Research is done throughout the product development process, and the feedback that companies receive about their products once they are out in the marketplace is vital in the development of the product. This feedback will influence how a company designs and develops the same or a similar product at a later time. The feedback might result in parts or components of a product being redeveloped or a new product being designed, manufactured and distributed altogether.

Figure 6.14 shows the product development process and those involved.

Identifying a need and market research	• Designers, manufacturers, marketing team, end-users (consumers)
Designing and planning for manufacture	• Designers, those involved in manufacturing, such as engineers, establishing of manufacturing costs, company directors consulted and advised, and finance sought
Manufacture and distribution	• Those involved with production, supplying of materials, company contractors and subcontractors, transportation, distribution, quality control, managers, company directors, and sales and marketing
Out in the marketplace and consumer use	• Retailers, end-users (consumers), market researchers
Evaluation of the product and modification	• Designers, manufacturers, those involved in finance, and market researchers

Figure 6.14 The product development process

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Design and innovation in the product development process

Innovation is a way to describe a new breakthrough in a **product development**, whether it be in an existing product's function, use of technology or style, or a novel product or range of products. It combines the development and marketing of a technical invention that can then be exploited because of this new market opportunity.

Without design and innovation, our world would be a very different place. End-users place value on products, and whenever a new or improved version of a product they value is on the market, it is very tempting to buy the latest model. Designers are busily improving such products, constantly thinking and designing innovatively.

End-users are influenced by what they first see when they look at a product, its functionality when used and the memories retained of the product, whether they be positive or negative. (Refer to Chapter 5, page 136, for a discussion on visual properties, use and memory.) It is vital as a designer to consider these responses and make sure the end-user/s experience of the product is a positive one, or one that through design and innovation creates an experience better than what they have had before, either with the same brand of product or with a different one.

The development of Australian cricket's pink ball for day/night Test matches provides an example of the need for design and innovation during the product development process to improve the design and technical performance of the existing cricket ball so it could function under lights at night. (Refer to Chapter 8, page 260, for the a case study on the pink ball.)

Kookaburra is the company that currently holds a contract through Cricket Australia to design and manufacture pink balls. Designers had to address the end-user/s' problem (Australian cricket players) and find a solution for this design problem.

Design and innovation and its importance in the product development process of a cricket ball for night games involved:

- improving the ball's visibility level under lights
- developing a pink ball with a green-and-white seam
- further development, as batsmen complained the green-and-white seam was hard to pick up and didn't contrast strongly enough with the pink ball
- development of a version of the pink ball with an altered shine and a black seam to provide greater visibility of an object sent hurtling towards the batsman at high speeds in twilight conditions
- indication of a possible need for further fine-tuning of the pink ball, as it appears to become incredibly soft after 60 overs and doesn't function as it should, according to Australia's cricket captain Steve Smith in 2016.

The design and development process in this case was revisited and reworked and resulted in a cricket ball that functions well enough but could potentially require further development. This means designers will need to continue to think in innovative ways to find a better solution to the current ball. In the future, they might have to research ways to make the pink ball stronger so it doesn't become soft after 60 overs, or even research other colour options that may be more resilient.

product development the overall process related to the development of a commercial product (new or redeveloped)

- **Complete the innovative product Activity 6.4 on page 136 of the workbook.**
- **Complete the product development process Activity 6.5 on page 138 of the workbook.**

ACTIVITY 6.8

What steps occur in the product development process?

ACTIVITY 6.9

How is the product development process different from the product design process?

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ACTIVITY 6.10

List ways in which design and innovation is an important part of the product development process.

CASE STUDY

Simone LeAmon – Bowling Arm Bangles

Figure 6.15 Bowling Arm Bangles

by-product
a secondary product that is produced as a result of a manufacturing process

With a focus on sustainable design thinking and application, and use of lean thinking by eliminating waste, Melbourne designer Simone LeAmon has designed innovative arm bangles made from leather waste from Australian-made cricket balls. She has been designing the bangles since 1999, when she first sourced the **by-product** and investigated its potential value, which has resulted in a product that sells internationally. The natural flexibility of the material means that the bangles, which are sold in red, white and yellow, are a one-size-fits-all product.

6.5 The relationship between market research and the product development process

Market research is vital for knowing what end-users want from a product's function, technology and style.

Once a product is out in the marketplace, a company can use market research to establish the strengths and weaknesses of the product, by gathering feedback from end-users. This process will help the company to determine whether the product needs to be improved (through its function or technology or style), or whether a completely new product needs to be designed and manufactured. Like Walmart, Volkswagen and Apple, mentioned earlier in this chapter, almost all well-known companies have achieved success in the marketplace by using market research during the product development process to make decisions about their products – products that will ultimately

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bring them greater revenue and set them apart from other similar companies.

Market research and the product development process

Function

Companies want to be ahead of their competitors, and looking at the way their product functions helps them to determine how well it meets the end-user/s' need in relation to other similar products on the market. If their product functions as intended and is competitive, the company may not change its function. If the product doesn't function as well as other similar products in the marketplace, a company might decide to improve its overall function or part of the way it functions, or they might decide to scrap the current model and design a completely new one. Once the product is out in the marketplace, the company can create hype about its **new or improved or innovative function** and potentially become leaders of that type of product in the marketplace.

Technology

If a product uses technology in some way, the technology needs to be the latest available. Technology is constantly developing, and big companies that use technology, such as Apple, are always looking at ways to make it more innovative and more appealing to end-users so that they have the edge in the marketplace. As with function, if a product's technology is not as up to date or as innovative as other products in the marketplace, the company might decide to improve parts or components of its technology or they may choose to scrap the current model and develop a completely new one. Once the product is out in the marketplace, the company can create hype about its **new or improved or innovative technology** and potentially become leaders of that type of product in the marketplace.

Style

How a product looks is very important to an end-user/s, as their first experience of a product is visual. If a product doesn't look as good as others in the marketplace, then people will usually prefer the more attractive product, even if it is of lesser quality and cheaper. Once the product is out in the marketplace, the company can create hype about its **new or improved style** and potentially become leaders of that type of product in the marketplace.

How do function, technology and style apply to this product?

A surfboard with Shark Shield

- Function: A fibreglass board is used to surf the ocean and protect the surfer from sharks.
- Technology: The board is streamlined to maximise speed across the water, with added shark-deterrent technology that surrounds the surfer with an electrical field. As the shark approaches, the field creates discomfort for the shark, producing muscle spasms and causing the shark to flee.
- Style: The streamlined board is coloured bright yellow.

Figure 6.16 Sydney surfer Michael James displays the SeaChange Shark Shield shark deterrent system mounted near the tail of his surfboard on Sydney's Bondi Beach.

How companies use market research during the product development process

There are several different reasons why companies use market research. These reasons change within the product development process, as shown in Figure 6.17.

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The product development process and market research

Identifying a need and market research

- Designers, manufacturers, marketing team, end-users (consumers)
- Market research establishes the needs of the end-users – How does a product need to function? What type of technology is needed? What style will appeal to the end-user?
- Niche markets – Where are there gaps? Who isn't catered for?

Designing and planning for manufacture

- Designers, those involved in manufacturing, such as engineers, establishing of manufacturing costs, company directors consulted and advised, and finance sought.
- Market research provides information about how a product's design is received by the end-user to determine if an aspect or aspects of the planning phase need to be modified to improve the product or scrap the product altogether.
- Buying trips overseas to get inspiration for design.

Manufacture and distribution

- Those involved with production, supplying of materials, company contractors and subcontractors, transportation, distribution, quality control, managers, company directors and sales and marketing.
- Market research enables companies to determine the most suitable and cost-effective production processes and the best people for the job. Companies can source suitable materials for their function, sustainability or visual appeal. Companies are able to establish the best transportation and distribution methods according to the type, quantity and distribution location. Quality control methods can be modified and improved and marketing and sales can better develop strategies to target the end-user/s and improve sales and company revenue.
- Visiting factories and getting production samples made.
- Analysing sources and methods.

Out in the marketplace/ and consumer use

- Collating data from retailers, end-users (consumers), market researchers.
- Looking at sales data.
- Buyers looking at trends, past sales.
- Market researchers can implement studies that look at the way end-users use the product. Retailers and end-users can provide feedback.

Evaluation of the product and modification

- Designers, manufacturers, those involved in finance and market researchers.
- Market research can use and apply evaluative information to improve/modify a product or range of products within a stage or step of the product design process.

Figure 6.17 The product development process and market research

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ACTIVITY 6.11

Look at ways that companies use market research in the product development process. How might you apply some market research strategies to your own work?

ACTIVITY 6.12

In a paragraph, define the relationship between market research and the product development process.

6.6 Sustainability frameworks and strategies that influence design, production and distribution

Every product has an impact on the Earth, from the sourcing of materials and use to the disposal of the product. With the increasing world population, continual development and marketing of new or better products and **planned obsolescence**, the impact of product use and disposal on our planet is steadily increasing.

This impact can be seen in all pillars of sustainability – environment, social and economic – as discussed in Chapter 1. Designers need to use materials and develop processes that produce products with the most minimal impact in all aspects. Frameworks and strategies can help us as designers to consider sustainable practices throughout a **product's life cycle**.

Some sustainability frameworks and strategies include life-cycle analysis/assessment (LCA), the cradle to cradle concept, design for disassembly (DfD) and extended producer responsibility (EPR) or product stewardship. It is vital to understand all parts of a product's life cycle, as it creates opportunities for you to think more sustainably. The ideas behind these frameworks are continually developing and growing, but they all make sustainability a key feature of the product design. As designers use these frameworks/strategies, they will discover and explore new processes and methods to increase the sustainability of new or redeveloped products.

planned obsolescence refers to a company planning for either the style, technology or function of a product only lasting for a set time and having to be replaced; it typically applies to technology like mobile phones

product life cycle the stages throughout the product life from idea to disposal

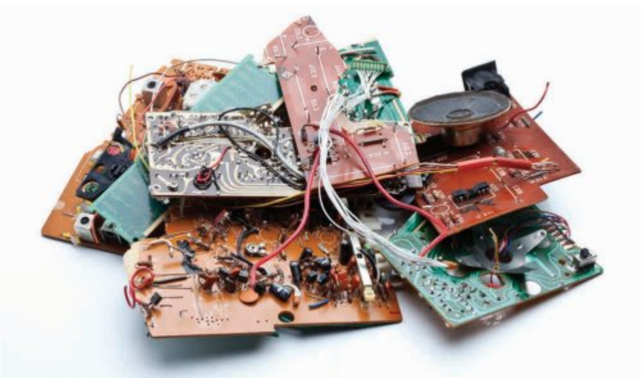

Figure 6.18 The methods of disposal differ for each product.

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	Design	Production	Distribution
Life-cycle analysis/ assessment (LCA)	Chosen materials to be used will have minimal environmental impact over others to achieve the same look.	Chosen processes and production techniques used will have minimal environmental impact over others to produce a quality product.	The product will be distributed with minimal environmental impact.
Cradle to cradle concept	Consider materials that have no environmental impact. Consider production techniques that are sustainable and have no environmental impact. Consider what the product may become at the end of its life.	Production techniques that produce no waste in materials or environmental impact are used.	Products will need to be transported to stores/end-users with no environmental impact.
Design for disassembly (DfD)	Product components are designed to be taken apart. Product components are made from a minimal amount of different materials that can be recycled.	Product components are joined without glue or with minimal joins. All components are labelled.	Products are shipped with packaging that can be removed easily and disposed of with sustainability in mind.
Extended producer responsibility (EPR) or product stewardship	The producer designs products that use materials they could recycle or reuse. The producer designs a product that can be easily and safely returned to them. The product can be taken apart or placed in a typical packaging size to be posted.	Production includes sustainable materials and processes.	The producer places information with the product to inform the end-user/s how to return the product at the end of its life.

Table 6.2 Sustainability frameworks and their influence on design, production and distribution

Sustainability frameworks and strategies that influence design

Seven key areas to consider when designing a sustainable product that link to LCA, DfD and EPR

In general terms, designers should be thinking about these key areas when designing a sustainable product:

- Create useful products designed with the end-user/s' needs in mind.
- Reduce waste in all stages.
- Reduce energy consumption in all stages.
- Use recycled materials.
- Use sustainably sourced materials.
- Reduce the materials needed for the product to complete its function.
- Create durable products and remove any pointless secondary functions.

Below are a few ideas on how a simple design change could improve the product's footprint:

- reduce materials needed to make the product
- reduce the packaging size and bulk needed to ship the product, which reduces fuel and space in transportation
- allow efficient use of energy when the end-user/s is using the product

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- allow the end-user/s to easily dispose of the item (for example, all of the product could be placed in a domestic recycle bin).

All stages in a product's life afford opportunities to explore and address sustainability frameworks. It is our role as designers to take these opportunities to allow further development in these fields.

Sustainability frameworks and strategies that influence production and distribution

Life-cycle analysis/assessment (LCA)

Life-cycle analysis/assessment is the scientific analysis of a product's environmental impacts at all stages of its life. Once an LCA is completed, a designer can refine their designs, product manufacturing process or how it is transported to improve its sustainability.

Cradle to cradle concept

The cradle to cradle concept looks at a product's life and how all aspects of the product can be reused or recycled or remanufactured. This creates no waste throughout the product's life.

Currently, more research and understanding is needed on how products and materials can be reused and recycled to reach the goal of no waste. We need all designers to create products that have this concept in mind. This milestone could occur in the near future if more designers take on the challenge and design and create products with this concept. The ideal would be creating products whose parts can be disassembled and then used to create higher-value products.

Design for disassembly (DfD)

Designing for disassembly is designing a product that is easy to disassemble at the end of its life, making recycling or repurposing easier. This type of disassembly can allow for toxic parts of the product to be removed so that recyclable parts can be processed. It must be easy for the end-user/s to disassemble the product's parts. Below are some ideas for creating a product that can be disassembled easily:

- Create instructions to allow the end-user/s to disassemble the product.
- Clearly label the parts of the product.
- Make the product out of recycled materials.
- Minimise the different materials needed to create the product.
- Use a minimal number of fasteners to join parts and avoid using glue.
- Use materials that could be placed in a household recycling bin.

Cradle to cradle (C2C)

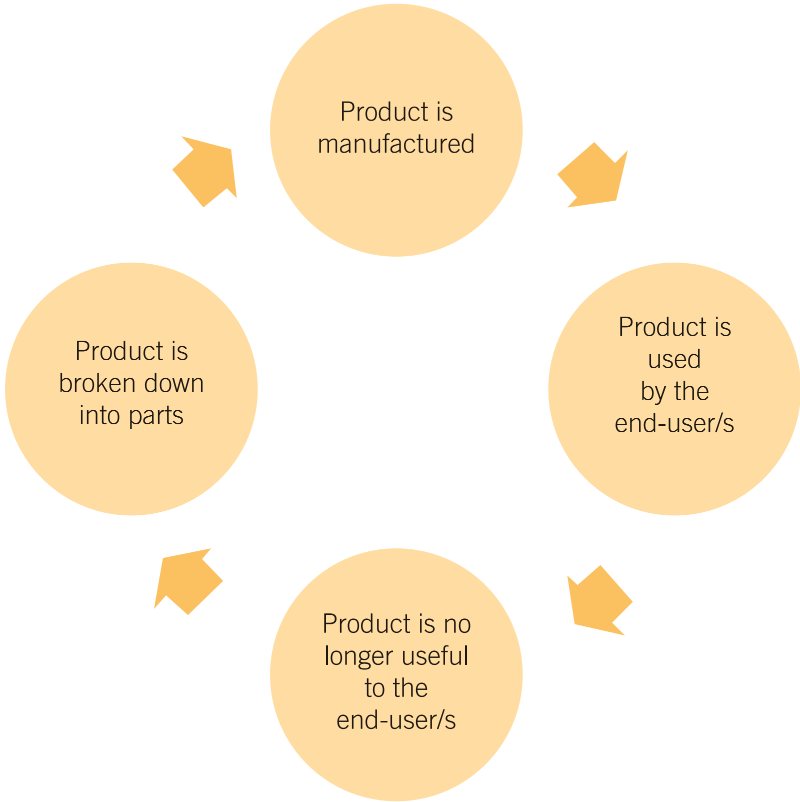

Figure 6.19 Cradle to cradle (C2C)

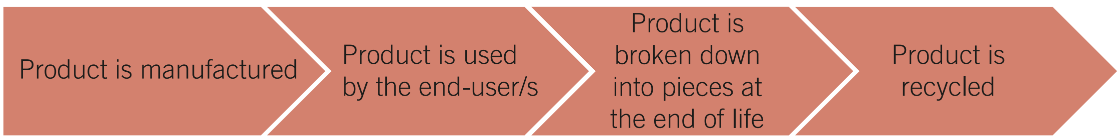

Figure 6.20 Design for disassembly (DfD)

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Some additional benefits of creating a product that can be easily disassembled include:

- easy repair and replacement of broken parts
- easy for the end-user/s to recycle the product
- product parts/components can be upgraded without having to replace the whole product.

Extended producer responsibility (EPR) or product stewardship

Extended producer responsibility (EPR) or product stewardship places the responsibility of the disposal, recycling or reuse of the product on the producer. The user will return the product to the manufacturer, who will then dispose of it correctly. With increased world population and more products being consumed and disposed of due to planned obsolescence, the waste throughout a product's life cycle is increasing at an alarming rate. EPR is a way of thinking that could stop products ending up in landfill and result in them being recycled correctly.

Shifting the responsibility of disposal of a product at the end of its life to the manufacturer might shift their thinking and be an incentive to create more sustainable products. It could also change the way an end-user looks at a product, increasing their interest in sustainable, recyclable products.

Refer to Chapter 1 for information on sustainability frameworks.

ACTIVITY 6.13

1 Why is it so important for designers to use the sustainability models and concepts when designing products?
2 Describe how a designer could improve the sustainability of a product by altering one stage of the product development process.
3 What do the abbreviations DfD, EPR and LCA stand for in product design?
4 What are the similarities and differences between product stewardship, the cradle to cradle concept and design for disassembly?
5 What is the role of the end-user/s in relation to sustainable products and their life cycle?

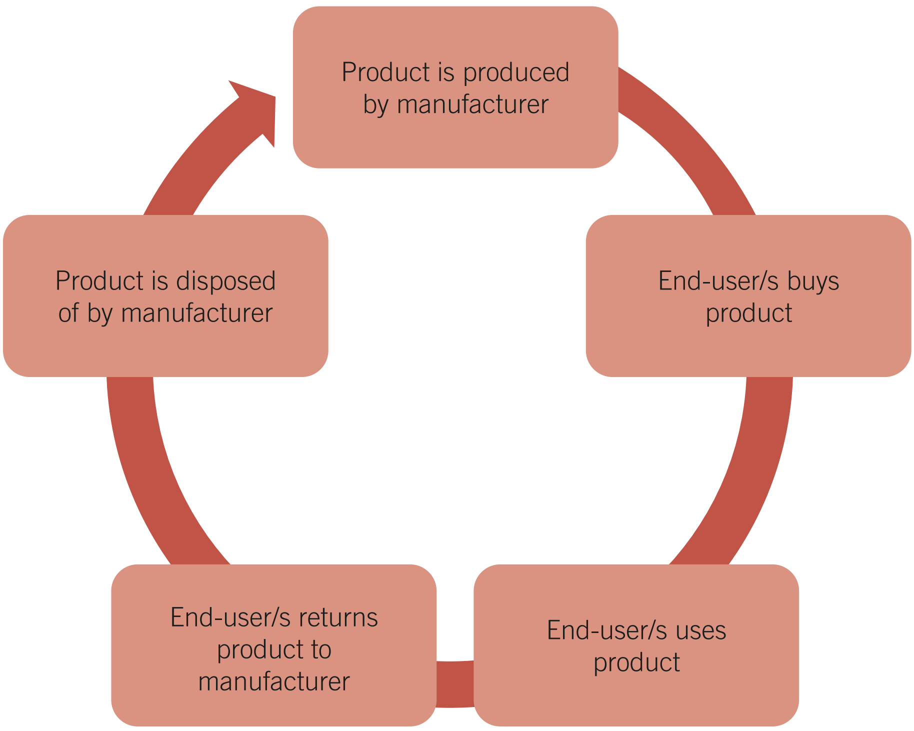

Figure 6.21 Extended producer responsibility (EPR)

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6.7 Planned obsolescence – style, technical and functional

Have you ever heard someone say 'they don't make them like they used to'? Everyone has heard stories from older generations of how products used to last forever – and they are right, they don't make products like they used to. In fact, some products are specifically made to fail after a designated time.

Why are products made to fail? To put it simply – they want us to buy more products. Designers and manufacturers rely on consumers to continually buy their products to make a profit. Creating products with planned obsolescence in mind is a way of continually generating sales. If consumers buy more products due to the product no longer meeting their needs or expectations, the companies will make more money.

Obsolescence is when a product is no longer needed, because it is either out of date, better technology is available or it no longer works. Many companies take advantage of products becoming obsolete and plan for this in their designing and manufacturing. This generates more sales for the company, but creates other issues as well.

Many products are designed to wear down and break after a certain time. Some products now are designed to cost less to replace than to repair. Manufacturers may make it too difficult to remove the back of the product or may have a requirement that it must be repaired by the company.

The manufacturer has to achieve a balance between creating a product that meets the end-user/s' expectations in quality, materials, function and price and creating a product that will need replacing so another product will need to be purchased. If they replace products too soon or products are priced too high, the end-user/s will stop purchasing the product.

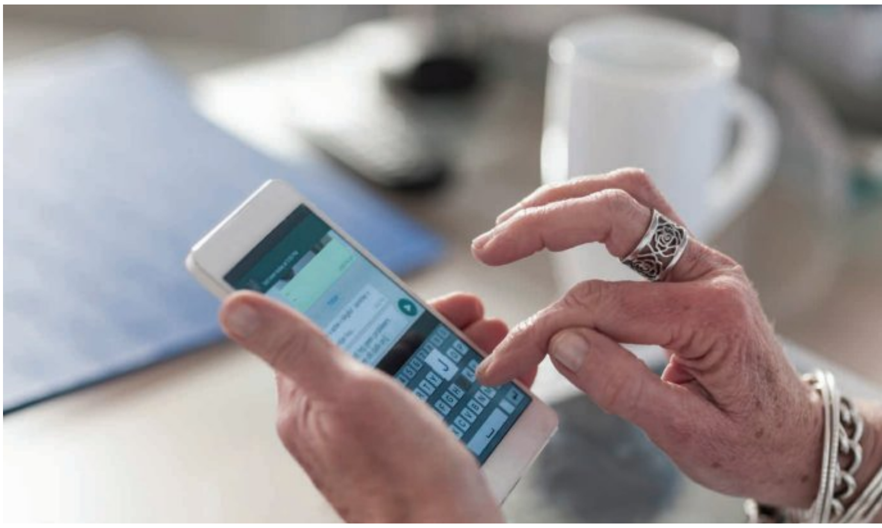

Figure 6.22 Technical planned obsolescence: After a few years, technical support is withdrawn for electronic devices, and operating system upgrades are introduced that cannot run on them.

Figure 6.23 With the introduction of flaws, some shoe brands are planned for obsolescence as they wear out more quickly

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Figure 6.24 Fast fashion has driven the increase of trends within the fashion industry.

Figure 6.25 A man in cardigan and slippers sits in a wheelchair, accompanied by a woman in the United Kingdom, 1920

obsolescence when a product's style, technology or function becomes outdated and is not wanted any more

DID YOU KNOW?

While video game consoles may become obsolete every few years, there is still a large market for retro consoles, such as previous Nintendo consoles, and many games not found on the new systems. This nostalgia-led market has resulted in companies re-releasing old games on the new platforms. Nintendo even released a mini-NES, a modern remake of one of their original consoles, so that old games could now be played clearly on new TVs.

Planned obsolescence can be divided into three key areas – style, technical and functional. A product may become obsolete due to one of these factors or a combination of them. As end-users, we need to understand how the manufacturer is creating products that have been designed with **obsolescence** in mind.

Style obsolescence

Style obsolescence is when a product becomes 'out of style', but is still functioning. Fashion garments are a good example of this. Fast fashion relies on the consumer always wanting the latest product and replacing garments before they become no longer functional. Style obsolescence relies on the end-user/s always wanting to have the latest product to ensure that they are always in style or on trend. Marketing and social needs play a huge role in how consumers see what is the latest trend and making the consumer believe that they need this product. Think about what is in your wardrobe. Is there a garment you used to love but won't wear because it is not on trend? As consumers, we need to be savvy in what we buy and how we consume clothing.

Style and technical obsolescence – wheelchair/mobility robot

Wheelchair designs are influenced by the style of the time and by the materials and technology available.

The first wheelchair is said to have been invented as early as 1595 and was called an invalid's chair. Since then, wheelchairs

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have developed throughout the years, from the addition of spoked wheels to the first motorised chair in the early 1900s and the first tubular folding wheelchair in 1932.

Toyota launched a mobility robot called Mobina in 2007 (see Figure 6.26). The style of this contemporary motorised wheelchair fits in with our modern idea of how products like this should look. Made of modern materials, the style of the Mobina is sleek, with curved edges, and gives the impression that it is very much a product of our time, and of our future. It has the motorised technical ability to easily move over uneven ground and automatically avoid obstacles without disturbing the passenger.

In contrast to the 2007 Mobina is the wheelchair designed and manufactured in the United Kingdom in the 1920s shown in Figure 6.25. The style of this approximately 100-year-old chair, with its wicker seat, curved armrests and spoked wheels, is now obsolete. Not only is its style obsolete but also its technical steering function. A long curved metal handle is attached to and extends out from a small front wheel, allowing the passenger to steer the direction of the wheelchair.

The design, visual appearance and technical aspects of these two wheelchairs are very different and they both reflect the style and technology of their time.

How long will it take for the style and technology of the Mobina to become obsolete?

Figure 6.26 In 2007, Toyota launched a mobility robot, Mobina, at the Universal Design Showcase in Tokyo. The robot is able to move over uneven ground and avoid obstacles automatically.

Technical obsolescence

Technical obsolescence is when a product (or a product's components) becomes outdated due to better or newer technology available, but still functions. A mobile phone is a good example of this. This a big issue facing designers and end-users. In the last few decades, computers have gone from filling whole rooms to fitting in the palm of our hands.

Functional obsolescence

Functional obsolescence is when a product no longer functions. A toothbrush becomes functionally obsolete and needs replacing quickly. All products at a point in their life cycle may become no longer functional. Materials may wear down due to use or parts or components needing replacement. The functional aspect of a product is very important

Figure 6.27 Floppy disks have been replaced by USB flash drives and cloud services.

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Figure 6.28 A toothbrush becomes functionally obsolete and needs replacing quickly.

to the end-user/s. End-users all want a product to function as intended.

Products in our modern society can be designed to no longer function after a set amount of time or to break easily. How do we know this? A well-known example is the Centennial Light, which has been faintly shining in a California fire station since 1901. If a light bulb that is nearly 120 years old can still shine today, why can't our modern light bulbs last more than a few thousand hours?

Nylon stockings are another example of products with built-in flaws. Even in their first wearing, stockings are prone to tearing if they catch on something, despite that fact that nylon can be strong and long-lasting, as it is used for parachutes. However, manufacturers plan on this happening, and know that consumers will continue to replace them.

The end-user/s finds this continually frustrating because they have no choice but to go and buy a new item. Essential products such as light bulbs and nylon stockings could last longer, but they have been made to last only a certain time.

Figure 6.29 The Centennial Light

Figure 6.30 A modern light bulb

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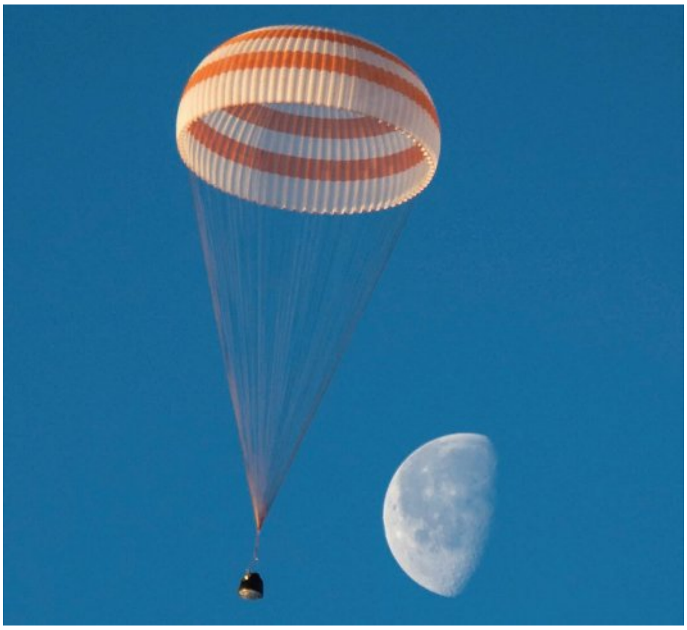

Figure 6.31 NASA astronauts return to Earth, their capsule suspended by a parachute made from the same material as nylon stockings.

- **Complete the planned obsolescence: benefits and problems Activity 6.8 on page 145 of the workbook.**

ACTIVITY 6.14

1 What is planned obsolescence and how does it relate to product design?
2 List the three types of planned obsolescence.
3 Why do designers and manufacturers design products to last for a certain amount of time?
4 How does planned obsolescence alter how products are designed and manufactured?
5 How does planned obsolescence alter the way products are seen by the end-user/s?

6.8 Benefits and problems for the producer and consumer and associated environmental issues with planned obsolescence

Obsolescence in product design has its obvious and wasteful flaws, but it also has its benefits. It is our job as designers and end-users of products to look at the positives and negatives and decide how we will design or use products.

Table 6.3 lists benefits and problems of obsolescence for different people within the product design process.

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Planned obsolescence and the consumer/end-user/s		
	Benefits for the end-user/s	**Problems for the end-user/s**
Technology	• Products are up to date. • There are multiple functions in the same product. • Product functions have faster speed.	• Constantly updating products is costly. • Useful products are now 'useless'. • Old technology will not work with the new software updates.
Function	• Products are reasonably priced. • Products are easily replaced. • New functions are now in average-priced products as well as higher-end products.	• It is necessary to buy the same product due to the cost of repair being more than the price of the product. • Products have a short life. • There is increased waste.
Style	• They will always be up to date. • New products will always be available.	• Newly purchased products might go out of style quickly. • Products may be of low quality due to rushed manufacturing.
Planned obsolescence and the designer		
	Benefits for the designer	**Problems for the designer**
Technology	• Companies that adapt and apply new technology will have an edge over their competitors.	• Money needs to be spent on R&D for product development. • Continual updating of software is required.
Function	• It can cost less to make products. • Materials can cost less.	• Knowing how to meet the end-user/s' expectation in quality with lower material costs is necessary.
Style	• New products need to be designed to meet new trends. • Designers can create trends to suit their product.	• Products might not sell before the new trend appears. • Products designed might not suit the current consumer trend.
Planned obsolescence and the manufacturer		
	Benefits for the manufacturer	**Problems for the manufacturer**
Technology	• Companies that adapt and apply new technology will have an edge over their competitors.	• Money needs to be spent on R&D for product development. • Tools, machinery and equipment need to be updated to meet new product demands.
Function	• It can cost less to make products. • Materials can cost less.	• There is a fine line between meeting the end-user/s' expectation in quality and using cheaper materials. • Quicker and cheaper production processes may result in poor-quality products.
Style	• New products need to be designed to meet new trends. • Designers can create trends to suit their product.	• Products might not sell before the new trend appears. • Products designed might not suit the current consumer trend.

Table 6.3 Planned obsolescence within the product design process

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Obsolescence and the environmental impacts

Planning to make a product obsolete in a certain time frame so that our end-users have to buy the next product is a great business model. Businesses make money, jobs are created and end-users enjoy that new product feeling. The biggest negative result is the wastefulness of materials and products and the impact on the environment.

ACTIVITY 6.15

1. What are some positive and negative aspects of planned obsolescence?
2. List the similarities and differences of the three types of planned obsolescence.
3. How does planned obsolescence affect how the end-user/s purchases a product?

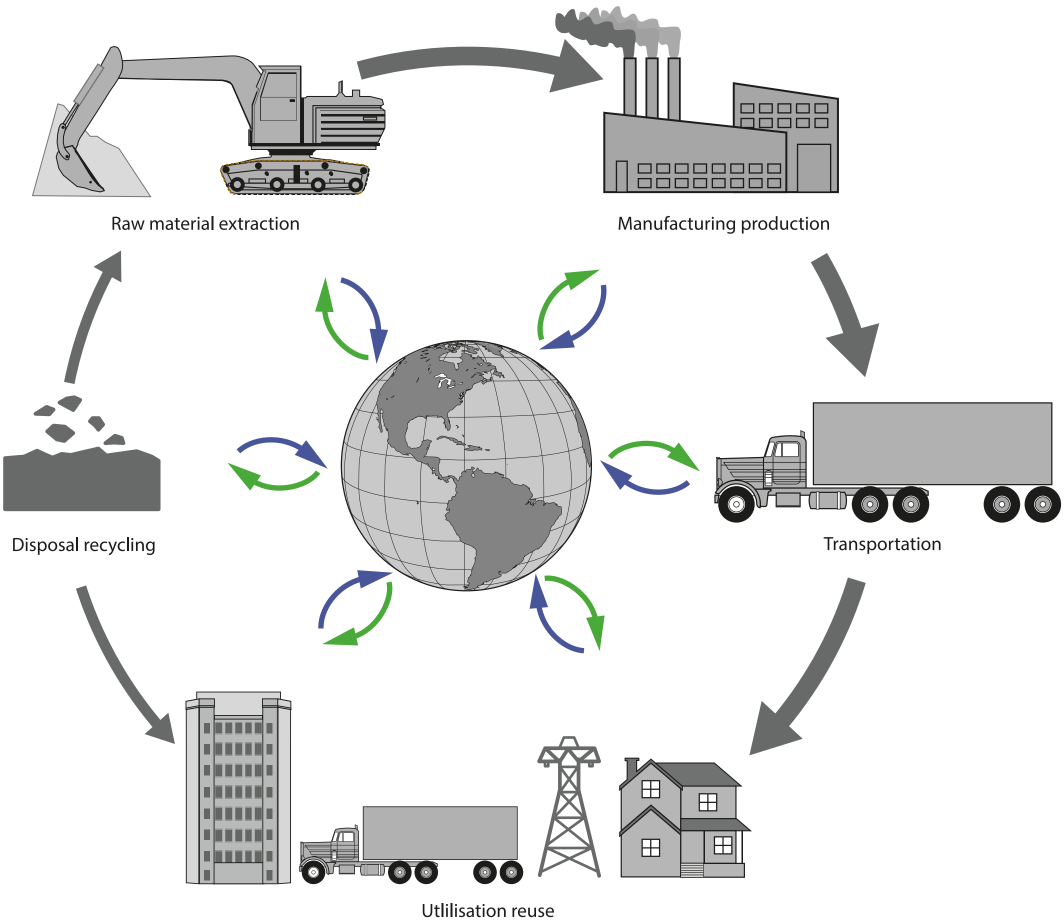

Figure 6.32 Products impact the environment throughout their life cycle.

6.9 Methods and suitability of different scales of manufacturing systems

When creating a product for sale, the developing and designing of the product is only the start of the process. The production of the product comes with new challenges in choosing the production processes, tools and quality measures.

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cost-effective term used to describe if the product development process meets the constraints of price considering the factors of design and development costs, materials, tooling creation and manufacturing

bespoke product made to order, commissioned or to a particular specification

Many factors need to be considered by a designer or manufacturer when deciding on the correct scale of manufacturing system for their product:

- Knowing the expectations of the end-user will ensure that the product will be made with the correct quality.
- Selecting the correct processes to directly relate to the resources available, time to make the product and when the product needs to be available to the customer.
- Demand of the product.

Designers and manufacturers need to choose the correct scale of manufacturing systems to suit their product while being **cost-effective**. It is about the supply and demand. If the incorrect scale of manufacturing is used, this could lead to loss of profit due to many items remaining on the shelf.

Only a few decades ago, manufacturing of products could be done in one country. Now, with the advances of transport, and the need and demand for cheaper products, a product could be made of materials sourced and assembled in different parts of the world. Many factories in Australia have moved overseas where products are cheaper to produce due to labour costs. Materials might be shipped from Australia, the product assembled in Asia and then shipped back to be sold in Australia. The actual cost of shipping and time it takes is cheaper for manufacturers than getting the product made in Australia. Manufacturing focuses on efficiency to make more profit, and this example of a worldwide supply chain may become common practice.

Figure 6.33 Kate Middleton's dress was a one-off product for her wedding. Her gown has been influential on wedding dress designs, with many brides creating similar gowns.

One-off production

In one-off production, products are made for a very select context and/or problem. Only one of these products is made, usually due to an order placed by an end-user/s. These products are often called **bespoke**. The expected quality from the end-user/s in one-off production is quite high. The product also will need to fit all their needs, wants and their expectations.

With only one product being created, the cost of production may be high due to:

- level of skill needed to complete the product
- high level of finishes in production processes
- quality of materials
- specialist equipment.

In your SAT, you will be producing a one-off product that has been made to suit select end-user/s. You have thought about the product from the idea to creation. Examples of one-off products include custom-made couture gowns or wedding dresses, which allow brides to have a unique design and a custom fit.

Bespoke and custom-made furniture pieces – one-off production

One-off production of furniture pieces is a sustainable way of producing furniture because the quality and hand building that goes into making a bespoke or custom piece of furniture means the end-user/s will value the product for longer and its design style could potentially be appealing for longer. The end-user/s also acquires a piece of furniture that is designed and made to their specifications.

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Figure 6.34 A custom-made chair constructed using pipes and old radiators sits in a living room.

There are many reasons for an end-user/s to source bespoke, custom-made furniture:

- Innovation, quality and attention to detail will be evident in all stages of the design process.
- Those involved in the design of the furniture product will have a more empathetic relationship with the end-user/s and therefore a better understanding of the end-user/s' needs and wants.
- Those involved in the production of the furniture product will have an emotional attachment to the product because they will have a passion for working with the materials they are using to handcraft the furniture piece.
- Small businesses involved in bespoke or custom-made furniture are supported, which helps local communities and contributes to the economy as a whole.

Low-volume and batch production

Batch production is where only a small number of products are made at one time instead of continuously. Manufacturers may use this style of manufacturing if the product has a niche market or is a new product. The designer could be producing a small number of products to gauge consumer interest in the product. If interest in the product increases, more product batches could be produced or a higher-volume production scale could be used.

Batch production could add an incentive to the end-user/s wanting the finished product. If a limited number of products is available, they may be willing to pay a higher price for the product. Releases of sneakers are an example of using hype and price due to a limited number of products being produced.

Figure 6.35 Sneakers that are released in small batches can generate strong interest among consumers.

High-volume/mass production

Today, high-volume or mass production is faster and cheaper than at any time in our history. High-volume or mass production is used when a manufacturer has to produce a high number of the same product with little or no difference. When creating thousands of the same product, some or all parts of the production process will be created using different tools. **Tooling** is made to create one or many aspects of the product.

As technology improves, so does the complexity and refinement of mass/high-volume processes. Robotics is now replacing people in the **assembly line** and doing jobs that once belonged to factory workers. The robotics

tool (tooling)/mould (moulds) assorted tools acquired for the manufacturing components and machines required for production; aluminium and plastic is generally used for low-volume tools and steel for high volume

assembly line a succession of identical products progressively assembled in a factory

Figure 6.36 A T-shirt production line

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can complete complex dangerous processes with high precision and efficiency. The increased efficiency of the production of the product can be passed down to the consumer. Mass/high-volume products are continually reducing in costs as manufacturers push towards the ideal of lean manufacturing.

Large fashion companies may use mass production to produce the large number of garments that they require for stores around the world. Garment production requires workers to sew the garment together in multiple steps and stages. As companies want to keep the cost of production low, some garment manufacturing has been moved to countries with low labour costs. The issues surrounding garment factory workers' safety, working environment and wages are of growing concern within the fashion industry.

Figure 6.37 Men stand beside the first Frigidaire, made by Delco Light Company, a subsidiary of General Motors

Figure 6.38 Consumers can now create shoes with their own colour combination.

The refrigerator – mass/high-volume production

The refrigerator is the most common appliance on our planet, and as early as the 1700s scientists were experimenting with artificial refrigeration. By 1913, consumers were able to shop for a refrigerator, and today no kitchen is complete without one to meet the needs of our modern diet, which requires food to be kept fresh longer. Most refrigerators also have freezers, which means the consumer can buy food in large quantities and eat it whenever they choose.

Customisation of products in manufacturing

Some end-user/s may not want what everyone else has or what is on the market, they might want something slightly different. As innovation is spurred by the needs and wants of the user, this encourages manufacturers to attempt to add a more personalised touch to their mass/high-volume products. Customisation allows the end-user to have control of some of the product attributes. What the manufacturer may change due to a special order may not cost a lot in production (for example, colour or added extra accessories). Yet it gives the illusion to the end-user that they have a unique product, when in fact only one aspect of the product has been changed.

This is a winning combination for the manufacturer. If the manufacturer only produces products made from a few set options (see Figure 6.37), these products will all sell. Because they have been specifically ordered by the consumer, the manufacturer will know exactly what the end-user/s want. This type of mass/high-volume customisation of products brings the individual touch of one-off products to the batch/low-volume or mass-production scales.

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Continuous production

Continuous production is production of one type of product 24 hours a day, seven days a week, only being shut down for maintenance or safety issues. This type of production is useful if you have to constantly supply the same material or product. It is mostly used in changing raw materials to useable materials to be used in higher-value products. An example is steel, which is made using continuous production and is used in buildings and appliances.

This type of production is quite cost-effective. Large amounts of material are continually being converted or produced, allowing the manufacturer to utilise the production equipment to maximise the possible profit. If something unexpected goes wrong in the equipment, the production line can be brought to a standstill. This can have a negative effect on profit due to loss of output and product. Some products not fully completed may have to be disposed of.

Cars – continuous production

The body of a car is continuously produced and goes through various stages of production.

The vehicle shown in Figure 6.7 on page 156 has gone through the stages of continuous production and is being inspected by robotics as part of quality control.

Car body – stages of production

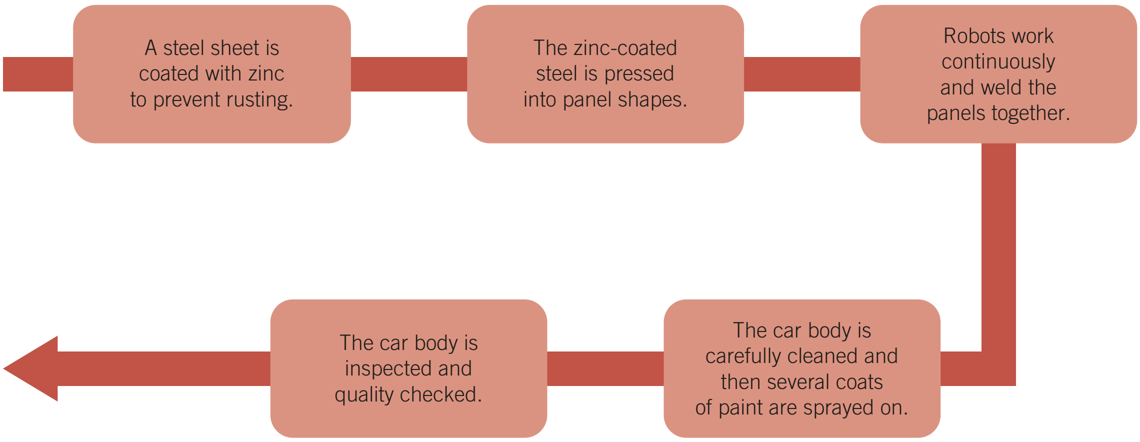

Figure 6.39 Stages of production of a car body

The positives and negatives of different manufacturing systems

Manufacturing system	Positives	Negatives
One-off	• The product will suit a select end-user/s. • The product is wanted by the end-user/s. • The end-user/s will have a unique, custom-made/bespoke product.	• Only one product is produced. • The cost of production may be high.
Batch/low volume	• Manufacturers can meet supply and demand. • Increased exclusivity of the product (for example, designer sneakers) could increase the price.	• Machinery may need resetting after each batch. • Only a set number of products are produced at one time – limiting product.

(Continued)

Table 6.4 Manufacturing systems – positives and negatives

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Manufacturing system	Positives	Negatives
High-volume/mass production	• Large numbers of the product mean that end-users can always have access to the product. • Tools and robotics can be used to create the product, reducing cost and increasing efficiency. • Many types of products can be made using the same materials, components or parts.	• One type or style of product is produced. • There can be large loss of profit if the product does not sell. • There is less individuality for the customer.
Continuous	• A product is continuously produced. • Production is low-cost once the production line is set up.	• A fault in the production line could mean loss of product and profit. • If the product is no longer needed, restructuring of the production line may be costly.

Table 6.4 Manufacturing systems – positives and negatives *(continued from previous page)*

Quality in production of commercial products

Quality control measures are used throughout production to ensure that the product meets expected quality. Tools that have been created need to be tested regularly to ensure that they continue to produce expected outcomes. Checks of components of the product for quality will mean a quality product is produced. Quality checks can be done in any scale of manufacturing.

Examples of quality control measures include:

- training the workforce in correct procedures
- debug tooling to ensure quality parts
- use of quality materials (no faults)
- monitoring quality of joining and finishing techniques
- efficient and effective use of tools.

ACTIVITY 6.16

1 What type of product would be made as a one-off product?
2 Why is it important to think about how many products will be bought by the target market?

The manufacturing process may finish when the product is produced and launched to the public, but that is not the end of the design process or product life cycle. The manufacturer and/or designer will look at the current product and explore ways to:

- reduce the cost of production (materials, quality, processes)
- refine and evaluate production processes and tools
- adjust production numbers to meet the demand of the product
- evaluate the overall design for further improvement
- seek market feedback on all aspects with qualitative and quantitative data (customer feedback, returns, sales)
- change the colour or style.

- **Complete the Extended Producer Responsibility (EPR) Activity 6.7 on page 143 of the workbook.**
- **Complete the scales of manufacturing Activity 6.9 on page 146 of the workbook.**

ACTIVITY 6.17

1 How are quality measures used in commercial production of different products?
2 What are some benefits of mass production?
3 Why would a manufacturer change the scale of the production of a product?

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CASE STUDY

Using your design skills to help others

Figure 6.40 Prosthetist Heather Stewart with some of her work

What is your role?

I work as a prosthetist at a public hospital in Victoria. My role involves working with amputees, providing prosthetic services to help them achieve their goals. I love my job because I'm able to help people regain their independence after losing a limb. The work I do is instrumental in helping people achieve their goals, and therefore very rewarding. I also love making things with my hands and being creative with materials, so this job combines a few interests!

Figure 6.41 Custom leg prosthetics

What about your design process?

The process involves taking a plaster cast of their residual limb, filling the cast with plaster, and then shaping the positive mould. From this mould, I then manufacture a prosthetic socket using materials such as foam, fibreglass, carbon fibre and resin. I consult with the client about the function and appearance of their prosthesis, and we come up with solutions together. The ideal result is a comfortable, attractive, well-fitting socket. I then align other components, including a suitable foot, to form a full prosthetic leg.

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Chapter summary

- Industries can use R&D to determine the strengths and weaknesses of a design.
- New and emerging technologies include laser technology, CAD, CAM, CNC, robotics and rapid 3D prototyping.
- The different types of manufacturing scales include one-off, low-volume, high-volume/mass production and continuous production.
- The three types of planned obsolescence are style, technical and functional.
- Sustainability frameworks that influence design, production and distribution are LCA, C2C, DfD and EPR.

Short-answer questions

1. List the three types of planned obsolescence.
2. Describe the environmental impacts of planned obsolescence.
3. Explain why it is important to pick the correct manufacturing scale or system for a product.
4. Describe the benefits of sustainability frameworks for design, production and distribution.
5. Discuss why it is important for industries to invest in research and development.

Extended-response questions

1. Describe how obsolescence affects the designer, manufacturer and end-user/s?
2. Discuss whether designers, end-user/s or manufacturers are responsible for the planned obsolescence of products.

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Figure 7.1 Student work by Madeleine Rosenbrock

7 Area of Study 3: Designing for others

INTRODUCTION

This area of study requires you to follow the product design process and, working as a designer, document the product design process used to meet the needs of an end-user, and commence production of the designed product. You will prepare a design brief that guides your work for both this area of study and Areas of Study 2 and 3 in Unit 4.

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KEY KNOWLEDGE

- the product design process to achieve a quality product for an end-user/s
- methods of accessing, analysing, organising and presenting relevant data and information used to determine the needs of an end-user/s
- product design factors relevant to identified problems, needs or opportunities
- the role of criteria to inform and justify design option selection and evaluate the finished product
- methods of exploring, researching and testing the characteristics and properties of materials to determine their suitability, and processes applicable to the development of the design
- the use of creative and critical design thinking techniques, including digital technologies where appropriate, to develop design ideas and methods of communicating these ideas and gaining feedback from end-user/s
- the purpose and role of annotated visualisations (concept sketches and drawings, design options), annotated presentation drawings, and working drawings of the justified preferred option
- methods of communicating a product specification in working drawings: assembly and detail drawings, templates, flats, plans, patterns and notations, as appropriate
- tools, equipment, machinery, facilities and other factors that influence productivity
- the role and components of production planning:
    - a scheduled work plan with timeline, production steps, materials, tools, equipment and machines, quality measures and estimated time to complete processes
    - a risk assessment
    - a materials and costing list
- techniques used to record progress and reasons for modifications to the design, planning and production plans
- methods of manufacturing in a mass/high-volume production or low-volume setting.

KEY SKILLS

- conduct research using interviews or market research to create an end-user/s' profile
- develop evaluation criteria to be used for both design options and the finished product
- conduct and present research relevant to the design brief, appropriately acknowledging sources and IP of others
- use a range of visualisations, drawing and communication methods, including digital technologies where appropriate
- use end-user/s' feedback to select and justify the preferred design option
- prepare a scheduled production plan
- research, test and use experimentation techniques and/or trial processes to ascertain appropriateness of characteristics and properties of materials for the product design
- record progress of production activities and explain and justify modifications and improvements
- identify relevant manufacturing processes needed to enable mass/high-volume or low-volume production of the preferred design.

7.1 The product design process to achieve a quality product for an end-user

In Unit 3 you start your school-assessed task (SAT)/folio, which you will work on across the year. The SAT contributes to 50% of your study score for Units 3 and 4 Product Design and Technology. You will follow the initial stages of the product design process, designing for an end-user/s, and will begin production before the end of Unit 3. Your folio is your major body of work, and there are many ways to approach the set tasks. This chapter will highlight some suggested approaches.

In this outcome, you will develop:

- an end-user profile
- a design brief
- evaluation criteria
- research
- visualisations
- design options with justification of the preferred option
- working drawings of the final option
- a scheduled production plan
- a list of relevant processes used for larger-scale production.

As you work through the VCE product design process for an end-user in Units 3 and 4, you develop skills as a designer by empathising with the needs of others, solving a design problem with creativity. This could involve (but is not limited to):

- designing a one-off piece for a specific end-user, such as a costume for a performer in a play or a study desk for a student
- designing for a community group of end-users, such as designing a set of wooden toys for a kindergarten or a uniform for a sports team
- designing for a target market of typical end-users, such as a range of children's pyjamas or a range of children's toys
- designing for an end-user belonging to a **niche market** that is not well catered for already.

Don't waste time deciding on an end-user or end-user group and product or range of products

The sooner you decide on an end-user/s and a product or range of products the better. You don't want to waste valuable time at the beginning of the unit. Ask your teacher for guidance on selecting the best product to design and produce for your end-user or end-user group in the time frame you have. You also want to make sure that you can easily source the materials you will need and that you will be able to carry out the necessary production processes in your school workshop or classroom.

TIPS

- Explore design situations you are interested in and passionate about, and approach the product design process with an open mind, not with design solutions already in mind, or end-users with inflexible ideas of what they want.
- Make sure the materials you select are from the materials categories listed in Chapter 2.
- You need to be organised and focused with the intention of making a quality product from the very beginning.
- If you have to outsource any parts of your work, make sure you acknowledge those contributions. Outsourcing of processes is suitable when the technology is not available in the classroom, you do not have the level of skill needed to undertake a production process or safety is a concern. For non-resistant materials, this could include digital printing or pleating, etc. and for resistant materials this could include the cutting of glass, for example.

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niche market a small group of consumers with specific needs

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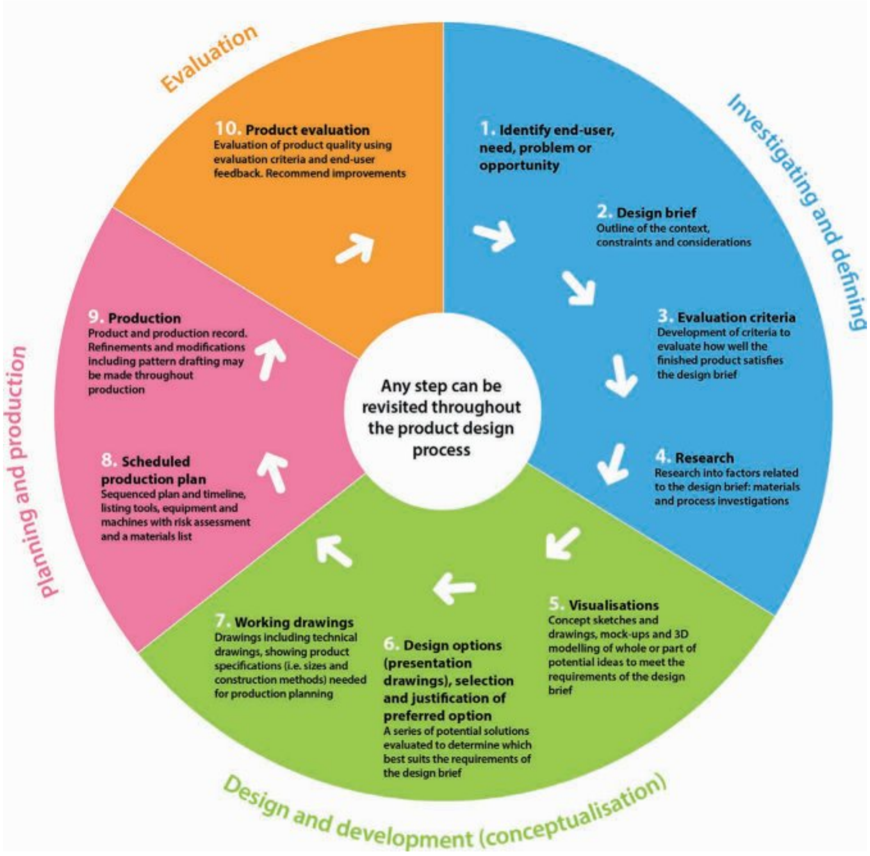

Figure 7.2 The product design process (© VCAA)

- Acknowledge all sources of information and include documentation of your decisions.
- You have chosen to undertake a design subject, which suggests you have an interest in design. Use this interest to guide your SAT folio presentation and keep the presentation consistent so it is easy to navigate with clear headings and subheadings as required.

Genuine feedback during the product design process

Allowing yourself to be creative and innovative is key. However, at multiple stages in the product design process, you will need to gain feedback from typical end-users as identified in your design brief and end-user profile. This works best if the feedback is genuine and constructive, from multiple people who could be typical end-users of the products. For example, if you chose to design a uniform for a sports team, you should seek end-user feedback from at least one person who plays on a sports team.

Good design problems are what you want when working with an end-user/s, so think carefully about whom you will design a product for.

Good and not-so-good design problems

Good design problems when working with an end-user/s	Not-so-good design problems when working with an end-user/s
The end-user/s: • is cooperative, open-minded and can give you helpful, constructive feedback • asks questions that you don't yet know the answer to, encouraging you to broaden your own knowledge • is open-minded and allows you to respond to their questions in many different ways • makes you think of a variety of ideas and inspires you as a designer • utilises your strengths as a designer • requires you to do varied research.	The end-user/s: • already has an image/idea of what they want • already has a solution – either a product that is already available, or they know what they want you to make • only has aesthetic needs • has a limited number of solutions and is not open to broader discussion.

Table 7.1 Good and not-so-good design problems

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ACTIVITY 7.1

Using a mind-mapping digital tool such as Inspiration or an A3 sheet of paper, complete a brainstorm to help generate ideas for potential design situations and end-users' needs that you may like to explore this year. Branches of your brainstorm could include:

- listing your strengths in the product design process
- describing your personal design aesthetic
- interests and hobbies and any area you are an 'expert' in
- designers you admire
- artists who inspire you
- materials you wish to explore using
- potential themes in your work
- potential end-users
- concerns you have in ethics and sustainability.

Refer to page 149 of the workbook for a folio checklist for the Units 3 and 4 SAT.

7.2 Methods of accessing, analysing, organising and presenting relevant data and information used to determine the needs of an end-user

The SAT requires you to generate an end-user/s profile with relevant information that will help you progress in the product design process. This requires you to complete market research to define their needs and help refine your design problem.

Empathising with your end-user/s and positive communication

When you first communicate with your end-user and show an empathetic interest in what they need and want, your end-user/s will feel confident that you understand their design problem. Open, positive and constructive communication should develop between you as a result.

If your end-user/s has many questions about how you are going to approach the design problem, this level of interest and enthusiasm should be inspiring. It is important to support your end-user/s' enthusiasm and maintain this level of interest throughout the design process.

Talking to the end-user' about your own particular focus as a designer, whether it be discussing other designers you find inspiring, particular materials you enjoy working with, or preferred production processes, will not only provide insightful information about the possibilities of design and production for your end-user/s, but could influence their ideas and guide them in a direction that enables you to draw on and utilise your strengths as a designer.

How to create an end-user profile

An end-user profile should include a range of information about the end-user/s that forms a sense of who they are.

You might like to include images in your profile, not only of your end-user but also images that relate to some of their responses.

Table 7.2 provides an example of the kind of information you can collect for an end-user profile. This end-user profile is about Ella, who wants a flat-pack stool with a detachable travel bag (refer to the design brief in Chapter 5).

Once you have completed your end-user profile, you can use this information to support your market research. You might like to carry out an interview with your end-user/s or perhaps create a questionnaire or survey. The information you gather from this research will enable you to then develop and write a detailed design brief.

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Areas of focus	Information	Visual information
Name Age	Ella 18	Photo of Ella
Background	Ella's father is British and her mother is Danish. She has a younger sister Sophie and a pet dog and cat. Her home is in Melbourne's south-east.	Perhaps a photo of Ella's home/family/pets/culture What else could you include?
Interests and hobbies	Ella enjoys the outdoors and in particular mountain climbing. She has a passion for environmental science and sustainability. She is inspired by biomimetic design and sees this as an important part of our future.	You could include photos of places she likes to go mountain climbing and examples of biomimetic design. What else could you include?
Personal taste Product design elements	Growing up, she was influenced by her mother's heritage and interest in Danish furniture. She likes the simplicity and look of this style of furniture and modern Bauhaus design. Ella likes earthy colours, not bright colours, and natural timber; in particular, sustainable materials such as plywood and recycled fabrics.	You could include photos/pictures from her Danish heritage, examples of Bauhaus design, and colour and material samples. What else could you include?
What product does Ella need and why?	Ella needs a flat-pack stool with a detachable travel bag to take on her backpacking holiday.	
What qualities might she value in the product?	Ella values sustainable materials and a modern and stylish design aesthetic.	You could include examples of some of the aspects she values, such as sustainable materials and modern design. What else could you include?
Where will the product be used?	The product will be used when Ella backpacks around Europe.	You could include a map showing the countries she will backpack through and the type of terrain she will encounter. What else could you include?
What is the expected quality of the finished product?	The product needs to be durable and lightweight, easy to assemble with non-traditional joining methods and made from sustainable materials.	You could include examples of existing products that demonstrate the quality of finish she is wanting. What else could you include?

Table 7.2 Example of information that could be included in an end-user profile

Market research to support the detailed writing of a design brief

Which approach would you prefer to take – interview or survey?

Interview

If you choose to interview your end-user/s, it is a good idea to write down your questions first and read them out to someone else to ensure that they are easy to understand, are in a logical order and are relevant. Remember, your end-user's responses should help you develop a detailed design brief. Ask open questions that require more than a yes or no answer.

Survey

You may prefer to gather information by creating a survey instead of conducting an interview. A survey involves the collection, recording and analysis of information gathered from an end-user/s in relation to a design problem.

TIP

Research examples of surveys and questionnaires to determine which approach you prefer for gathering relevant information and support the writing of the design brief. There are many online survey platforms you could also use.

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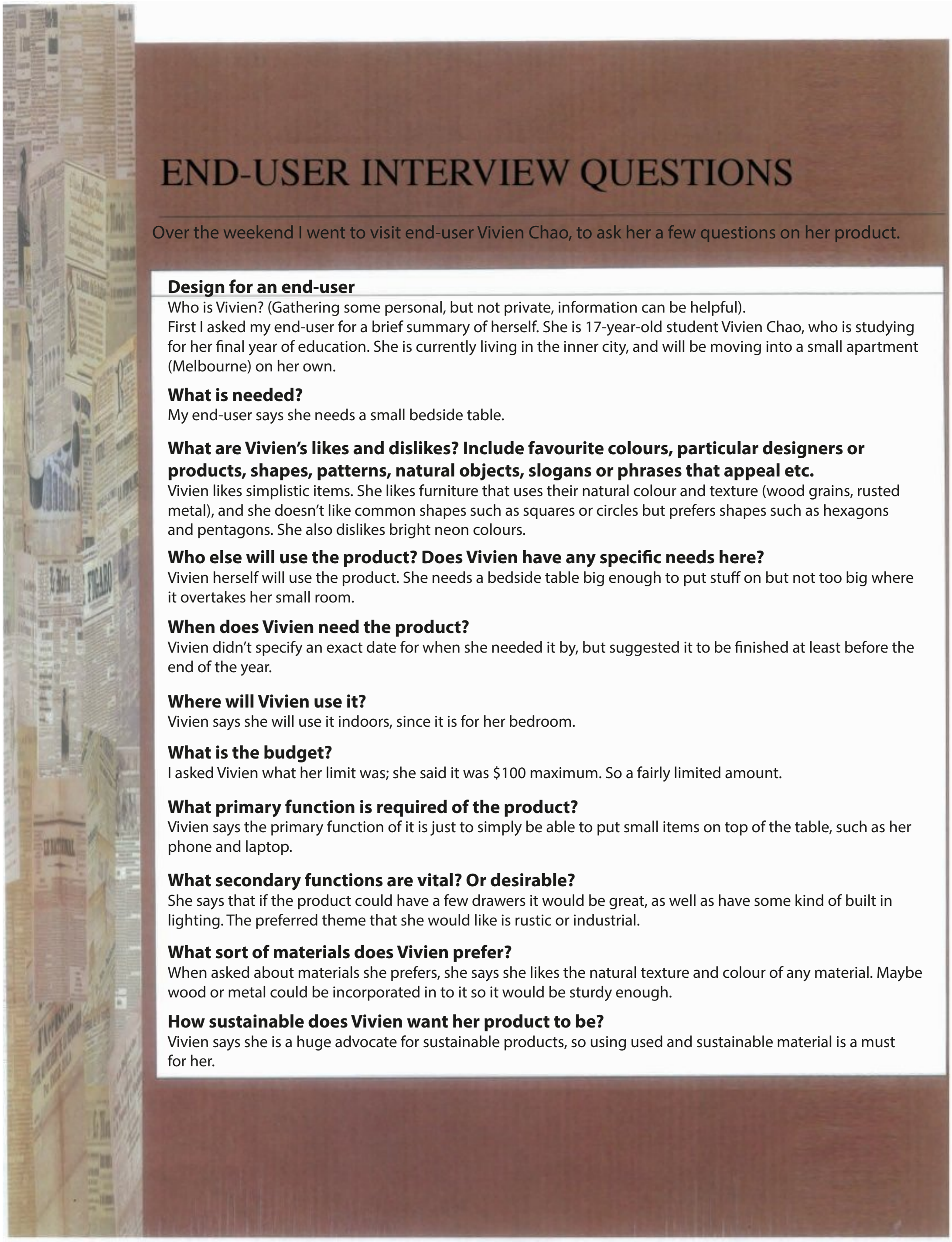

END-USER INTERVIEW QUESTIONS

Over the weekend I went to visit end-user Vivien Chao, to ask her a few questions on her product.

Design for an end-user
Who is Vivien? (Gathering some personal, but not private, information can be helpful).
First I asked my end-user for a brief summary of herself. She is 17-year-old student Vivien Chao, who is studying for her final year of education. She is currently living in the inner city, and will be moving into a small apartment (Melbourne) on her own.

What is needed?
My end-user says she needs a small bedside table.

What are Vivien's likes and dislikes? Include favourite colours, particular designers or products, shapes, patterns, natural objects, slogans or phrases that appeal etc.
Vivien likes simplistic items. She likes furniture that uses their natural colour and texture (wood grains, rusted metal), and she doesn't like common shapes such as squares or circles but prefers shapes such as hexagons and pentagons. She also dislikes bright neon colours.

Who else will use the product? Does Vivien have any specific needs here?
Vivien herself will use the product. She needs a bedside table big enough to put stuff on but not too big where it overtakes her small room.

When does Vivien need the product?
Vivien didn't specify an exact date for when she needed it by, but suggested it to be finished at least before the end of the year.

Where will Vivien use it?
Vivien says she will use it indoors, since it is for her bedroom.

What is the budget?
I asked Vivien what her limit was; she said it was $100 maximum. So a fairly limited amount.

What primary function is required of the product?
Vivien says the primary function of it is just to simply be able to put small items on top of the table, such as her phone and laptop.

What secondary functions are vital? Or desirable?
She says that if the product could have a few drawers it would be great, as well as have some kind of built in lighting. The preferred theme that she would like is rustic or industrial.

What sort of materials does Vivien prefer?
When asked about materials she prefers, she says she likes the natural texture and colour of any material. Maybe wood or metal could be incorporated in to it so it would be sturdy enough.

How sustainable does Vivien want her product to be?
Vivien says she is a huge advocate for sustainable products, so using used and sustainable material is a must for her.

Figure 7.3 Example of an interview conducted by student Monica Ngo

A survey using the product design factors ranking table

Using information obtained from the end-user profile, you can create a detailed survey based on the product design factors ranking table in Chapter 5 (Table 5.3). Against each product design factor in the table, write relevant questions about your end-user's design problem (see the example in Table 7.3). The questions should be specific to the design factor. Some of the information you obtained in the end-user/s profile you might be able to develop into questions and include in this survey.

Once your end-user/s has answered the questions, have a discussion with your end-user to determine what factors the end-user finds most important to least important. This ranking will help you establish early on what aspects of the design problem are of most importance to the end-user. This knowledge will help you to focus on the core of the design problem, write a relevant design brief resulting in a final product that successfully meets the needs and wants of the end-user/s.

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Survey with ranked product design factors against an end-user/s' design problem

This survey identifies relevant product design factors and determines their level of importance according to the end-user/s design problem. Refer to page 150 of the workbook for this worksheet.

Product design factors	Questions against each factor related to the end-user/s' design problem	Ranking of importance (most important = 1, least important = 9)
End-user/s Name: Age: Design problem	 Ella Smith 18 Flat-pack stool with a detachable travel bag	Ranking of product design factors according to what factor the end-user/s finds most important to the least important
1 Purpose, function and context	**What is its purpose?** To travel with while backpacking around Europe. **How should it function?** It needs to be flat-packed, fold away easily and have a small detachable travel bag. **Where will it be used?** It will be used in the outdoors while travelling/backpacking.	1
2 User-centred design	**What aspects of the stool's design will need to consider your physical needs while travelling?** It needs to be light, easy to carry while backpacking and easy to fold away. **What aspects would make the flat-pack stool a quality product for you?** I like modular design and simple but strong joining methods.	3
3 Innovation and creativity	**Do you consider the potential of the stool to be flat-packed an innovative solution while travelling?** I do because when I am backpacking through hilly terrain and jumping on and off public transport I need it to be securely packed away. **How would you like the travel bag to attach and detach from the stool?** I would be happy with light plastic clasps.	5
4 Visual, tactile and aesthetic	**What is the range of your preferred earth-based colours?** Probably different shades of green and I like black. **Can you provide any examples of designers' work that you appreciate or find inspiring for your flat-pack stool?** I have a keen interest in Danish design and in particular Finn Juhl's work. I also like Philippe Starck's furniture.	6
5 Sustainability	**With your interest in sustainable materials, what materials would you prefer your flat-pack stool and detachable travel bag to be made from?** The flat-pack stool needs to be made from a sustainable material such as plywood. The travel bag could be made from recycled canvas. It should be durable and waterproof.	2
6 Economics – time/cost	**When would you need it to be completed and what do you expect to pay?** I need it to be completed by September and my parents are paying for the stool, so cost isn't a concern for me.	7
7 Legal responsibilities	**Do you have any concerns around the safety of the flat-pack stool?** It is important that its design allows for easy assembly and disassembly, it is strong and won't collapse when in use or any parts fail.	9
8 Materials, characteristics and properties	**What characteristics are you looking for in the flat-pack stool and detachable travel bag materials?** Durability and strength for the stool and malleability of the canvas for the travel bag.	4
9 Technologies – tools, processes and manufacturing methods	**Are there any specific manufacturing processes you would like used for either functional or sustainability reasons?** As it is a one-off product, I would prefer most of the stool and small detachable travel bag to be handcrafted.	8

Table 7.3 Example of a survey with questions and ranking of the product design factors

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	Person 1	Person 2	Person 3	Person 4	Person 5
What is your age?	18	20	17	22	18
What is your height?	186	180	185	182	183
What size are you?	14	12	14	14	12
How often do you wear sports clothes?	At least 3-4 times a week	Everyday!	I exercise about 5 times a week- so a lot.	Around 4 times a week	3 times a week
Do you think there's enough sportswear available for tall women?	There is definitely not enough sportswear available for women my height. The sportswear market just doesn't cater for tall women with long extremities.	Absolutely not. I struggle to find sportswear that is fits longer limbs. It can be very frustrating as I exercise everyday!	No. I believe sportswear is marketed at small, unrealistic sizes. Being tall, I find this very annoying.	Yes and no. I am tall and I do find fitting my size an issue, but I'm not sure whether there' s enough sportswear available for tall women as a whole.	There is not enough sportswear for women who are tall like me. It just isn't available in the sports market.
Do you find it difficult to find sportswear that fits?	I often find it hard to find sports clothes that aren't too short in length or tight. I usually have to buy a bigger size just for my long legs, which makes me appear larger than I am.	I can never find sportswear that fits my body. I have long legs and so sports leggings hardly ever fit properly.	No, shopping for sportswear is often a nightmare because I can't find sportswear that is long enough in the legs or body.	Sometimes, however I am tall in the body, so sometimes I find buying clothes easier than my other tall friends do.	Yes, I have long arms and legs, which often make sports clothes too baggy in the midriff or too short for my liking.
Where do you buy your sportswear?	I buy my sportswear mostly from Lulu Lemon, their clothing is expensive but I appreciate the quality of their products.	I buy my sportswear from 2XU because it's a cheaper alternative to other higher-end brands such as Nike.	I buy my sportswear from Lorna Jane because I like the bright and bold colour palette they use. I believe they also have great quality products.	I like to buy my sportswear from Nike as trust their quality products. The materials used always perform well whilst I'm excising.	I buy my sportswear from Rebel sports. They offer a wide range of sports products from Nike to Adidas.
What material preferences do you have?	I like to wear breathable materials, mostly high performance fabrics.	When exercising, I like to wear materials that do not show sweat.	I like to wear materials that are odour resistant and comfortable whilst I 'm exercising.	I like high performance materials that are light and easy to care for.	I like to wear natural fibres that are light and breathable.
What sports brands do you like?	I am interested in high quality brands such as Lulu Lemon and Lorna Jane. They're both innovative and creative in their design.	I like Adidas and 2XU. They offer a great quality and design at a friendly price. However I also like Nike and their sleek sporting range.	I like to wear Lorna Jane as their products are comfortable and I their tops have inbuilt bras, making wearing their products easy.	I like Running Bare because their sportswear is young and vibrant in colour. I think they're a really stylish brand.	I like the sports brand Under Armour because their sportswear has a more casual and comfortable style.
What innovation and creativity do you look for in sports outfits/products?	I look for embellishments as they make a garment unique as well as young and fun.	I like shape and bold lines in the design of the product.	I look for sportswear that accentuates my long limbs without making me appear larger than I really am.	I like buying unique, exciting designs that are bold and colourful.	I like embellishments such as frills, mesh, pleats etc.
What aesthetic preferences do you have when buying sportswear?	I like sportswear to be bright and colourful. It is the only occasion I like wearing a lot of colour.	I like sportswear that is fitted and slimming.	I like wearing sportswear that has interesting patterns. I especially like tops with an open back.	I usually look for sportswear that has either mesh or cutouts for breathability. I like vibrant and bold colours.	I like sportswear that looks sleek and young.
How much are you willing to spend when shopping for sportswear?	Anywhere between $60-90	$80-100	Around $100 depending on the item.	$60-80	Probably $60-70 depending on the product.

Figure 7.4 End-user profile and market research by student Catherine Ingham

Figure 7.5 End-user profile by student Natalie Dubinski

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Design brief – outline of the situation

My end-user Ella is a first-year university student studying Environmental Science. She is very concerned with the issues surrounding sustainability and is inspired by biomimetic and Bauhaus design. As part of her course, she will be studying in Europe for one semester and reconnecting with her British and European heritage. Ella's taste in furniture reflects modern Bauhaus design and she would like an innovative, stylish and modern flat-pack stool that is unique, easy to assemble and disassemble and has a small detachable travel bag that can hold necessities, including a travel guide, water bottle and energy bars. The flat-pack stool with its detachable travel bag needs to be constructed from lightweight sustainable materials. As Ella will be backpacking around various countries, the flat-pack stool and detachable travel bag will need to be durable and able to cope with some rough handling, so quality production processes with limited use of traditional joining methods using sustainable materials are important. Ella is not concerned with how much it will cost to produce, as her parents will be paying. She will need it completed by September.	1 Purpose, function and context 2 User-centred design 3 Innovation and creativity 4 Visual, tactile and aesthetic 5 Sustainability 6 Economics – time and cost 7 Legal responsibilities 8 Materials – characteristics and properties 9 Technologies – tools, processes and manufacturing methods

Product design factors	Constraints and considerations
1 Purpose, function and context	• Must be a flat-pack stool that will be assembled and disassembled • Must include a small detachable travel bag • Must be able to hold a range of necessities • Height and weight of stool and bag need to be suitable for Ella
2 User-centred design	• Could use biomimetic design philosophy in its construction • Could apply Bauhaus design aesthetics • Must be easy to assemble and disassemble
3 Innovation and creativity	• Could include a unique method for carrying and storing both the stool and detachable travel bag when not in use

Table 7.4 Each of the nine product design factors has been listed and highlighted in a different colour to show where it is located in the outline of the situation.

- **Complete an end-user/s profile on page 152 of the workbook, Activity 7.3.**
- **Complete an end-user/s survey on page 150 of the workbook, Activity 7.2.**

ACTIVITY 7.2

Complete research of multiple typical end-users by searching key words on social media sites. Collect images and data to use in your end-user profile.

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7.3 Product design factors relevant to identified problems or needs

The product design factors help frame the needs of your end-user in your design brief. In Units 3–4, your design brief must include an outline of the situation, constraints and considerations, as well as detail the expected quality of the finished product/s. See Chapter 5 for more details on how to develop a design brief for Units 3–4.

With the information obtained from the survey you undertook as shown in Section 7.2 of this chapter, use the ranking of importance of the nine product design factors to help you develop a design brief. For example, the three product design factors that were most important to the end-user (Ella) in order of ranking were purpose, function and context, sustainability and user-centred design.

Design brief

A design brief contains an outline of the design problem or situation that needs a solution and constraints and considerations. A design brief makes reference to the relevant product design factors and also describes the expected quality of the finished product.

Making reference to the product design factors should be a straightforward task if you have completed a survey like the one provided in Section 7.2 (Table 7.3). You can use the answers to the questions found in the survey to form your outline, as shown in the example in Table 7.4.

Outline of the situation

Constraints and considerations

The constraints and considerations are listed next to the top three product design factors that were ranked the most important to Ella in the survey. You can add more product design factors and list more constraints and considerations within each factor as required.

Constraints are particular specifications that your end-user has requested and aspects that you can't change. For example, Ella said it must include a small detachable travel bag.

Considerations are product design factors that you need to explore further. For example, you could explore a unique method for carrying and storing both the stool and detachable travel bag when not in use.

Expected quality

A brief statement needs to be written that contains information on the end-user's expected quality of the finished product/s. However, you must not describe an end product.

For non-resistant materials/textiles, you could consider:

- seams and construction methods
- linings and other processes
- fit of products
- hems
- ironing
- using machines and stitches specific to the fabric
- how the garments/products may be presented
- quality of materials.

For resistant materials, you could consider:

- finishes used
- joining methods
- quality of materials.

- **Complete a design brief draft with additional extra step on page 154 of the workbook, Activity 7.4.**

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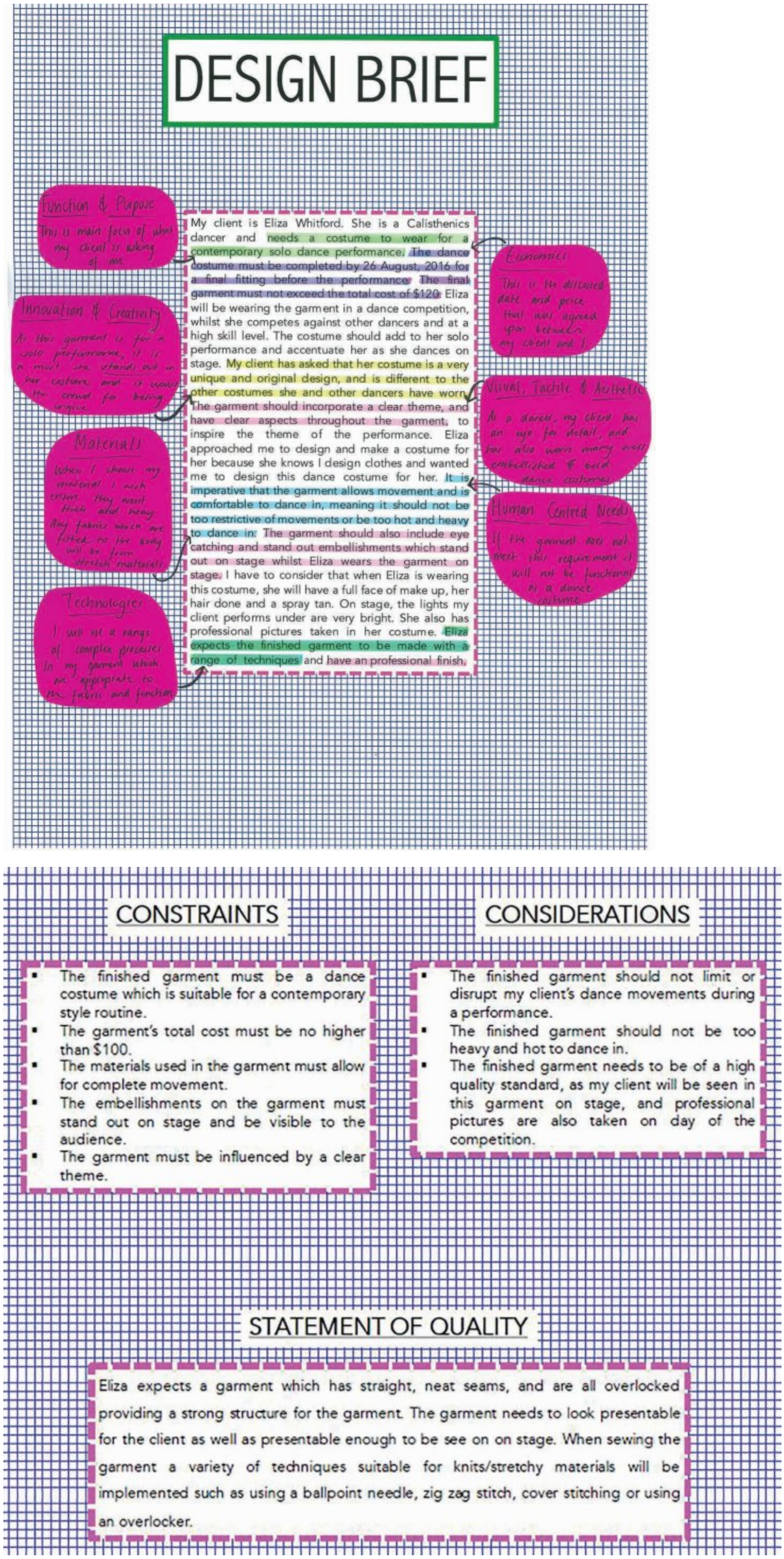

DESIGN BRIEF

Function & Purpose
This is main focus of what my client is asking of me

Innovation & Creativity
As this garment is for a solo performance, it is a must she stands out in her costume

Materials
When I choose my material I wish ensure they aren't thick and heavy. Any fabrics which are fitted to the body will be from stretch materials.

Technologies
I will use a range of complex processes in my garment which are appropriate to the fabric and function.

My client is Eliza Whitford. She is a Calisthenics dancer and needs a costume to wear for a contemporary solo dance performance. The dance costume must be completed by 26 August, 2016 for a final fitting before the performance. The final garment must not exceed the total cost of $120. Eliza will be wearing the garment in a dance competition, whilst she competes against other dancers and at a high skill level. The costume should add to her solo performance and accentuate her as she dances on stage. My client has asked that her costume is a very unique and original design, and is different to the other costumes she and other dancers have worn. The garment should incorporate a clear theme, and have clear aspects throughout the garment, to inspire the theme of the performance. Eliza approached me to design and make a costume for her because she knows I design clothes and wanted me to design this dance costume for her. It is imperative that the garment allows movement and is comfortable to dance in, meaning it should not be too restrictive of movements or be too hot and heavy to dance in. The garment should also include eye catching and stand out embellishments which stand out on stage whilst Eliza wears the garment on stage. I have to consider that when Eliza is wearing this costume, she will have a full face of make up, her hair done and a spray tan. On stage, the lights my client performs under are very bright. She also has professional pictures taken in her costume. Eliza expects the finished garment to be made with a range of techniques and have an professional finish.

Economics
This is the discussed date and price that was agreed upon between my client and I.

Visual, Tactile & Aesthetic
As a dancer, my client has an eye for detail, and has also worn many well embellished & bold dance costumes.

Human Centred Needs
If the garment does not meet this requirement it will not be functional as a dance costume.

CONSTRAINTS

- The finished garment must be a dance costume which is suitable for a contemporary style routine.
- The garment's total cost must be no higher than $100.
- The materials used in the garment must allow for complete movement.
- The embellishments on the garment must stand out on stage and be visible to the audience.
- The garment must be influenced by a clear theme.

CONSIDERATIONS

- The finished garment should not limit or disrupt my client's dance movements during a performance.
- The finished garment should not be too heavy and hot to dance in.
- The finished garment needs to be of a high quality standard, as my client will be seen in this garment on stage, and professional pictures are also taken on day of the competition.

STATEMENT OF QUALITY

Eliza expects a garment which has straight, neat seams, and are all overlocked providing a strong structure for the garment. The garment needs to look presentable for the client as well as presentable enough to be see on on stage. When sewing the garment a variety of techniques suitable for knits/stretchy materials will be implemented such as using a ballpoint needle, zig zag stitch, cover stitching or using an overlocker.

Figure 7.6 Design brief by student Madeleine Rosenbrock

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ACTIVITY 7.3

Write a design brief for your design situation and end-user/s' needs, making reference to all applicable product design factors. Include:

- an outline of the situation
- constraints and considerations
- the expected quality of the end product/s.

7.4 Role of criteria to inform and justify design option selection and evaluate the finished product

In the SAT folio for Units 3–4, evaluation criteria are used to help decide on the preferred option to produce and to evaluate the end product/s. Each criterion must include:

- a question
- justification and relevance to the brief
- the process used to evaluate the success of the product
- how the finished product could be tested or checked.

The survey questions and answers with the product design factors ranking table used in Section 7.2 and the design brief you created in Section 7.3 can help you develop evaluation criterion.

Table 7.5 provides an example of evaluation criteria using information gathered in Sections 7.2 and 7.3.

For more details on how to generate evaluation criteria, see Chapter 1 (pages 21–2) and Chapter 5 (pages 140–1).

Evaluation criteria – for a flat-pack stool with a detachable travel bag

Constraint or consideration	A question	Justification and relevance to the brief	The process used to evaluate the product	How the finished product could be tested or checked
The flat-pack stool must be easily assembled and disassembled	Is the flat-pack stool easy to assemble and disassemble?	The end-user/s will be carrying the stool around Europe and needs to assemble and disassemble it with ease and without the use of hand tools.	Use non-traditional joining methods, such as strong and durable wood pieces that slot together.	• Have the end-user/s test the ease of assembly and disassembly by assembling and disassembling it a number of times. • Have the end-user/s sit on the stool to determine its strength and durability.

Table 7.5 An example of four-part evaluation criteria for a flat-pack stool with detachable travel bag

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ACTIVITY 7.4

Writing a four-part evaluation criterion for the SAT folio

1 Select a constraint or consideration in your design brief.
2 Turn this constraint or consideration into a question.
3 Explain its relevance and importance to the brief.
4 Discuss ways this could be achieved through design and production.
5 List ways this criterion could be checked on the finished product.
6 Repeat this process for all of your constraints and considerations.

Complete your evaluation criteria on page 160 of the workbook, Activity 7.5.

Criterion no.		Question	Justification and relevance to the design brief	The process used to evaluate the success of the product	How this is checked/tested on the finished product
Purpose, function and content	1	Is the product appropriate as a uniform?	The client has insisted the product be a uniform for her small business.	Research a variety of existing work uniforms, particularly those of small businesses and physical jobs. Research different colours and patterns that complement various physiques and complexions.	Discuss with the end-user what she expects of a uniform during the designing and then show her the product/s and ask if she is satisfied with the aesthetic design of the product/s.
Economics	2	Has the prototype been made between the $150 budget?	The end-user has only provided $150 for the product's manufacture.	Draw up a budget involving all of the materials required and the amount that each costs. This would then be compared to the allotted budget ($150) to see if any changes need to be made before purchasing any materials.	Keep all receipts of purchases and refer to the budget plan.
Visual, tactile and aesthetics	3	Does the product clearly display the Funtastic Fitness logo?	The end-user has requested that the logo be displayed in order to promote her business to the community.	Research a variety of different techniques and complex processes concerning ways in which the logo can be attached/ displayed and do some trials of these different techniques to see which work and look the best.	Show the product to the end-user and also stand different distances away from the logo to see how clearly the logo can be viewed and read.
Economics	4	Was the product completed to the end-user's standards by August?	The end-user has requested this date as she requires it for wear at her boot camp class at the start of September.	Make a timeline and set small goals to be achieved until the due date. Refer to this chart each week and if the project is behind schedule then additional hours can be used to get the project back on schedule.	Show the prototype to the end-user and ask if they are happy with the standard quality of the product/s.
Materials and technology	5	Will the product require only little and/ or easy maintenance?	The end-user insists that the product be sustainable. This includes needing little maintenance to save energy and resources.	Research different materials and construction techniques and test them to see which would be most durable and which are stain resistant and wear less.	Test the fabrics and construction techniques used in the final product to see if they are durable and resistant to wear.
User-centered needs and materials	6	Is the prototype comfortable?	The end-user has requested that the product be comfortable as it will be frequently worn.	Research different materials, fibres and construction techniques, and get samples of a variety of them to see which would be most comfortable against the skin and provide some stretch.	Try on, and also get the end-user to try on, the dress and jacket to test how comfortable they are and if they have some give/stretch.

Table 7.6 Evaluation criteria by student Madeleine Hosemans

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7.5 Methods of exploring, researching and testing the characteristics and properties of materials, fittings and fastenings to determine their suitability

Throughout the product design process, you are encouraged to improve your understanding of the materials you work with, their properties and characteristics, and which processes are best suited to your design work.

This can take place at any time, but could include:

- investigating materials available at retailers before commencing visualisations
- completing production process trials to inspire you during visualisations and design options
- researching how similar products are constructed, and with what materials
- testing similar materials after deciding on a preferred option, to determine which one is most suitable
- completing a mock-up/toile to test both materials and the design before making your final product
- trialling of processes before you complete them on your preferred option to master your skills and decide which techniques are most effective and efficient.

You might decide to work on most of this section of your SAT folio further along in this unit as you get closer to production.

Investigating materials available at retailers before commencing visualisations

Looking at potential materials for a garment/product is both inspirational and informative in the product design process. This enhances your design work and helps inform the end-user/s when making decisions. Fabric stores and various timber stores, for example, will often give samples of materials (if you ask nicely) that you can include in your research.

Tables 7.7 and 7.8 provide general lists of retailers for resistant and non-resistant materials.

Resistant materials store	Range of products
Atlas Steels	Aluminium, stainless and carbon steel
Beyond Tools	Tools and equipment
Bunnings	Tools, equipment and materials
LETObamboo	Bamboo sheets
Loggerheads	Sustainably sourced timber
Mathews Timber	Sustainable high-performance wood
Megara	Polypropylene
Mitre 10	Tools, equipment and materials
Shiver Me Timbers	New and recycled timber
Showcase Plastics and Displays	Acrylic
Timbersearch	New and recycled timber
Tools for Schools	Tools, equipment and materials
Urban Salvage	Recycled timber salvaged from urban landscapes

Table 7.7 Resistant materials retailers

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Non-resistant materials store	Range of products
Astratex	Fine European fabrics
Beautiful Silks	Wide range of silks and textile art supplies
Buttonmania	Nice range of buttons; self-covered belt and button service
Clear It	Ex Alannah Hill and Dangerfield fabrics
Clegs	Bridal and evening fabrics, craft fabrics; higher prices
D'Italia	Bridal, lace and eveningwear type fabrics; higher cost
Darn Cheap Fabric	Cheap/well-priced fabrics; lots of interesting knits and trims
Davisha	High-quality wool fabric
Franke Stuart	Evening fabrics
Frankie & Swiss	Digital printing service and art prints; higher cost
Flashback Fabrics	Vintage and retro woven fabrics
GJ's Fabrics	Lots of stretch fabrics and lycras, craft and some eveningwear type fabrics
Jimmy Buttons	Trims and buttons
Kim Anh Fabric	Unusual laces, knits and eveningwear type fabrics, and wide variety of trims
Koodak	Purely jewellery making supplies
La Modiste	European/designer fabrics
Lefflers	Leather, saddlery, rivets, studs, eyelets
Lincraft	Fabric and craft store
Rathdowne Fabrics	Wide range of well-priced and interesting fabrics
Silkworld	Wide variety of silks
Specialty Pleaters	Fabric pleating company for permanent pleats in your garments
Spoonflower	American-based website that allows you to upload graphics/photos and digitally prints a repeat pattern on your chosen fabric
Spotlight	Wide range of fabrics
Super Cheap Fabrics	Inexpensive fabrics in a variety of colours and prints
Tessuti	Designer-type fabrics
The Fabric Store	Higher-end fashion fabrics; lots of silks and printed fabrics, wools
Trimmings & Remnants	Dance fabric mega store; lycra in every colour imaginable, printed lycra, foil print, tulles, mesh; stretch fabric specialist; amazing range of trims and beads
Tylers Fabrics	Bridal and evening fabrics

Table 7.8 Non-resistant materials (textiles) retailers

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Properties and characteristics of materials

Your detailed design brief, evaluation criteria and research plan will guide you as to what knowledge you need to gain about materials for the production of your garment/s or product/s for the SAT.

Areas of research that can be helpful to complete are:

- characteristics and properties of materials you have selected to use from the materials categories listed in the study design and in Chapter 2
- materials testing to compare and decide on suitable materials for your design option
- product process samples
- completing a toile/mock-up.

For non-resistant materials, you should specify why that fabric (including its fibre and construction) is or isn't suitable, making reference to both the properties/characteristics and aesthetics (see Figure 7.7 on page 208).

For resistant materials, you should specify why that material is or isn't suitable, making reference to both the properties and characteristics (see Table 7.15 on page 207).

TIP

Note the difference between the characteristics and properties of materials (resistant materials).

- Properties: You might be researching two types of wood and through your research and testing you discover they both have the same properties – they are durable yet malleable.
- Characteristics: One is a pinkish red in colour with a fine grain, while the other is white to pinkish brown with a curly grain.

Properties of non-resistant materials

Fabrics and their properties

Two key elements that make up a fabric's properties are its construction and fibre. Fibre refers to what it is made of (for example, silk) and construction refers to how it is put together (for example, knitted). When describing fabrics, always list the fibre and the construction. A yarn refers to a fibre that is ready to be woven or knitted, turning it into fabric.

Fabric components				
Fibres		Construction		
Natural	Man-made	Knits	Weaves	Non-woven
Wool	Nylon	Jersey	Basic weave	Leather
Cotton	Acrylic	Rib	Twill	Felt
Linen	Acetate	Tricot	Satin	Webbing
Silk	Polyester	Interlock	Sateen	
	Elastane	Raschel	Jacquard	
	Viscose	Purl	Pile weaves	

Table 7.9 Components of some popular fabrics

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knitted fabric fabric formed by knitting loops, often allowing the cloth to stretch

woven fabric fabric formed by weaving, interlacing two yarns (a warp and a weft) at right angles

natural fibres fibres sourced naturally, including from plants and animals, such as cotton or wool

synthetic fibres fibres generated by man-made means, such as polyester or nylon

Fabric construction refers to how the fabric is made. Knitted and woven are the two major types of fabric construction.

Knitted fabrics are formed with interlocking loops of yarn, which often allow the cloth to stretch and recover. This makes the fabric suitable for garments needing comfort, movement and to be close to the body, such as underwear, T-shirts or active wear, and often removes the need for closures such as zips or buttons. Some knits can run (like a ladder in a stocking), can be circular knitted (like a sock), are often less stable to sew, use and launder, and need speciality machines and equipment to be sewn, such as overlockers, ball-point needles and zigzag stitches, and need to be cut on the maximum stretch.

Woven fabrics generally feature warp and weft yarns weaved at 90-degree angles to each other, and are often a more stable cloth than knits to sew, use and launder, and won't stretch unless the yarns are blended with elastane, or the fabric is cut on the bias. This makes them suitable for more formal clothes such as suits and work wear. They will fray, and need stitches such as overlocking to prevent this, and need sharp needles to be sewn in a sewing machine, and need to be cut on the 'grain'.

Natural fibres are sourced through nature, whereas **synthetic fibres** are man-made. Generally, natural fibres are more absorbent, crease easily and can be laundered and ironed with hotter temperatures. Generally, synthetic fibres are less absorbent, don't crease as easily, pill more and need to be laundered and ironed at lower temperatures or they will melt.

However, many of the fabrics we use and wear are blended fibres, meaning two or more fibres are spun together to improve the performance of the fabric. Blended fibres are popular, but are harder to repurpose at the end of their life.

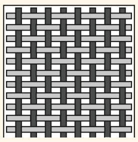
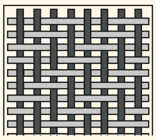
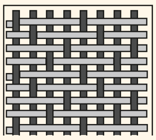
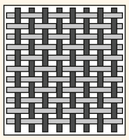
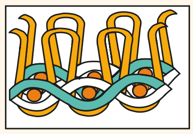
Fabric construction – weaves						
	Basic weave	**Twill**	**Satin**	**Crêpe**	**Loop-pile weave**	**Cut-pile weave**
Diagram						
Characteristics	• Flat • Inexpensive	• Sturdy and resilient • Has a 'front' and 'back' face, with visible diagonal lines on the front	• 'Floats' in the weave give it lustre • Fluid drape and easily snagged (satin)	• Textured, irregular surface and floats, woven with crêpe yarns	• Extra yarn woven to create a 3D loop, creating an absorbent surface area	• Extra yarn woven to create a 3D cut surface, sometimes in rows
Typical fabrics	• Calico • Muslin • Gingham • Plaid • Broadcloth • Chiffon • Organza	• Drill • Denim • Gabardine • Tweed • Houndstooth • Herringbone	• Satin • Duchess satin • Crêpe back satin • Sateen • Stretch sateen	• Crêpe • Granite • Moss crêpe	• Terrycloth	• Corduroy • Velvet • Velveteen
Typical uses	• Craft • Shirts • Manchester • Toiles	• Jeans • Workwear • Suiting	• Evening • Bridal wear • Lingerie • Sleepwear • Manchester	• Womenswear • Eveningwear	• Towels • Dressing gowns • Carpets	• Garments • Home decor • Carpets

Table 7.10 Woven fabrics

ISBN 978-1-108-41389-3

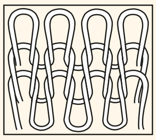
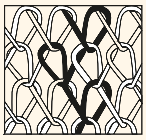
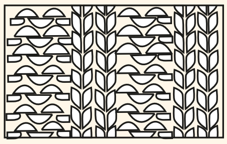
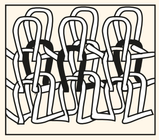
Fabric construction – knits				
	Jersey weft knit	**Tricot warp knit**	**Rib knit**	**Interlock weft knit**
Diagram				
Characteristics	• Simplest knit fabric • Obvious front and back • Can ladder • Can be knitted with a second yarn to create a pile, forming velour or knit terrycloth	• Often knitted with elastane blended fibres for greater stretch (such as lycra)	• Gives more stretch and thickness than jersey	• Looks the same on both sides • Not as flexible as rib knits
Typical uses	• T-Shirts • Underwear • Dresses • Leggings • Hosiery	• Swimwear • Active wear • Lingerie	• Cuffs, collars and hems of knit garments • Socks	• Womenswear • Slips

Table 7.11 Knitted fabrics

Natural fibres				
	Cotton	**Linen**	**Silk**	**Wool**
Classification	Cellulose	Cellulose	Protein	Protein
Where does it come from?	Cotton bolls grow on a plant	The cellulose fibres inside the flax plant	The cocoons of silk worms	Made from the fleece of (mostly) sheep
Attributes	• Soft and comfortable to wear • Absorbent • Easy to sew • Easily dyed • Wrinkles easily • Conducts heat	• Comfortable • Absorbent • Wrinkles easily • Conducts heat	• Luxurious and lustrous fibre • Drapes well • Costly • Smooth and soft hand	• Warm and insulating • Soft hand • Resilient
Typical uses	• Clothing • Underwear • Manchester • Towels	• Clothes • Home wear	• Eveningwear • Lingerie • Scarfs and ties • Womenswear	• Suiting • Jumpers and winter wear • Carpets
Care instructions	• Machine washable, up to a hot temperature for white cotton; warm temperatures for coloured cottons	• Machine washable	• Dry-cleaning is advisable • Gently hand wash in warm water with mild detergent	• Dry-cleaning is recommended • Can be gently hand washed in warm water

Table 7.12 A general guide to natural fibres

(Continued)

ISBN 978-1-108-41389-3

	Natural fibres			
	Cotton	**Linen**	**Silk**	**Wool**
Dry	• Line dry or tumble-dry (hot)	• Line dry or tumble-dry (hot)	• Dry-clean or press dry (see ironing)	• Air dry flat (if hand washed) • Do NOT tumble-dry
Bleach	• Chlorine bleach can be used to spot-remove stains • Excessive bleaching not recommended	• Chlorine bleach suitable	• Avoid bleach	• Avoid bleach
Iron	• Hot iron • Steam recommended	• Hot iron	• Iron damp with a press cloth	• Warm steam iron on reverse side
Dry-clean	• Dry-cleanable	• Dry-cleanable	• Dry-cleanable	• Dry-cleanable
Any other instructions	• Remove items promptly from the dryer to avoid creasing	• Avoid pressing sharp creases in garments	• Perspiration and sunlight will weaken and yellow silk fibres	• Hang woven garments on padded hangers; store knitted garments folded • Protect from insects

Table 7.12 A general guide to natural fibres *(continued from previous page)*

	Synthetic/man-made fibres				
	Acetate	**Acrylic**	**Nylon**	**Polyester**	**Viscose**
Classification	Regenerated cellulose	Synthetic	Synthetic	Synthetic	Regenerated cellulose
How is it made?	Wood pulp (cellulose) mixed with chemicals, then extruded through spinnerets into warm air (dry spinning)	Acrylonitrile polymers dissolved in solvent, extruded through spinnerets into a chemical bath or warm air	Raw materials polymerised, cut into chips, melted then extruded through spinnerets into air (melt spinning)	Raw materials melted, extruded through spinnerets into air (melt spinning)	A wood pulp (cellulose) viscose solution is extruded through spinnerets into a chemical bath (wet spinning)
Attributes	• Soft hand and drape • Available in a wide range of colours • Weak, especially when wet • Hypo-allergenic • Resistant to moths and mildew • Wrinkles • Low cost • Static	• Low water absorbency, making it moisture wicking and quick to dry • Easy to care for • Appears luxurious • Soft drape • Cheap wool-like alternative	• Thermoplastic – can be heat set • Very strong • Pills easily • Easy to wash and quick to dry • Abrasion resistant • Resists wrinkling	• Thermoplastic – can be heat set • Pills easily • Strong • Easy to wash and quick to dry • Low absorbency • Abrasion resistant • Resists wrinkling	• Absorbent • Soft drape • Weak when wet • Can shrink or stretch • Comfortable

Table 7.13 A general guide to man-made fibres

(Continued)

ISBN 978-1-108-41389-3

Synthetic/man-made fibres					
	Acetate	**Acrylic**	**Nylon**	**Polyester**	**Viscose**
Typical uses	• Linings • Clothing	• Often used to imitate wool • Blankets, throws and homewares • Craft and knitting	• Clothing • Outerwear and jackets • Swimwear and activewear (when blended with elastane and knitted) • Tents • Ropes • Hosiery and underwear	• Clothing • Often blended with cotton	• Clothing • Homewares
Care instructions	• Hand wash in cool water • Dry-cleaning recommended • Do not wring	• Machine wash up to warm temperature	• Machine wash at low temperature with similar colours • Fabric softener recommended • Hot water may be needed to remove oily stains; however, hot water can cause wrinkling	• Machine washable, up to warm temperature • Hot water may be needed to remove oily stains	• Dry-cleaning recommended • Do not wring if hand washed
Dry	• Line dry or tumble-dry at low temperature	• Line dry or tumble-dry at low temperature	• Line dry or tumble-dry at low temperature	• Line dry or tumble-dry at low temperature • Remove items promptly from the dryer	• Line dry or tumble-dry at hot temperature
Bleach	• Chlorine bleach suitable	• Chlorine bleach can damage fibre	• Can be bleached • Continued bleaching will yellow white nylon	• Chlorine bleach suitable	• Chlorine bleach suitable
Iron	• Cool iron on wrong side of fabric	• Cool to warm iron	• Cool iron	• Cool to warm iron	• Warm to hot iron
Dry-clean	• Dry-cleanable	• Dry-cleanable			• Dry-cleanable

Table 7.13 A general guide to man-made fibres *(continued from previous page)*

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DID YOU KNOW?

Many students often mix up silk and satin. Silk is a luxurious fibre, and satin is a type of fabric construction. Silk satin does exist as a fabric, but it is costly. The satin you see most often is polyester satin.

Properties and characteristics of resistant materials

Understanding a material's property will help you to decide the best material/s for the product. For example, the flat-pack stool with detachable travel bag needs to be durable. This means the stool will need to be able to withstand repeated use (wear and tear) and the weather. By devising a way to test the durability of a range of possible materials for the stool, this will help you determine the most durable material and therefore the most suitable.

The best way to select suitable materials is to research them and learn about their properties. Remember, the materials you research must come from the materials categories shown in Table 7.14 and listed in Chapter 2.

DID YOU KNOW?

Bamboo can be both a natural and a man-made fibre. The bamboo most commonly found in clothing is a man-made fibre, more specifically a regenerated cellulose fibre made of bamboo pulp. It is considered similar to viscose and should be cared for in the same way. Bamboo fabrics are increasing in popularity as the plant can grow quickly without pesticides, making it a more sustainable alternative to some other fibres.

Resistant materials categories (from the VCE study design)

Category 1	Wood Metal	Softwood Hardwood Manufactured boards Ferrous metals Non-ferrous metals Alloys Coated metals
Category 2	Ceramics Glass	Stoneware Porcelain Bone china Terracotta Raku and cement Soda lime Lead glass (crystal) Float/laminated/ toughened Borosilicate
Category 3		Chemical fasteners (adhesives) Dyes/paints Surface treatments/ protective coatings Finishes (oil-based, water-based, organic)

Table 7.14 Materials categories from the *VCE Product Design and Technology Study Design*

To research the properties of materials that best suit your end-user/s' product, you can collect some sample pieces and note down your observations.

Research

Table 7.15 is an example of research on the properties and characteristics of plywood. You can do this research for as many materials as you think necessary, depending on what your end-user/s wants.

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Research on the characteristics and properties of materials – plywood

Type of material	How sustainable is it?	Describe its visual appearance (characteristics)	How is it used?	How easy is it to work with? (properties)	How does it need to be finished?	How suitable do you think this material is?
Plywood	It is made from sustainable sources and does not come from rainforests.	It is light in colour with a wood grain pattern.	It is often used in furniture construction, shelving, dog kennels, and for lining walls, roofs, floors.	Because it is made from layers of thin sheets of plywood with the grain on each sheet running in a different direction, this makes it a light but very strong building material. Its varying grains of wood in each layer mean screws grasp the wood very easily.	It is best to use an opaque stain. For outdoor use, a primer and top coat such as an acrylic varnish is best.	This material is very suitable. It is sustainably resourced, has a modern appearance, and is often used in furniture construction.

Table 7.15 Research on the properties and characteristics of plywood

Materials research – resistant materials

Tables 7.16–7.18 list softwoods, hardwoods, sustainable woods, and types of metals and plastics that can be researched for a resistant materials product or range of products (also refer to Chapter 2, page 59).

Commonly used softwoods	Commonly used hardwoods	Sustainable options Australian Sustainable Timbers that hold a Forest Stewardship Council (FSC) certificate
Cedar	Redgum	Tallowwood
Cypress pine	Balsa	Grey Gum
Radiata pine	Beech wood	White Mahogany
Hoop pine	Blackwood	Sydney Blue Gum
Huon pine	Mountain ash	Blackbutt Forest Red Gum
Spruce		Grey Box
Queensland kauri		Grey Ironbark
		Stringybarks
		Red Mahogany
		Rose Gum
		Spotted Gum
		Brush Box

Table 7.16 Types of wood and sustainable wood certified by the FSC who focus on environmentally appropriate, socially beneficial and economically viable management of the Earth's forests.

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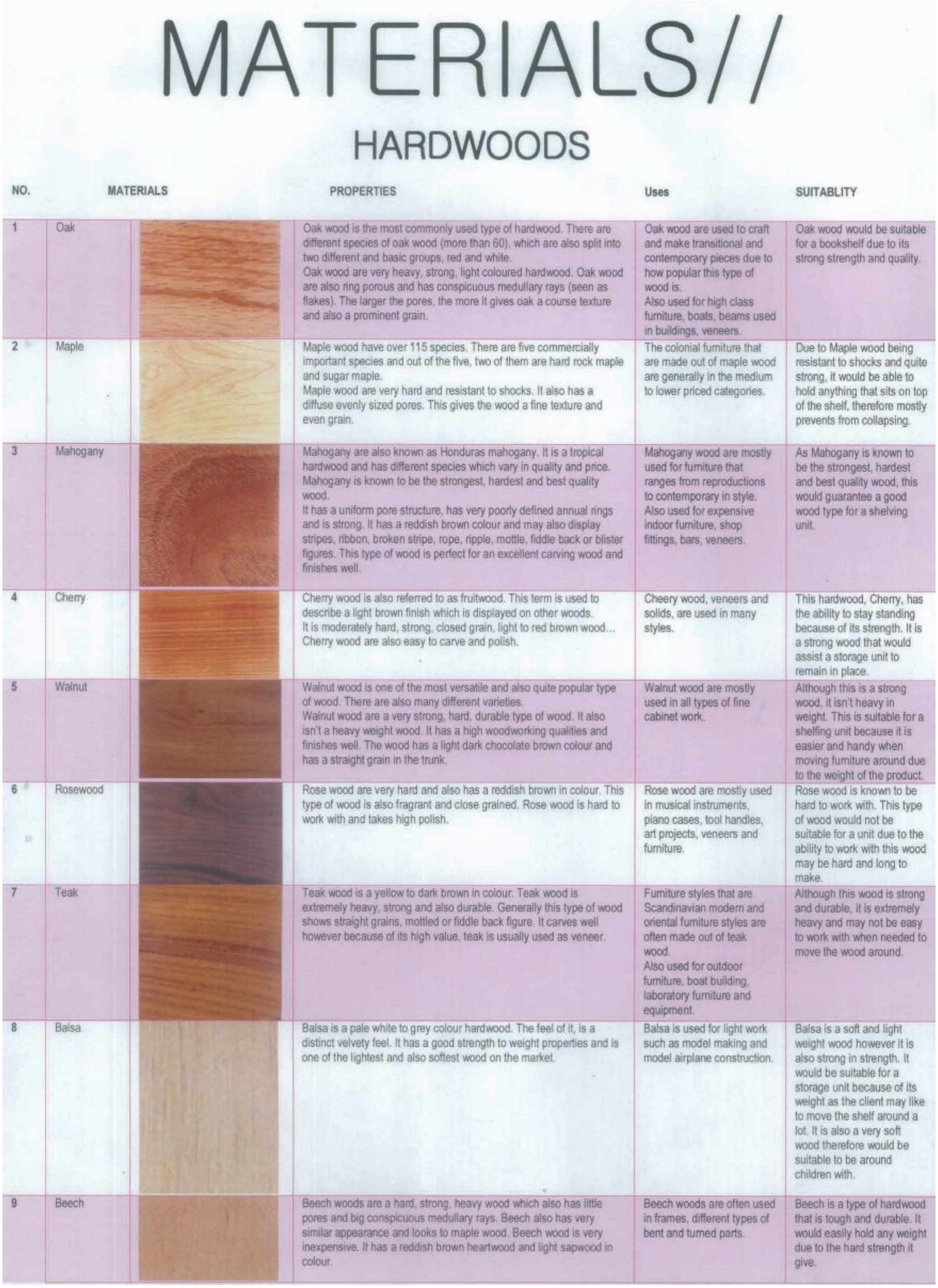
Ferrous metals	Non-ferrous metals	Alloys
Mild steel	Copper	Brass
Tin plate	Aluminium	Pewter
High-carbon steel	Tin	

Table 7.17 Types of metal

Thermoplastic	Thermosetting plastic
Acrylic/perspex	Epoxy resin
Rigid PVC	Polystyrene resin
Polystyrene	Phenolic resins

Table 7.18 Types of plastic



MATERIALS//

HARDWOODS

NO.	MATERIALS	PROPERTIES	Uses	SUITABLITY
1	Oak	Oak wood is the most commonly used type of hardwood. There are different species of oak wood (more than 60), which are also split into two different and basic groups, red and white. Oak wood are very heavy, strong, light coloured hardwood. Oak wood are also ring porous and has conspicuous medullary rays (seen as flakes). The larger the pores, the more it gives oak a course texture and also a prominent grain.	Oak wood are used to craft and make transitional and contemporary pieces due to how popular this type of wood is. Also used for high class furniture, boats, beams used in buildings, veneers.	Oak wood would be suitable for a bookshelf due to its strong strength and quality.
2	Maple	Maple wood have over 115 species. There are five commercially important species and out of the five, two of them are hard rock maple and sugar maple. Maple wood are very hard and resistant to shocks. It also has a diffuse evenly sized pores. This gives the wood a fine texture and even grain.	The colonial furniture that are made out of maple wood are generally in the medium to lower priced categories.	Due to Maple wood being resistant to shocks and quite strong, it would be able to hold anything that sits on top of the shelf, therefore mostly prevents from collapsing.
3	Mahogany	Mahogany are also known as Honduras mahogany. It is a tropical hardwood and has different species which vary in quality and price. Mahogany is known to be the strongest, hardest and best quality wood. It has a uniform pore structure, has very poorly defined annual rings and is strong. It has a reddish brown colour and may also display stripes, ribbon, broken stripe, rope, ripple, mottle, fiddle back or blister figures. This type of wood is perfect for an excellent carving wood and finishes well.	Mahogany wood are mostly used for furniture that ranges from reproductions to contemporary in style. Also used for expensive indoor furniture, shop fittings, bars, veneers.	As Mahogany is known to be the strongest, hardest and best quality wood, this would guarantee a good wood type for a shelving unit.
4	Cherry	Cherry wood is also referred to as fruitwood. This term is used to describe a light brown finish which is displayed on other woods. It is moderately hard, strong, closed grain, light to red brown wood... Cherry wood are also easy to carve and polish.	Cheery wood, veneers and solids, are used in many styles.	This hardwood, Cherry, has the ability to stay standing because of its strength. It is a strong wood that would assist a storage unit to remain in place.
5	Walnut	Walnut wood is one of the most versatile and also quite popular type of wood. There are also many different varieties. Walnut wood are a very strong, hard, durable type of wood. It also isn't a heavy weight wood. It has a high woodworking qualities and finishes well. The wood has a light dark chocolate brown colour and has a straight grain in the trunk.	Walnut wood are mostly used in all types of fine cabinet work.	Although this is a strong wood, it isn't heavy in weight. This is suitable for a shelfing unit because it is easier and handy when moving furniture around due to the weight of the product.
6	Rosewood	Rose wood are very hard and also has a reddish brown in colour. This type of wood is also fragrant and close grained. Rose wood is hard to work with and takes high polish.	Rose wood are mostly used in musical instruments, piano cases, tool handles, art projects, veneers and furniture.	Rose wood is known to be hard to work with. This type of wood would not be suitable for a unit due to the ability to work with this wood may be hard and long to make.
7	Teak	Teak wood is a yellow to dark brown in colour. Teak wood is extremely heavy, strong and also durable. Generally this type of wood shows straight grains, mottled or fiddle back figure. It carves well however because of its high value, teak is usually used as veneer.	Furniture styles that are Scandinavian modern and oriental furniture styles are often made out of teak wood. Also used for outdoor furniture, boat building, laboratory furniture and equipment.	Although this wood is strong and durable, it is extremely heavy and may not be easy to work with when needed to move the wood around.
8	Balsa	Balsa is a pale white to grey colour hardwood. The feel of it, is a distinct velvety feel. It has a good strength to weight properties and is one of the lightest and also softest wood on the market.	Balsa is used for light work such as model making and model airplane construction.	Balsa is a soft and light weight wood however it is also strong in strength. It would be suitable for a storage unit because of its weight as the client may like to move the shelf around a lot. It is also a very soft wood therefore would be suitable to be around children with.
9	Beech	Beech woods are a hard, strong, heavy wood which also has little pores and big conspicuous medullary rays. Beech also has very similar appearance and looks to maple wood. Beech wood is very inexpensive. It has a reddish brown heartwood and light sapwood in colour.	Beech woods are often used in frames, different types of bent and turned parts.	Beech is a type of hardwood that is tough and durable. It would easily hold any weight due to the hard strength it give.

Figure 7.7 Research on different types of hardwoods and softwoods by student Thanh Thy Tran. *(Continued)*

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MATERIALS//

SOFTWOODS

NO.	MATERIALS	PROPERTIES	USES	SUITABLITY
1	Pine	Pine is a type of softwood which has over 100 species worldwide. Pine is a soft, white (also sometimes pale yellow) wood. It is very light weight and has straight grained but also lacks figure. Pine wood also resist in swelling and shrinking.	Country or provincial furniture are often made out of pine wood. Pickled, whiten, painted and oil finishes are used on this type of wood.	Pine would is easy to work with and also is light weight. This makes it easier when making the actual shelf as a heavy wood would be difficult to lift up and move around.
2	Hickory	Hickory has around 15 species. Hickory wood are one of the heaviest types of wood that are available. Pecan is one of the popular species of hickory. Pecan wood is also a closed grain type without much figure to it.	Furniture or products that need strengthen and thinness are require are most likely used from hickory. It is also used in furniture, toys, tool handles.	The heaviness of the wood may be rather difficult to work with however it will ensure great hold coming from the décor the client wishes to use.
3	Cedar	Cedar wood is a knotty type of softwood. It has a reddish brown colour with very light streaks.	Cedar aromatic and moth repellent qualities of it, has made this wood one of the popular woods lining drawers, chests and boxes. Also, simple cases and some storage closets are made from this wood due to it being light and brittle. Also used for furniture, boat building, veneers, and model making.	This wood is suitable for a storage-unit due to the aroma it gives. It is a repellent for moths and therefore keeps the wood good in quality.
4	Birch	Although there are many species of birch wood, the yellow birch is the most commonly used. Birch woods are hard and heavy. They are also very close to grained hardwood and has a light brown/ reddish colour in heartwoods and a cream or light colour in sapwood.	Birch wood's pattern varies from rotary or flat sliced, yielding straight, curly or wavy grain.	This soft wood have both hard and heavy qualities to it which assists the unit to stay in place and ensure a good quality unit.
5	Redwood	Redwood at its best quality comes from heartwood. This is because of its resistant to deterioration due to sunlight, moisture and insects. Redwood are very rare and valuable.	Redwood are mostly used for outside furniture. Also used for general woodwork, cupboards, shelves, roofs.	Redwood has very good quality however it is very rare and valuable therefore it wouldn't it suitable for the storage unit.
6	Hemlock	Hemlock are very light weight type of woods and also has a uniform texture. Hemlock has low resistance to decay and non-resinous.	Hemlock are commonly used for construction umbers, planks, doors, boards, panelling, sub flooring and crates.	Hemlock has a good light weight. This makes it easier to work with as well as lifting and moving around when renovating.
7	Fir	Fir wood works easily well, not to mention finishes well also. It is also uniform texture and is non-resinous. Fir wood is also has low resistance to decay.	Fir wood is mostly used in furniture, doors, frames, windows, plywood, veneer, general millwork and interior trim.	Fir is a type of soft wood that would suit a storage unit well as it is quite easy to work with. The finish product would also have a nice finish keeping the appearance appealing.
8	Spruce	Spruce wood are strong and hard. It also finishes very well. Spruce wood has a low resistance to decay. It also has a moderate shrinkage and has a light weight.	Masts and spars for ships, aircraft, crates, boxes, general millwork and ladders, all mostly are made from spruce. Also used for general indoor work, whitewood furniture used in bedrooms and kitchens.	The light weight would be suitable for a bookshelf due to when lifting the shelf around. It is also strong and hard enough to hold certain objects when placed on it.

Figure 7.7 Research on different types of hardwoods and softwoods by student Thanh Thy Tran *(continued from previous page)*.

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MATERIALS RESEARCH

SAMPLE	PRICE	FIBRE & CONSTRCUTION	PROPERTIES	SUITABILTY TO SITUATION
	$20.00 p/m	87% Nylon, 13% Elastane Knit	▪ Very strong and supportive ▪ Extremely stretchy ▪ Wrinkle-resistant ▪ Durable ▪ Retains shape	The materials needs to be strong in order to provide support to the bust area.
Lycra 	$20.00 p/m	Nylon Spandex Knit	▪ Stretchy ▪ Wrinkle-resistant ▪ Durable ▪ Retains shape ▪ Lightweight ▪ Resists pilling and abrasion ▪ Moisture wicking	The stretch of the material allows movement in the garment, whilst my client dances in it.
Chiffon 	$10.00 p/m	Polyester Weave	▪ Lightweight ▪ Delicate ▪ Frays very easily ▪ Sheer ▪ Slippery texture	Flowy and lightweight, which will not obstruct my client while she moves. Aesthetically it will give the garment a delicate look.
 Tulle Netting	$3.50 p/m	100% Nylon Warp Knit	▪ Stiff ▪ Lightweight ▪ Provides volume	My skirt must have volume so it stands out on stand, the gathered tulle underneath the chiffon will give it more shape.

Figure 7.8 Materials research by student Madeleine Rosenbrock

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- **Complete the materials research activity for non-resistant materials on page 162 of the workbook Activity 7.6b.**
- **Complete the materials research activity for resistant materials on page 162 of the workbook Activity 7.6a.**

Materials testing – non-resistant materials

Tests must be relevant to the design situation. For example, Figure 7.10 shows the student testing the stretch of fabrics for a dance costume, which needs to allow for movement. Some tests could include, but are not limited to:

- absorbency
- colourfastness
- comfort
- dimensional stability (tear strength)
- drape
- durability
- effects of bleach
- pilling
- snagging
- stiffness
- stretch.

Figure 7.9 Materials research by student Monica Ngo

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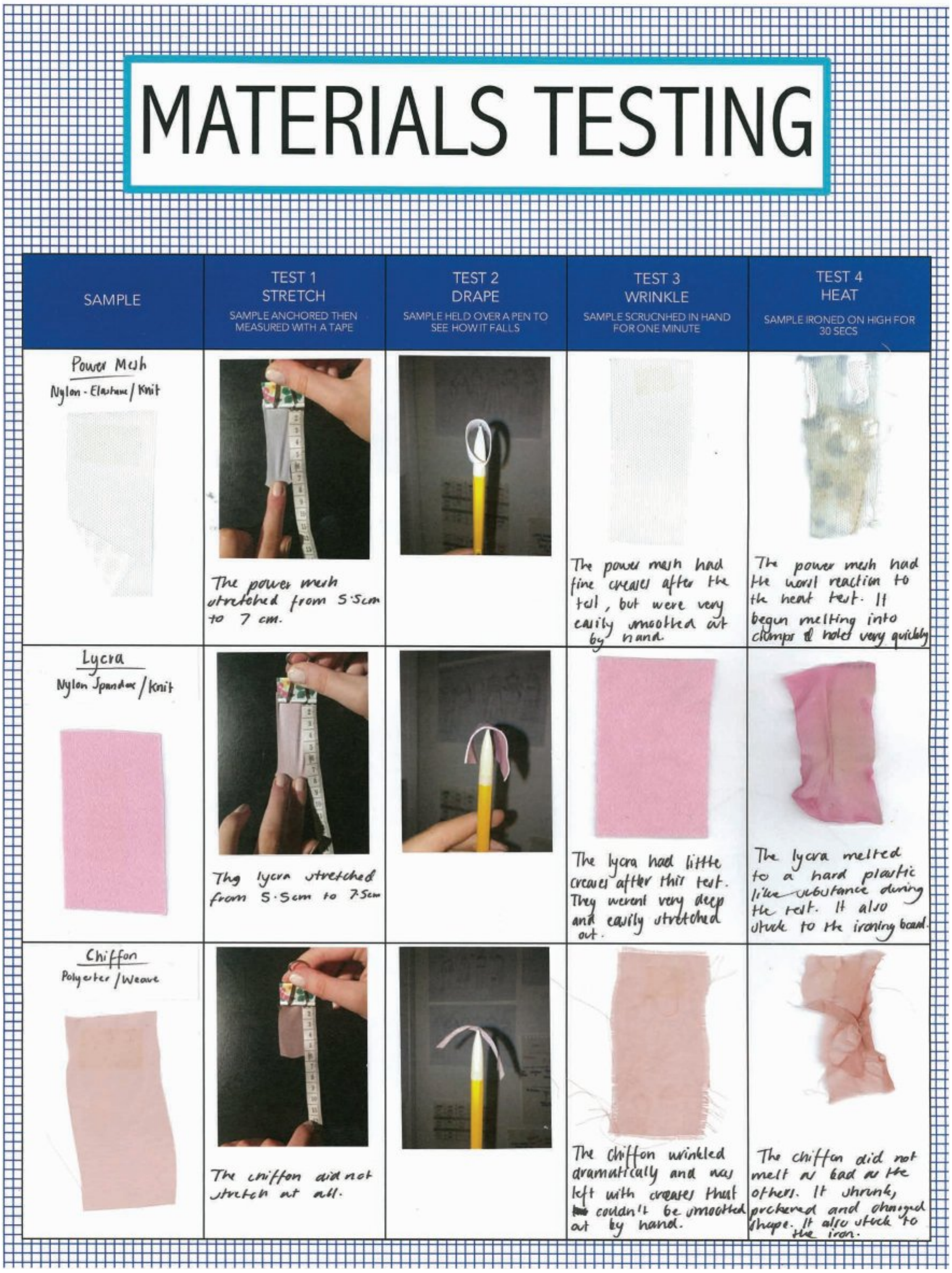

Figure 7.10 Materials testing by student Madeleine Rosenbrock

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Materials testing – resistant materials

Properties you could test for in materials include:

- malleability – how much the material can be manipulated before it breaks or tears
- hardness – how easily the material can withstand wear and tear, such as bending and denting (abrasive)
- tensile strength – how well the material can withstand repeated forces without breaking
- toughness – how difficult it is to break or snap the material
- durability – how well the material can withstand repeated use (wear and tear)
- corrosiveness – the degree to which the material is affected by certain environments (weather/temperature conditions)
- brittleness – how easily the material cracks or breaks when put under force (acrylic and glass).

Materials testing

How could you test plywood to determine if is a suitable material for the flat-pack stool?

You need to refer to your design brief, evaluation criteria, research plan and materials research and determine the most important properties that the materials the stool could be made from need to have.

In the case of the flat-pack stool, it needs to be durable because of rough handling, it needs to be able to cope with the outdoors and cope with continual assembly and disassembly. The end-user, Ella, has said she wants it to be made from a sustainable wood such as plywood.

Testing the properties of plywood

Table 7.19 shows three properties tested and rated according to how well they performed.

Testing the properties of resistant materials

Property tested	Why does this property need to be tested?	How has the property been tested?	What are the results of the test?	Material rating according to property tested (satisfactory, good, excellent)
Durability	The material needs to withstand constant use and assembly and disassembly.	A sample length of plywood was clamped securely at one end and at the other a heavy object was carefully positioned for a set amount of time. The weight and length of time were gradually increased and the time recorded until the sample showed some stress.	The sample showed that the plywood's construction of thin layers glued together in different directions makes it a very durable material.	Excellent
Corrosiveness	The material needs to be able to handle all weather conditions.	A plywood sample was placed in a tub of water for a period of time.	The sample showed that plywood is susceptible to water damage.	Satisfactory
Hardness	The end-user likes quality modern Danish design and wants the material to retain a look of quality through constant use.	A plywood sample had an object with a sharp edge and a small heavy object dropped on its surface from a measured height.	The sample showed that the surface of plywood does damage easily.	Satisfactory

Table 7.19 Testing the properties of a resistant material – plywood

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Materials testing and reporting

To support the writing of a report at the end of your testing, you could consider adding the following to your materials testing folio page/s:

- a column that provides a photo of each test you undertake
- a sketch or diagram showing your testing process with relevant annotations
- a before and after photo of the material tested with observation notes
- a list of potential problems of material/s tested.

Report – evaluate your testing

The example materials testing table shows only one material (plywood) tested and rated. If you undertook the same properties testing with cedar, what results would you get and what ratings?

You might find that cedar rates 'Excellent' with two properties and 'Satisfactory' with the third. In your report, you will need to explain this and you will need to discuss the result with your end-user, who prefers plywood for its sustainability.

Plywood		
Property tested	**Material rating according to property tested (satisfactory, good, excellent)**	**Testing results**
Durability	Excellent	The test demonstrated that the manufactured board's construction of thin layers of plywood sheeting glued together makes it a durable material.
Corrosiveness	Satisfactory	After a period of time, the test showed a slight swelling of the material and separation of a top layer of thin plywood sheet.
Hardness	Satisfactory	Some marks appeared on the surface of the material after testing.
Cedar		
Property tested	**Material rating according to property tested (satisfactory, good, excellent)**	**Testing results**
Durability	Excellent	The test demonstrated that, like plywood, this softwood can handle the same weight over the same period of time.
Corrosiveness	Excellent	The resin in cedar makes it resistant to rot and ideal for outdoor use. It holds moisture and expands, which means it doesn't crack and it was not affected by the water test.
Hardness	Satisfactory	As cedar is a softwood, some marks appeared on the surface of the material after testing.
Conclusion The results show that cedar outperforms plywood against the properties tested. While cedar showed it was similar in its durability to plywood, it performed better in the corrosive test and was not affected by the water, unlike the plywood, which swelled. In the hardness test, like plywood, its surface marked fairly easily. My end-user prefers plywood, but after the results of the materials testing, might reconsider plywood and choose cedar instead.		

Table 7.20 Evaluation of materials testing

Complete the testing properties Activity 7.7 on page 163 of the workbook.

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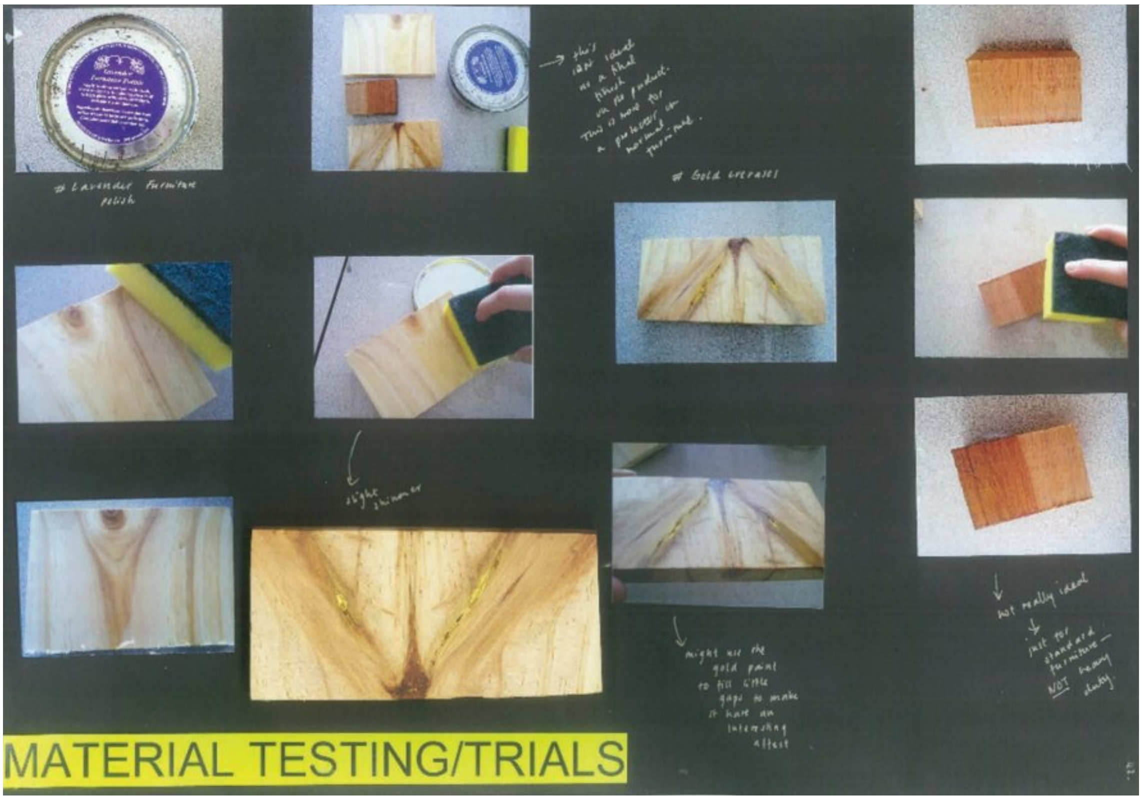

Figure 7.11 Materials testing (polishing wood) by student Natalie Dubinski

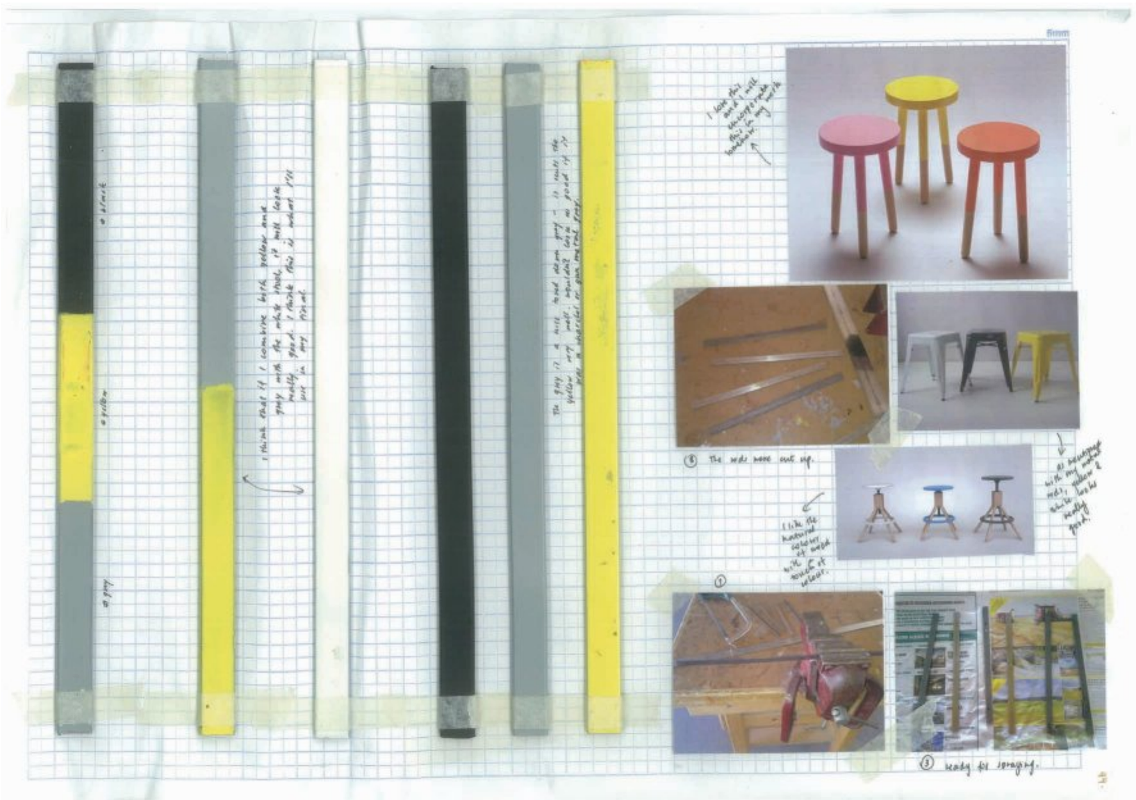

Figure 7.12 Materials testing (painting metal) by student Natalie Dubinski

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Figure 7.13 Materials testing (acrylic wood stain and resin) by student Natalie Dubinski

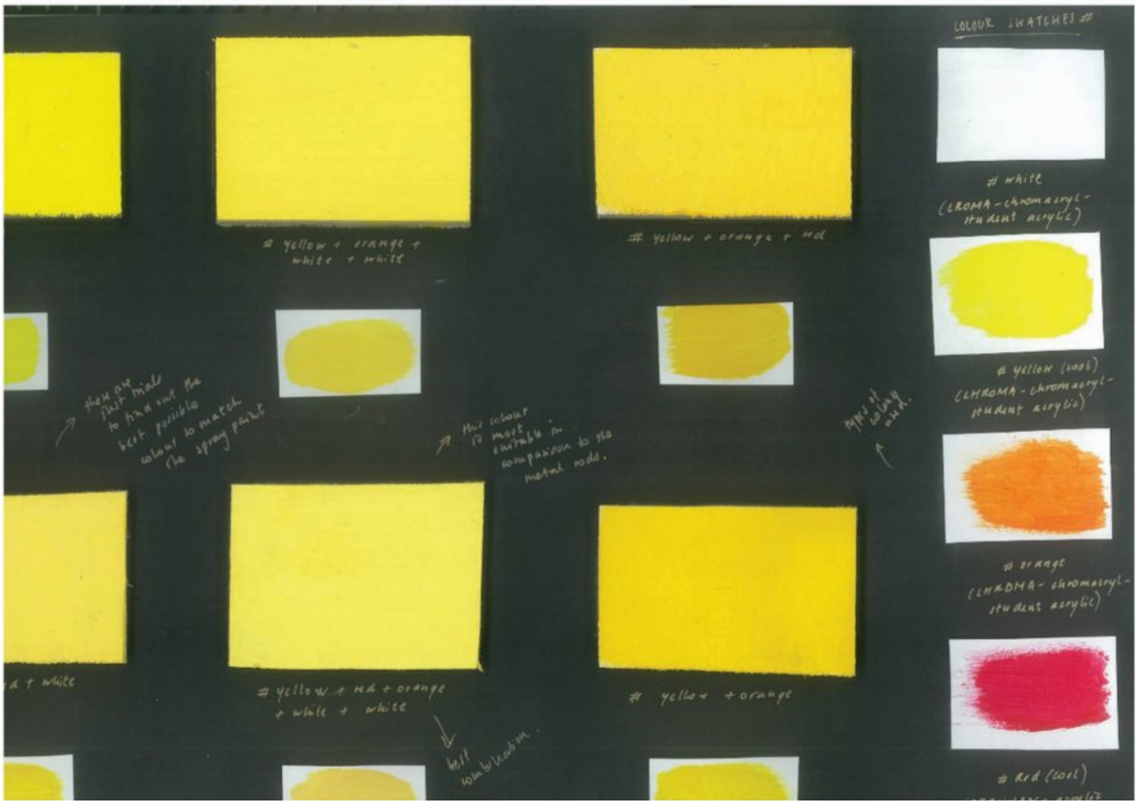

Figure 7.14 Materials testing (painting wood) by student Natalie Dubinski

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Trialling of production processes

You are encouraged throughout the product design process to trial techniques you may use in your design development, design options or preferred option. As always, this research needs to be relevant.

Not only do you want to identify and select the most suitable material that will meet your end-user/s' need, you also want to establish the best production processes to use. Perhaps in resistant materials you need to join metal pieces together and you are considering MIG welding or drilling holes and using nuts and bolts. The best way to decide which process works the best and satisfies your end-user/s specification is to trial each of these processes.

Table 7.21 shows an example of how you can document your process trials for resistant materials. Only one example is provided; how many processes you trial will depend on the product you are making.

Table 7.22 shows examples of potential process trials for joining wood, plastic and metal. For more information on production processes, refer to Chapter 2 (pages 55–9).

Table 7.23 shows examples of potential process trials for types of finishes.

Trialling of joining processes for a mild steel floor lamp			
What is being trialled	**Why this process is being trialled**	**How this process will be trialled**	**Result of the trial**
• MIG welding of mild steel • Joining of mild steel using nuts and bolts	The end-user/s prefers nuts and bolts as the method of joining for an industrial look. The joining method needs to be strong and sturdy.	Sample pieces of mild steel will be cut and: • two pieces joined using a MIG welder • two pieces joined using nuts and bolts.	The trial showed welding to be a stronger and sturdier method of joining. The end-user/s also didn't like the aesthetic look of nuts and bolts.

Table 7.21 Process trial for joining – resistant materials

Potential process trials for resistant materials

Joining methods – wood joints	Joining methods – nuts and bolts	Joining methods – screws	Joining methods – pop rivets and nails	Joining methods – adhesives
Butt joint Lap joint Mitred joint Dowel joint Mortise and tenon Halving joint Biscuit joint	**Nuts** Square nut Wing nut Nylon nut Lock nut **Bolts** Square head Square U-bolt Eye bolt Hexagonal head	**Screws** Countersunk head Raised head Round head Self-tapping screw Coach screw	**Rivets** Split rivet Pop or blind rivet Explosive rivet Solid rivet **Nails** Bullet head Flat head Panel pin Twisted Cut tack Staple	**PVA glue** (wood/paper) **Epoxy** (non-porous materials) **Contact adhesive** (for all materials)

Table 7.22 Potential process trials for joining wood, plastic and metal

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Figure 7.15 An example of joining wood for architecture, Kumamoto, Japan, Sou Fujimoto Architects, 2008

Potential process trials for types of finishes – resistant materials

Type of finish	Use	Surface finish
Water-based varnish	Best for indoor use, and it is not as harmful to the environment as oil-based finishes	Matt or gloss finish
Oil-based varnish	General purpose	Matt or gloss finish
Shellac (French polish)	Does not protect the surface as well as other finishes	Medium to high gloss
Polyurethane	Ideal for products and surfaces that will wear quickly/easily	Durable matt or gloss finish

Table 7.23 Potential process trials for types of finishes – resistant materials

Table 7.24 shows examples of potential production process samples for non-resistant materials.

Potential production process samples for textiles		
Mola	Cuff making	Lining a garment
Quilting	Gathering	French seams
Appliqué	Piping	Ditch stitching
Embroidery (machine or hand)	Pleating	Fly front
Beading	Pocket making	Cover stitching
Dyeing	Rolled hemming	Darts
Fabric printing	Blind hem	Square corners
Boning	Sleeve insertion	Pintucking
Buttonhole making	Zip insertion	Collar making

Table 7.24 Potential production process samples for non-resistant materials

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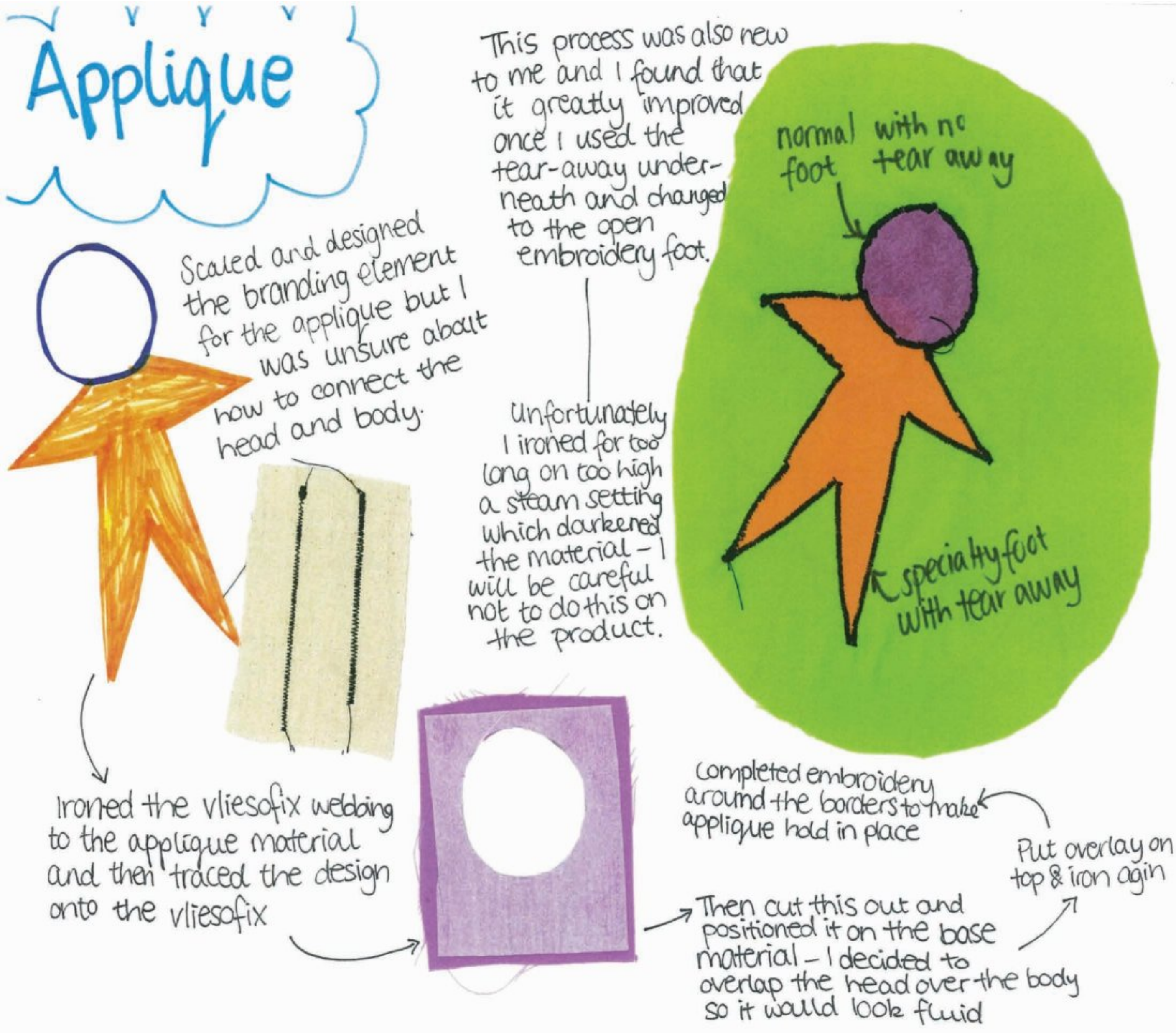

Figure 7.16 Process trials by student Madeleine Hosemans

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Toiles

A toile (a French term for a mock-up or a prototype made in cheap material to test the garment) is a helpful research task to undertake before producing your preferred option – if time allows. It also allows you to:

- test the fit of the garment and affords you opportunities to modify the pattern before making your final product/s
- test the product's ergonomic needs as per the design brief and evaluation criteria (for example, if it is a dance costume, can the end-user/s dance in it?)
- trial production processes in the toile (for example, sleeve insertion, darts)
- develop your production skills and competency with machinery before producing your preferred option
- help decide which processes, materials, techniques and machinery are best suited for the preferred option.

A toile needs to be documented in your SAT folio and production record. See Activity 7.7 for ideas.

TIPS

By being accurate at the start of production you will avoid problems throughout the production process. If you are making a wood product, to achieve a quality product you should make sure that:

- edges of the wood you are using are square
- your wood has a flat surface so it is easy to mark out accurately
- you prepare the wood properly with the correct equipment/tools/machines.

The acronym FEWTEL is often used to remind people working with wood how to prepare it for production (see Activity 7.5).

ACTIVITY 7.5

Resistant materials

Find out what the preparation stages listed below mean in more detail.

FEWTEL:

Face
Edge
Width
Thickness
End
Length

ACTIVITY 7.6

Materials testing – resistant and non-resistant materials

1. Highlight any areas of your design brief, evaluation criteria and research plan that may need materials testing.
2. Complete your tests using sample pieces of material.
3. Document your findings, including:
   - an original, untested sample
   - the reason for the test
   - the test sample
   - an analysis of your findings.

Figure 7.17 Student toiling a garment on the stand

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ACTIVITY 7.7

Non-resistant materials

Complete a toile of your final product/s and document it in your folio.

1. Choose a fabric that is similar to what your preferred option is to be made in. For example, if you are making a T-shirt, a jersey knit would be appropriate.
2. Make up your toile as per your scheduled production plan and pattern instructions. Hems and fastenings can be skipped.
3. Ask an end-user/s to try on the toile, and pin it together where fastening would be. Pin and mark any changes you or the end-user/s wish to make in marker.
4. Take front, back and side pictures of your toile being worn.
5. Write a list of changes that need to be made to the pattern.
6. Modify your pattern accordingly.
7. Put your toile pictures in the centre of a page in your folio. Annotate the toile, listing the processes completed, any feedback from the end-user/s, and changes you wish to make.

7.6 Use of creative and critical design thinking techniques

Critical and creative design thinking

The SAT requires you to use both your creative and critical design thinking skills to develop design ideas. Creative thinking includes generating new ideas, including visualisations and design options, and critical thinking includes the analysis and evaluation of your ideas, including gaining feedback from end-user/s, deciding on the preferred option, and evaluation of the end product. (See Chapter 1 for more detail on creative and critical design thinking.)

Creative and critical design thinking techniques

A variety of critical and creative thinking techniques can be used to explore the product design process. There are no wrong answers in design. Some design thinking tasks include, but are not limited to:

- completing a graphic organiser (see Figure 7.18), such as a brainstorm, mind map, fishbone or lotus diagram
- completing a research plan (see Figure 7.19)
- creating mood boards (see Figures 7.20 and 7.21)
- completing process trials (see Tables 7.21 and 7.22) and generating some visualisations from them
- researching and analysing existing products
- researching current trends in your material
- researching historical and contemporary design movements, cultures or styles
- completing materials research (see Section 7.5)

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- exploring ergonomic and anthropometric needs of end-user/s
- generating visualisations inspired by the above tasks
- using a variety of media to generate designs.

Your folio needs to read like a story, and the link between your research should be obvious and flow throughout the product design process. Your research also needs to be relevant. This means you should aim to learn something in your gathering of images, inspiration, information and data. The needs of the end-user/s should guide your research.

Plan your research

To ensure that your research is relevant and to help manage your time, you are encouraged to make a plan of the things you wish to research. This can be as simple as writing a list, using a graphic organiser (see Chapter 1, page 24) or preparing a detailed research plan using the product design factor and ranking table established in the previous sections. Only one product design factor is used in the example in Table 7.24. Your design brief, evaluation criteria and the product design factors provide a good structure for creating a detailed research plan.

Design thinking tasks – lotus diagram

Figure 7.18 Lotus diagram by student Madeleine Rosenbrock

Complete the research plan Activity 7.8 on page 165 of the workbook.

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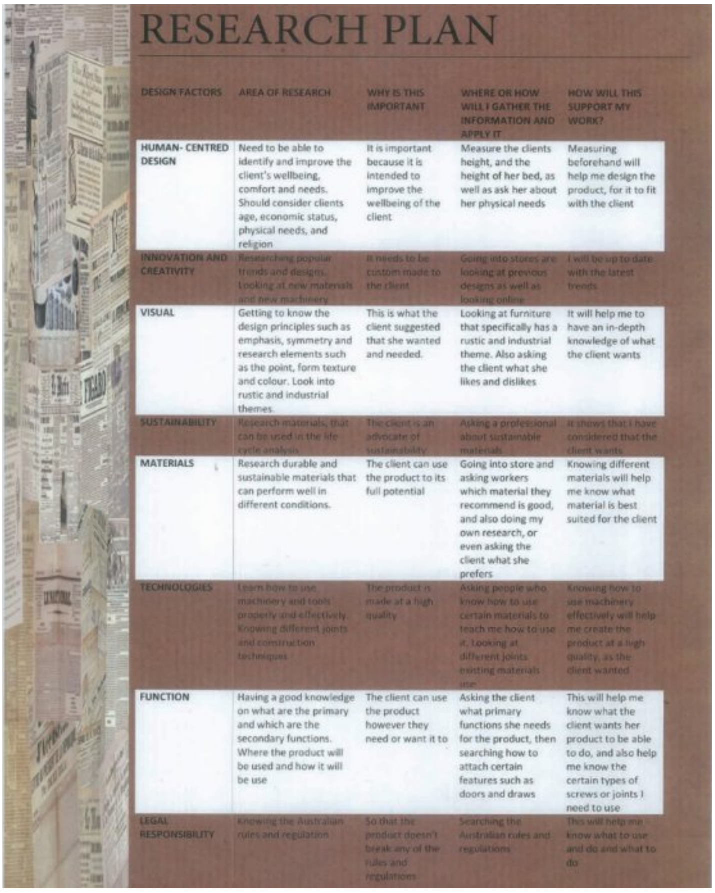
Research plan

Research plan – for a flat-pack stool with a detachable travel bag				
Product design factors	**Areas for research – primary and secondary**	**Level of importance (1 = high importance, 9 = low importance)**	**How this research will support my work**	**How I will apply this research**
1 Purpose, function and context	**Primary research** Look at existing products on the market and visit travel supply stores. **Secondary research** Refer to books in the school library on travel/carry bags and ways of designing compartments to hold necessities.	1	**Primary research** See functionally what works well and not so well, the way the modular concept is applied. Measure height of stools to determine a suitable size. Sit on stools to determine a level of comfort according to the design and material/s used. **Secondary research** Use examples of travel/carry bags to inspire ideas and draw concept sketches.	I will be able to produce concept sketches based on construction methods using modular pieces. Measurements taken of the stool will support the development of the working drawing and provide necessary ergonomic and anthropometric information for the design and development stage. Travel/carry bag research undertaken from books in the library will provide ideas for the design and development stage.

Table 7.25 Research plan using the product design factors and ranking from previous sections of this chapter. Only one product design factor is shown as an example.



RESEARCH PLAN

DESIGN FACTORS	AREA OF RESEARCH	WHY IS THIS IMPORTANT	WHERE OR HOW WILL I GATHER THE INFORMATION AND APPLY IT	HOW WILL THIS SUPPORT MY WORK?
HUMAN-CENTRED DESIGN	Need to be able to identify and improve the client's wellbeing, comfort and needs. Should consider clients age, economic status, physical needs, and religion	It is important because it is intended to improve the wellbeing of the client	Measure the clients height, and the height of her bed, as well as ask her about her physical needs	Measuring beforehand will help me design the product, for it to fit with the client
INNOVATION AND CREATIVITY	Researching popular trends and designs. Looking at new materials and new machinery	It needs to be custom made to the client	Going into stores are looking at previous designs as well as looking online	I will be up to date with the latest trends
VISUAL	Getting to know the design principles such as emphasis, symmetry and research elements such as the point, form texture and colour. Look into rustic and industrial themes.	This is what the client suggested that she wanted and needed.	Looking at furniture that specifically has a rustic and industrial theme. Also asking the client what she likes and dislikes	It will help me to have an in-depth knowledge of what the client wants
SUSTAINABILITY	Research materials, that can be used in the life cycle analysis	The client is an advocate of sustainability	Asking a professional about sustainable materials	It shows that I have considered that the client wants
MATERIALS	Research durable and sustainable materials that can perform well in different conditions.	The client can use the product to its full potential	Going into store and asking workers which material they recommend is good, and also doing my own research, or even asking the client what she prefers	Knowing different materials will help me know what material is best suited for the client
TECHNOLOGIES	Learn how to use machinery and tools properly and effectively. Knowing different joints and construction techniques	The product is made at a high quality	Asking people who know how to use certain materials to teach me how to use it. Looking at different joints existing materials use	Knowing how to use machinery effectively will help me create the product at a high quality, as the client wanted
FUNCTION	Having a good knowledge on what are the primary and which are the secondary functions. Where the product will be used and how it will be use	The client can use the product however they need or want it to	Asking the client what primary functions she needs for the product, then searching how to attach certain features such as doors and draws	This will help me know what the client wants her product to be able to do, and also help me know the certain types of screws or joints I need to use
LEGAL RESPONSIBILITY	Knowing the Australian rules and regulation	So that the product doesn't break any of the rules and regulations	Searching the Australian rules and regulations	This will help me know what to use and do and what to do

Figure 7.19 Research plan by student Monica Ngo

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Research – mood boards

A mood board is a visual collection of images and inspiration. Mood boards are used to collect ideas and inspire the design team. They can include existing products as inspiration, colour palettes, text, material samples and other secondary sources of inspiration, such as art, architecture, nature and graphics.

Figure 7.20 Mood board and visualisations by student Madeleine Rosenbrock

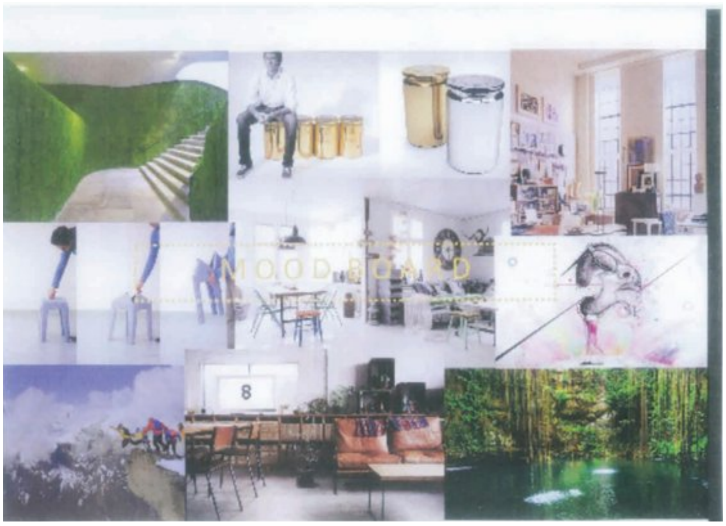

Figure 7.21 Mood board by student Tina Tran

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Research and analysis of existing products

All products are developed from products that already exist. As discussed in Chapter 6, companies use research and development to improve products. Researching and analysing existing products similar to the product or range of products that you are designing for your end-user/s will help you get a better idea of how other designers have approached a similar design problem. You can gauge the similarities and differences of the product you are designing against the existing one and what aspects of the existing products you think work well and not so well. This analysis of existing products might also inspire further research.

Figure 7.22 Research of existing products by student Natalie Dubinski

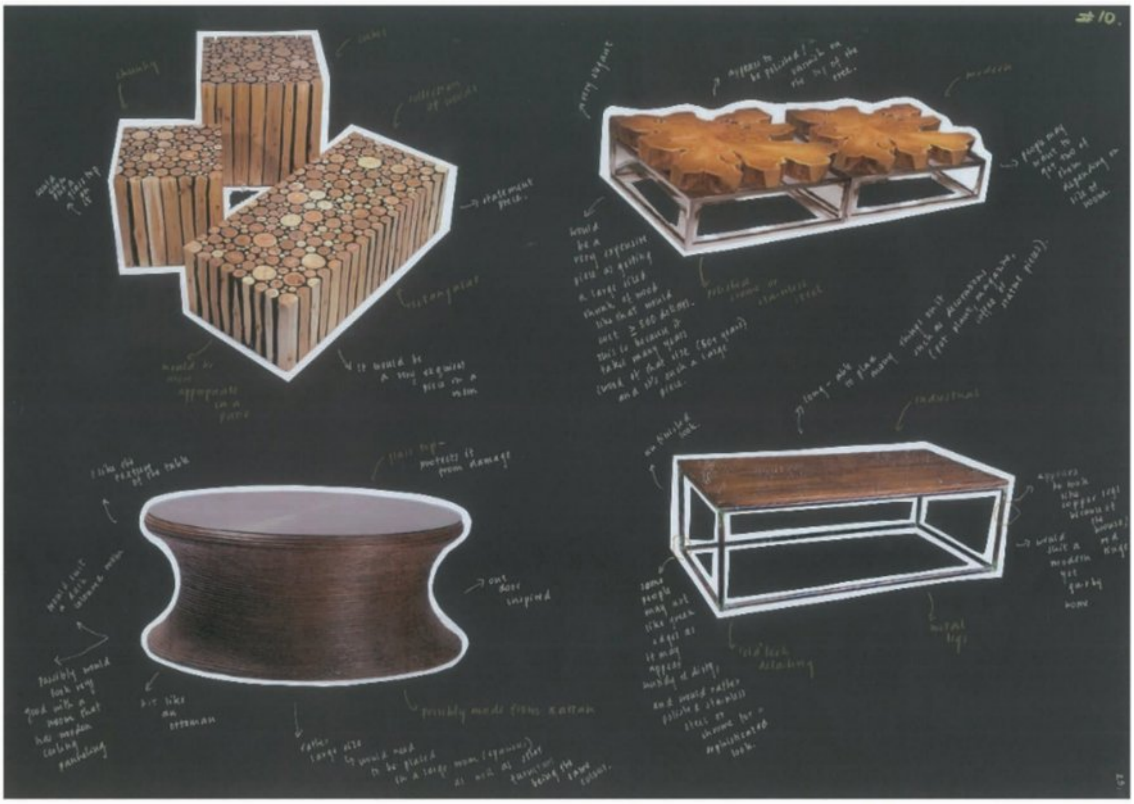

Figure 7.23 Research of existing products by student Natalie Dubinski

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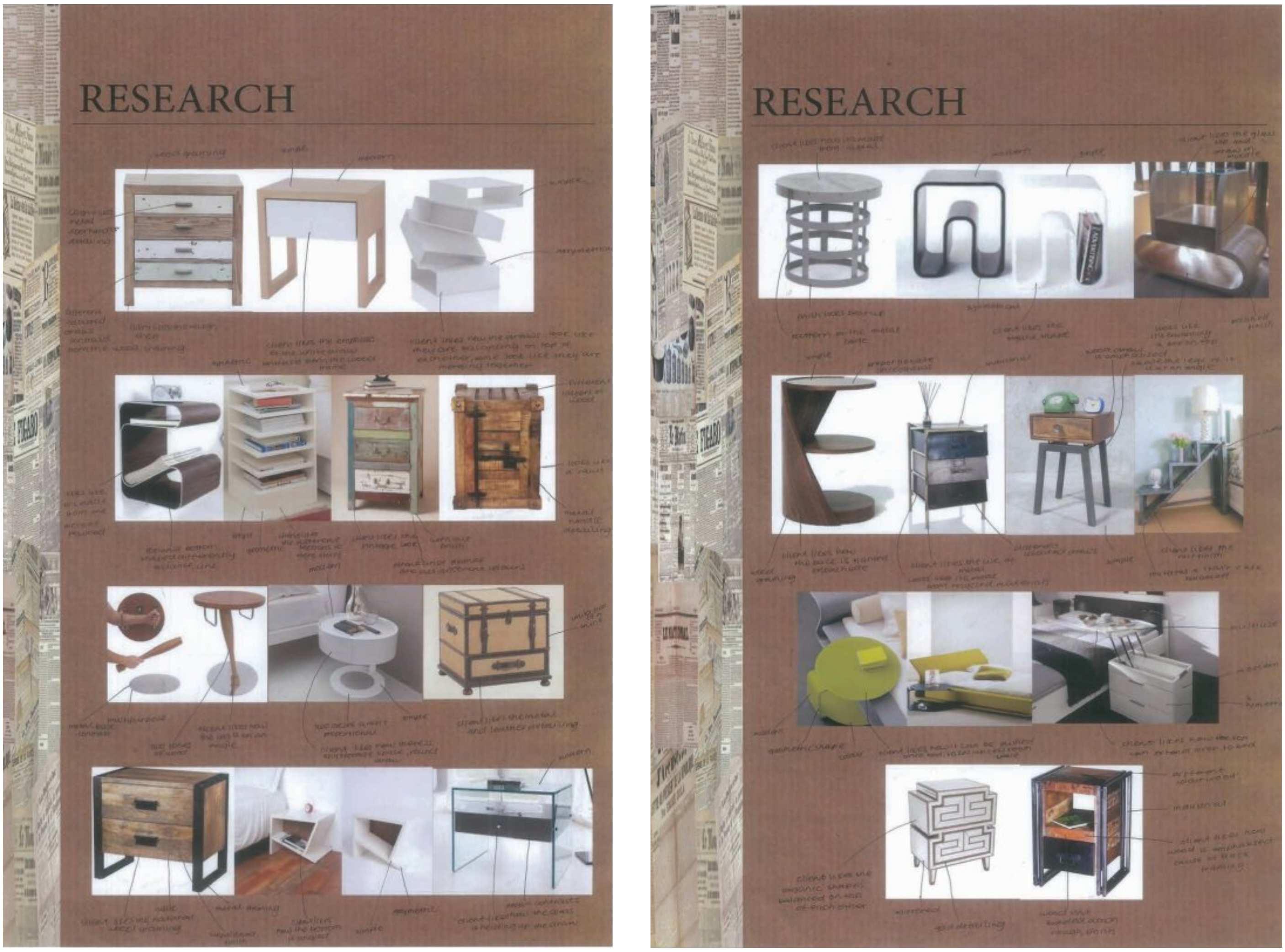

Figure 7.24 Research of existing products by student Monica Ngo

Research of historical and contemporary design movements, cultures or styles

Researching historical design movements, cultures or styles allows you to see how other designers have tried to solve the same design problem you may be trying to solve.

Contemporary design movements, cultures or styles relate to what is happening now. Sustainable design and biomimetic design can be seen as contemporary design movements because they are happening now. If your end-user is particularly interested in contemporary design, then researching sustainable or biomimetic design would be relevant.

Refer to Chapter 3 for more information on historical and contemporary design movements, cultures and styles.

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CASE STUDY

Steampunk culture

The culture of steampunk (a term that started in the 1980s) has developed from a subgenre of science fiction and literature that incorporates technology, clothing, engineering and music, and is inspired by nineteenth-century industrial steam-powered machinery.

People inspired by steampunk culture enjoy the challenge of creating and building things out of random junk or scrap and transforming their found materials and objects into elegant clothing or contraptions.

Figure 7.25 This man wears a contraption he has made that is typical of steampunk culture.

Figure 7.26 Claire and Rupert Callender, founders of the Green Funeral Company, with an environmentally-friendly coffin

DID YOU KNOW?

Some companies produce bamboo coffins. The production of bamboo coffins encourages the use of traditional skills ensuring that the manufacturing processes are kept as green as possible. Bamboo coffins are 100% natural and biodegradeable.

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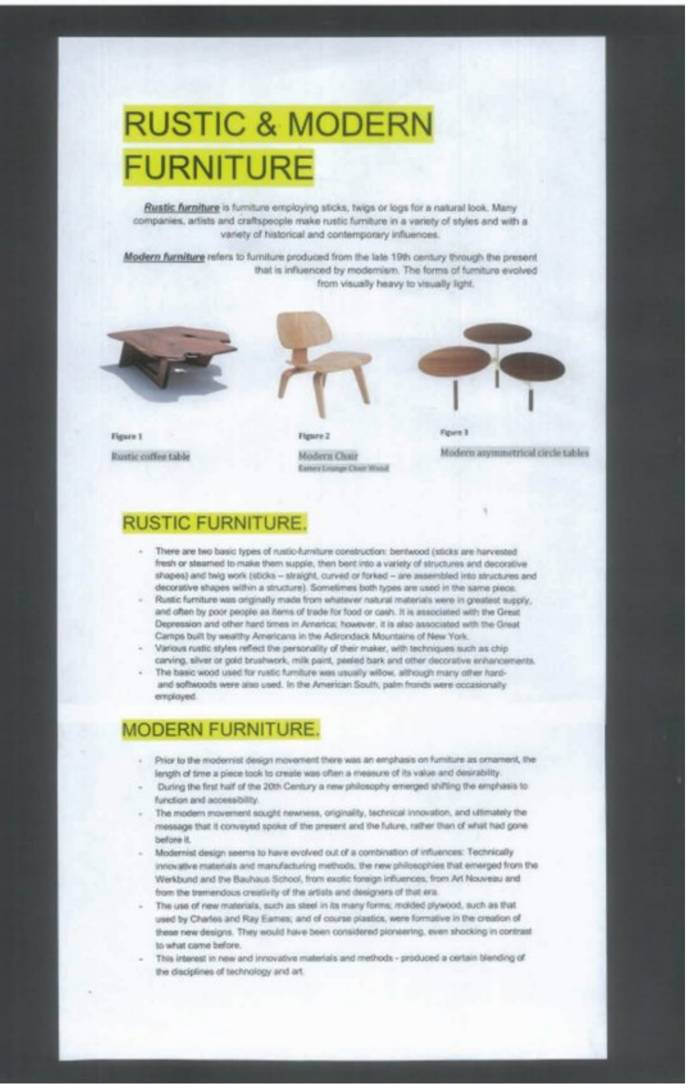

RUSTIC & MODERN FURNITURE

Rustic furniture is furniture employing sticks, twigs or logs for a natural look. Many companies, artists and craftspeople make rustic furniture in a variety of styles and with a variety of historical and contemporary influences.

Modern furniture refers to furniture produced from the late 19th century through the present that is influenced by modernism. The forms of furniture evolved from visually heavy to visually light.

Figure 1
Rustic coffee table

Figure 2
Modern Chair
Eames Lounge Chair Wood

Figure 3
Modern asymmetrical circle tables

RUSTIC FURNITURE.

- There are two basic types of rustic-furniture construction: bentwood (sticks are harvested fresh or steamed to make them supple, then bent into a variety of structures and decorative shapes) and twig work (sticks – straight, curved or forked – are assembled into structures and decorative shapes within a structure). Sometimes both types are used in the same piece.
- Rustic furniture was originally made from whatever natural materials were in greatest supply, and often by poor people as items of trade for food or cash. It is associated with the Great Depression and other hard times in America; however, it is also associated with the Great Camps built by wealthy Americans in the Adirondack Mountains of New York.
- Various rustic styles reflect the personality of their maker, with techniques such as chip carving, silver or gold brushwork, milk paint, peeled bark and other decorative enhancements.
- The basic wood used for rustic furniture was usually willow, although many other hard- and softwoods were also used. In the American South, palm fronds were occasionally employed.

MODERN FURNITURE.

- Prior to the modernist design movement there was an emphasis on furniture as ornament, the length of time a piece took to create was often a measure of its value and desirability.
- During the first half of the 20th Century a new philosophy emerged shifting the emphasis to function and accessibility.
- The modern movement sought newness, originality, technical innovation, and ultimately the message that it conveyed spoke of the present and the future, rather than of what had gone before it.
- Modernist design seems to have evolved out of a combination of influences: Technically innovative materials and manufacturing methods, the new philosophies that emerged from the Werkbund and the Bauhaus School, from exotic foreign influences, from Art Nouveau and from the tremendous creativity of the artists and designers of that era.
- The use of new materials, such as steel in its many forms; molded plywood, such as that used by Charles and Ray Eames; and of course plastics, were formative in the creation of these new designs. They would have been considered pioneering, even shocking in contrast to what came before.
- This interest in new and innovative materials and methods - produced a certain blending of the disciplines of technology and art.

Figure 7.26 Historical research of rustic and twentieth-century modern furniture by student Natalie Dubinski

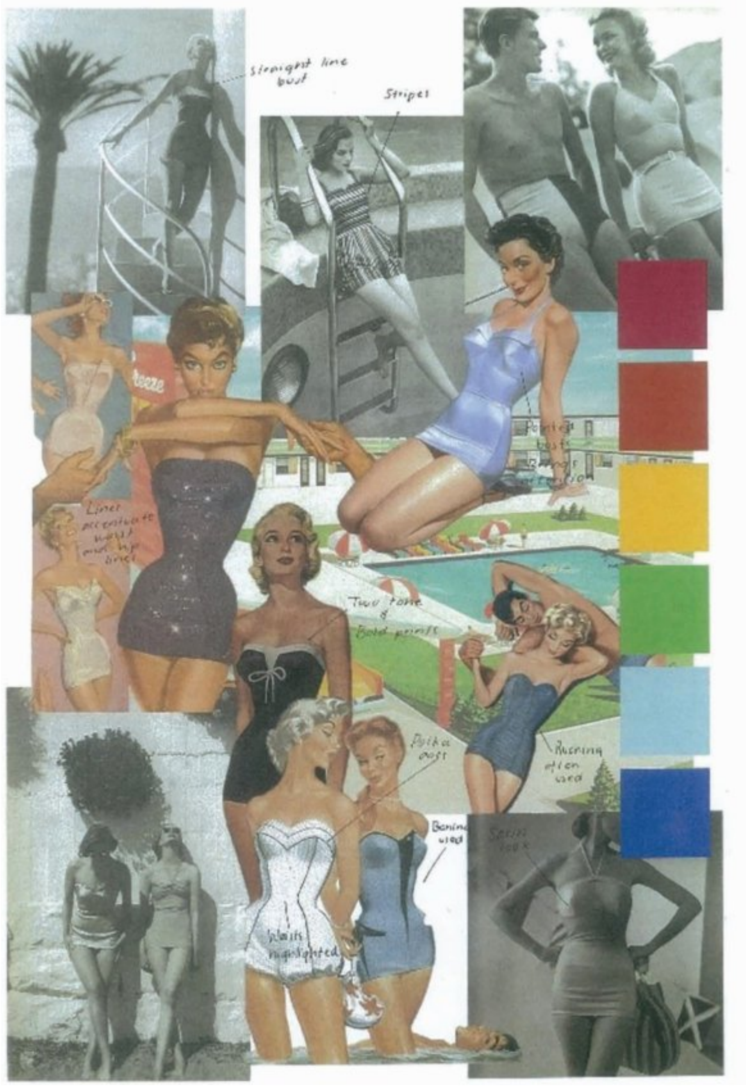

Figure 7.27 Historical research of 1950s swimwear by student Madeleine Rosenbrock

Exploring ergonomic and anthropometric needs

Ergonomics is one of the first factors a designer should consider when designing a product for human use, as it will help generate a better user experience. The product will be safe, comfortable and easy to use. The ergonomic factors required in a design for an adult male will be different from those required for a child or a person with a disability. Ergonomic design considers human limitations and abilities (anthropometrics) that might alter how the end-user interacts with a product. Anthropometric data is a collection of measurements often shown as annotated diagrams of human figures.

Ways to use anthropometric data when designing include:

1. Determine the end-user/s. What body dimensions will be important? The length of a dress or the height of a table will be different depending on age.
2. Determine if you are going to design for the average, adjustable or extreme. Will a specific end-user/s or everyone be using your product?
3. Find anthropometric data relating to who you are designing for.
4. Have this data as a reference point when creating your designs. Write down the important data for your reference throughout the design process.

For more information on anthropometric data, refer to Chapter 5 (page 130).

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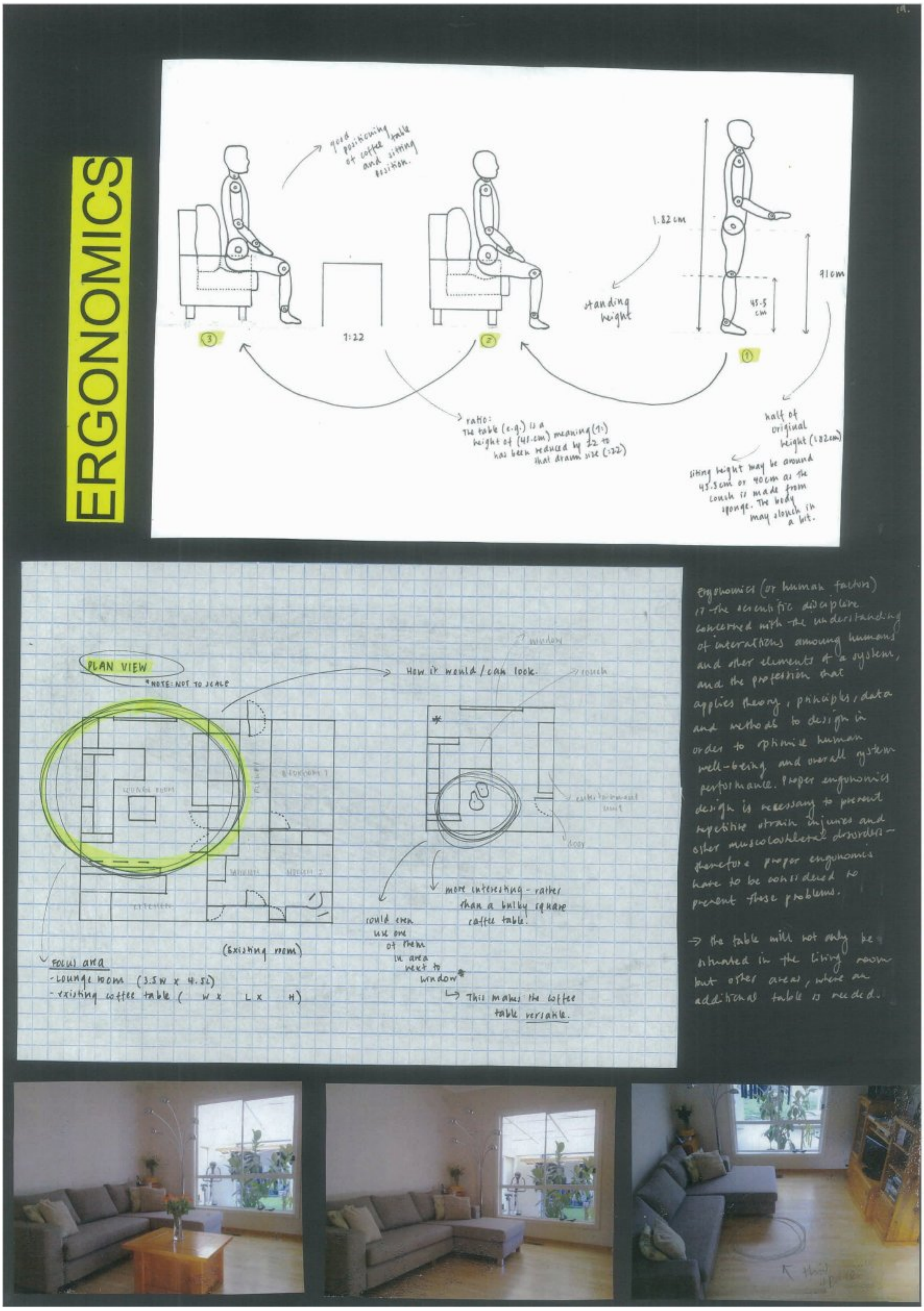

Figure 7.28 Ergonomic and anthropometric research by student Natalie Dubinski

Complete the ergonomic and anthropometric Activity 7.9 on page 166 of the workbook.

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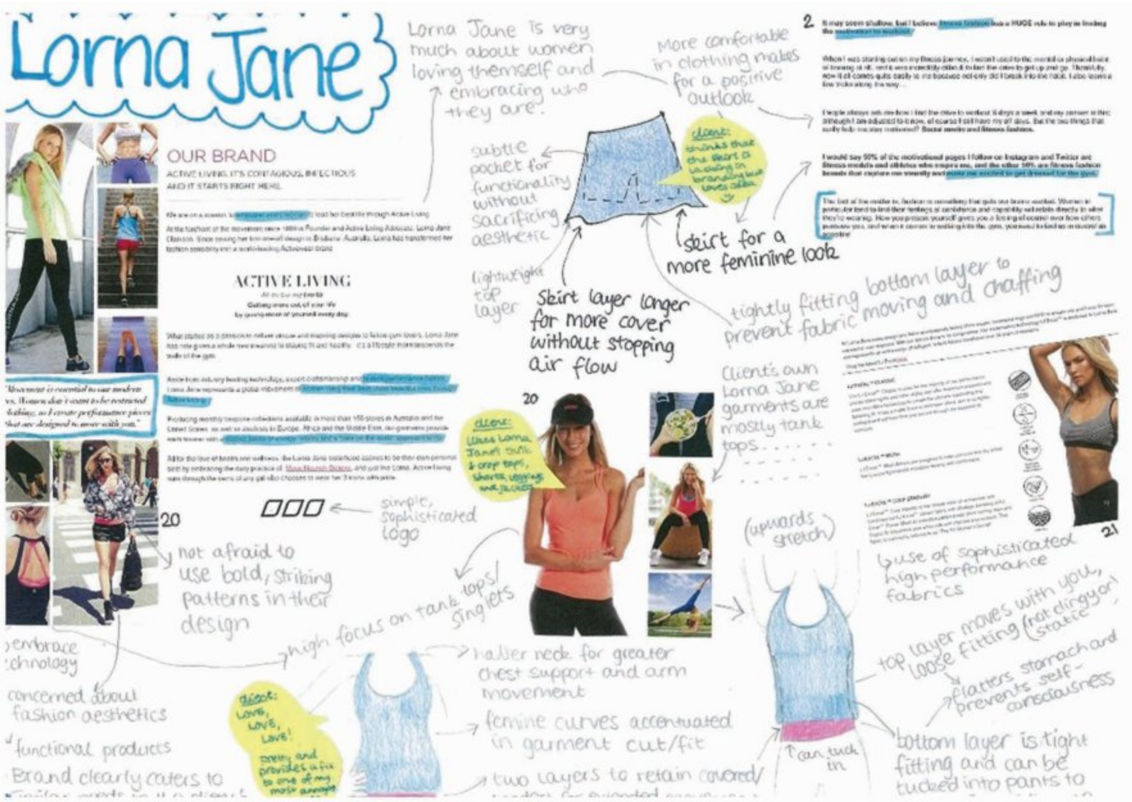

Figure 7.29 Ergonomic research by student Madeleine Hosemans

Development of design ideas – research, visualisations and annotations

You can work through this section by either:

- referring to your research plan linked to the product design factors as shown in Table 7.24, or
- using relevant criteria from your evaluation criteria for a finished product, making a copy of the criterion that requires further research and using the key terms in the criterion question as a heading.

Generate a page of design development (research, visualisations and annotations)

Complete research identified in your research plan or within each criterion taken from your evaluation criteria and then generate visualisations with clear, relevant annotations.

The following student examples demonstrate the use of specific areas of research to develop ideas (visualisations with relevant annotations).

TIP

Using layout can make the link between your research and visualisations clearer.

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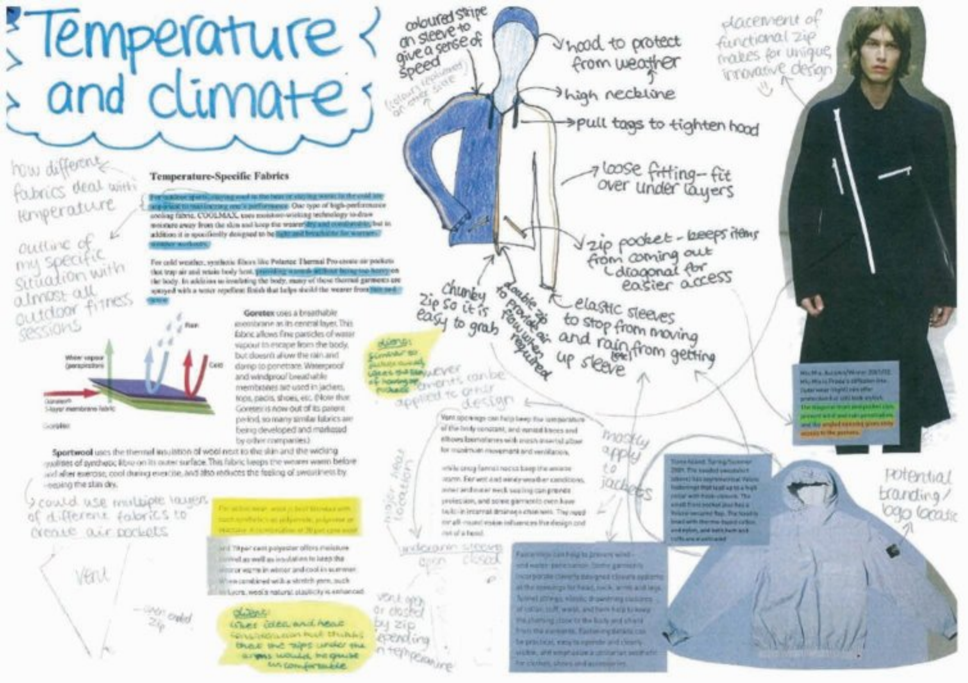

Figure 7.30 Design development by student Madeleine Hosemans. This non-resistant materials student needed her designs to be appropriate for outdoor temperatures and completed relevant research in this area.

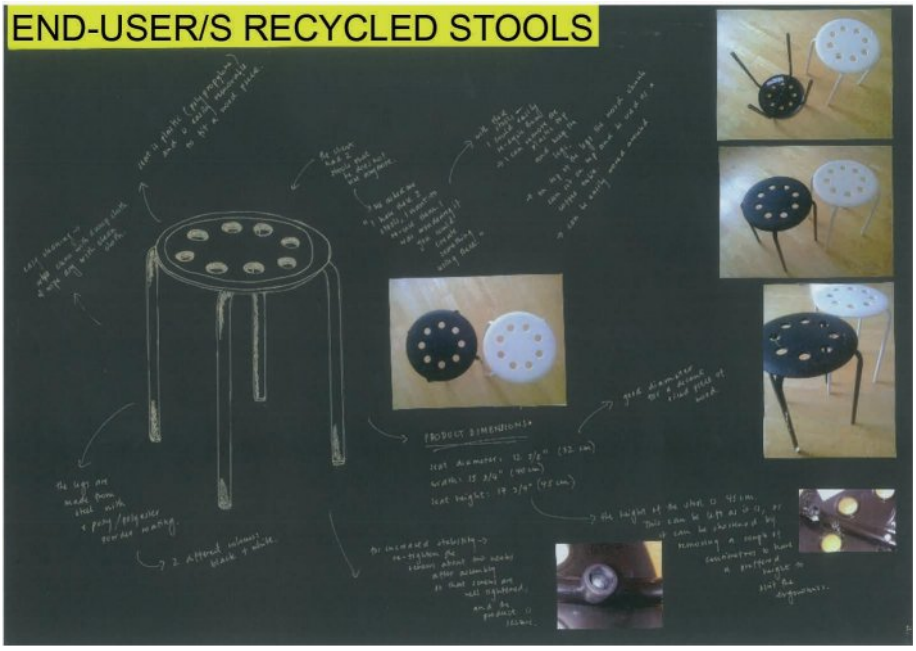

Figure 7.31 Design development by student Natalie Dubinski. This resistant materials student had to research her end-users to determine which of the two recycled stools was the best one to use.

Illustration techniques

You are encouraged to explore a variety of media and presentation techniques in your SAT. This could include (but is not limited to):

- pencils and fineliner and other traditional mediums
- watercolours, paints and inks
- alcohol-based markers such as Copics
- CAD techniques such as Adobe Illustrator or SketchUp (see Figures 7.32, 7.33 and 7.35)
- collage using actual materials in design work (see Figure 7.34).

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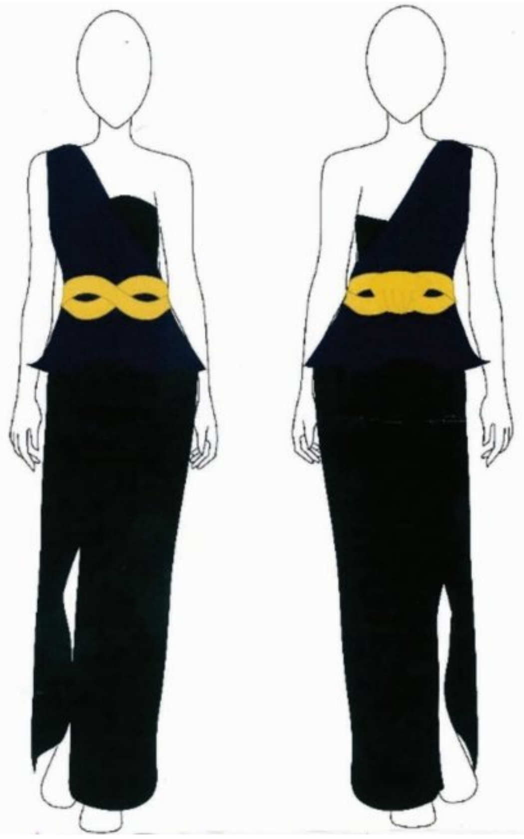

Figure 7.32 Design work using ICT method Adobe Illustrator by student Erica Little

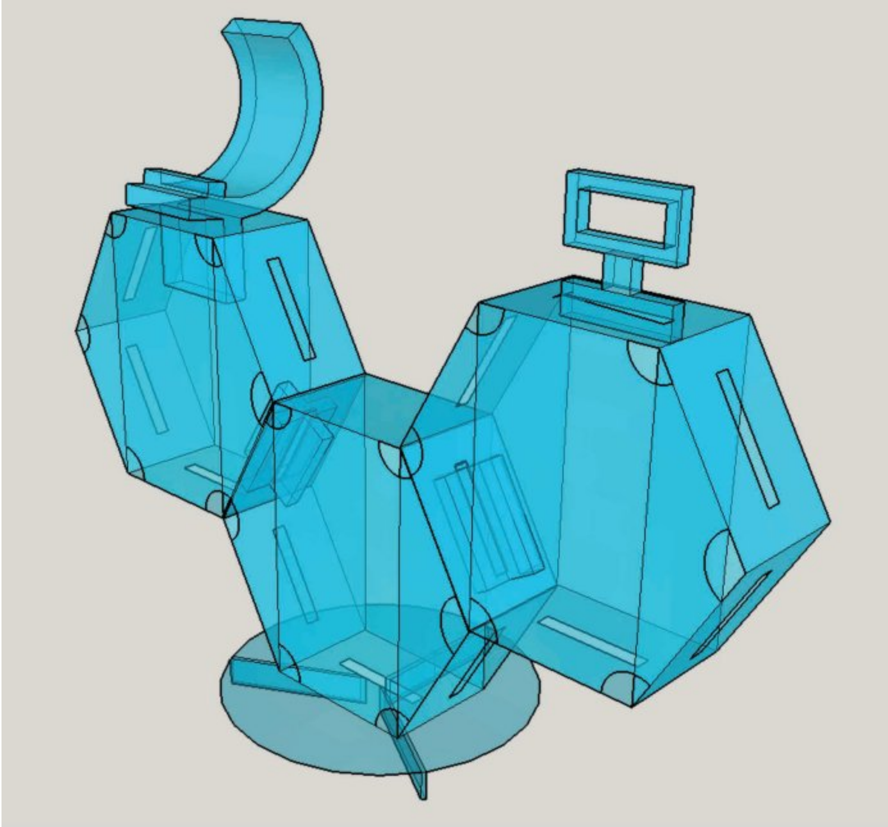

Figure 7.33 Design option of an acrylic storage unit drawn using ICT method SketchUp by student Baptist Zacharia

Figure 7.34 Collage visualisations by student Erica Little

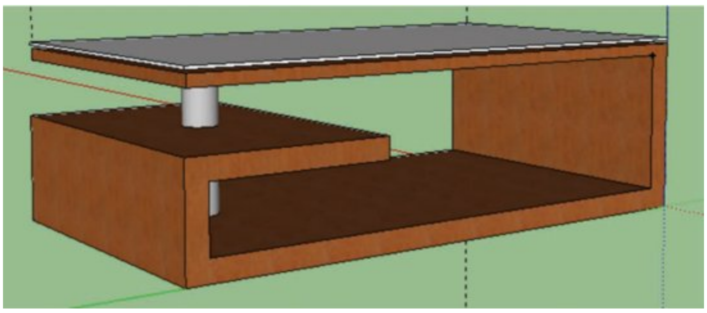

Figure 7.35 Design option using Sketch-up by student Liam Grech

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Tolix Bar Stool
Xavier Pauchard (1880–1948)

ONLINE REVIEW:
The Model A chair has become an icon of industrial aesthetics; its unfailing popularity since 1934 has enabled it to enter the Collections of the Vitra Design Musuem, MOMA and the Pompidou Centre. This mythical chair, crafted of sheet metal, has been assured by its fool-proof solidity, its unequalled lightness, its easy maintenance – advantages of which can be included – inexpensive.

All merit goes to Xavier Pauchard (1880–1948) who was a pioneer of galvanisation in France. Shortly after Wolrd War 1, based in Autun, Burgundy, he found himself (a visionary and inventive entrepreneur) in charge of a flourishing manufacture of galvanised sheet-metal domesic items, which at the time, embodied household comfort. It was in 1927 that he registered the trademark TOLIX, at the same time converting to the production of chairs, armchairs, stools and metal furniture.

We owe the revival of the brand Tolix to Chantal Andriot. It was with passion and loyality for the company that this, ex Financial Directrice, launched into the adventure, along with a handful of employees, and bought back Tolix. The only woman in a man's world and with her knowledge she was able to give back a new vitality, in perpetuating the dual standards of quality and innovation to an industry skilled in the making of functional furniture.

To assist in the artistic direction, Chantal Andriot has chosen the designers Jean-François Dingjian et Eloi Chafaï alias Normal Studio. Their design questions industrial workmanship, freeing it from the past in order to valorise the workshop's legendary know-how. Today this enterprise is endowed with the latest technology which accompanies its numerous inherited manual processes and equipment.

Figure 7.36 Research with visualisations by student Tina Tran

Gaining genuine and constructive feedback from end-user/s

At the visualisation step in the product design process, you must get feedback from end-user/s on your design work and document this in your folio. This helps you decide which of your visualisations to develop into design options. (See Figure 7.39, where the student has used speech bubbles in her design work to quote end-user/s' feedback.)

Annotations

Your annotations link your design development together, and explain your thinking and any details not visually obvious, and form part of your assessment. See Chapter 1 (pages 30–1) for more information on annotating a folio.

Respecting intellectual property in the SAT

All through Units 1–4, the intellectual property of others needs to be respected in your folio, and can form part of your assessment. You must indicate in your folio where work is not your own, such as listing a designer below the image of their work you have put in your design development.

For more information on intellectual property, see Chapter 1 (pages 26–8).

CASE STUDY

Home-Work

Home-Work is a Melbourne-based textiles and homewares company run by Jess Wright and Lara Davies. The have a focus on unique printed textiles, often featuring bold patterns and colours, and the products are made in Melbourne. They also design prints for other product design companies such as Rollie and Casetify.

Figure 7.37 Home-Work design studio

Mood boards as inspiration

With art and design training, Jess and Lara are big on visuals and have a constant

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'Mood Board Wall' in their studio as inspiration for their design process (see Figure 7.37). This includes inspirational images (Egypt and Hip Hop are recurring themes) as well as hand-drawn images and test runs of prints they have designed.

Figure 7.38 Home-Work products

Gaining feedback from end-user/s in the design process

Being a smaller operation, Jess and Lara harness the power of social media, putting out potential designs and prints on Instagram to gauge interest and get feedback.

Ensuring a quality product

Where bigger companies have testing departments and staff dedicated to quality assurance, a small team means Jess and Lara must do this themselves. Often they will make samples of products and get their family and friends to test them out before batch-producing their commercial range.

7.7 Purpose and role of visualisations

Different styles of drawings have different purposes in the product design process, and are created in formats best suited to your skills and chosen materials.

For more information on how to generate these three drawing styles, see Chapter 1 (pages 29–35).

Visualisations are quick thumbnail sketches that are informed by your research. In Units 3–4, you must gain feedback from an end-user/s on your visualisations and document this in your folio. This gives you guidance as to which ideas you should develop into design options. Your visualisations should show a development of ideas. See Section 7.5 for places to source materials for both resistant and non-resistant materials.

Figure 7.39 shows an example of visualisations for non-resistant materials.

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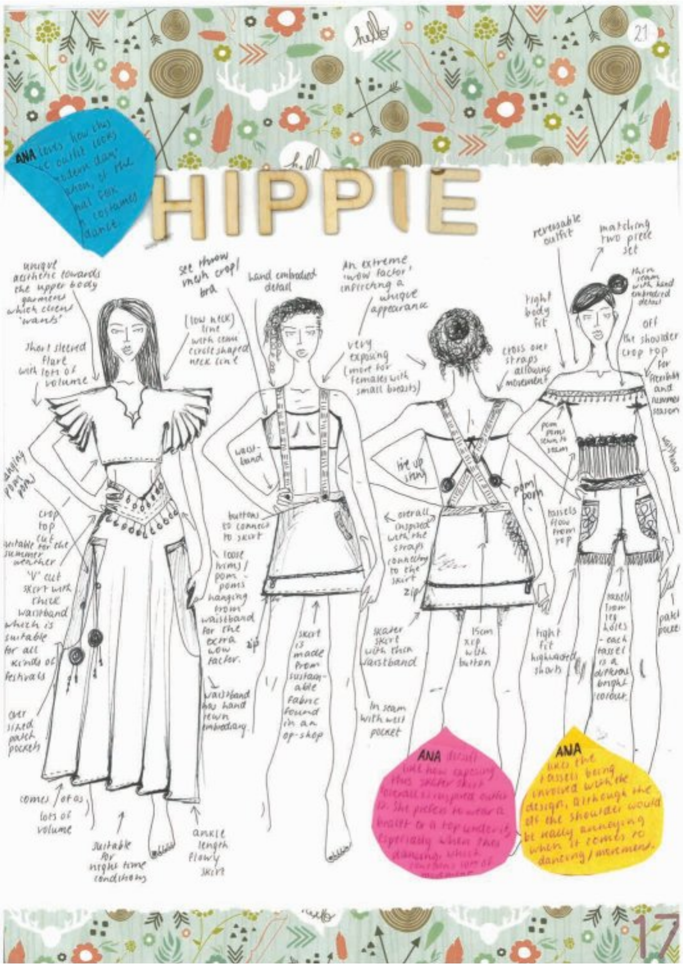

Figure 7.39 Visualisations by student Katarina Kristo

Figures 7.39 and 7.40 show examples of visualisations for non-resistant materials and resistant materials

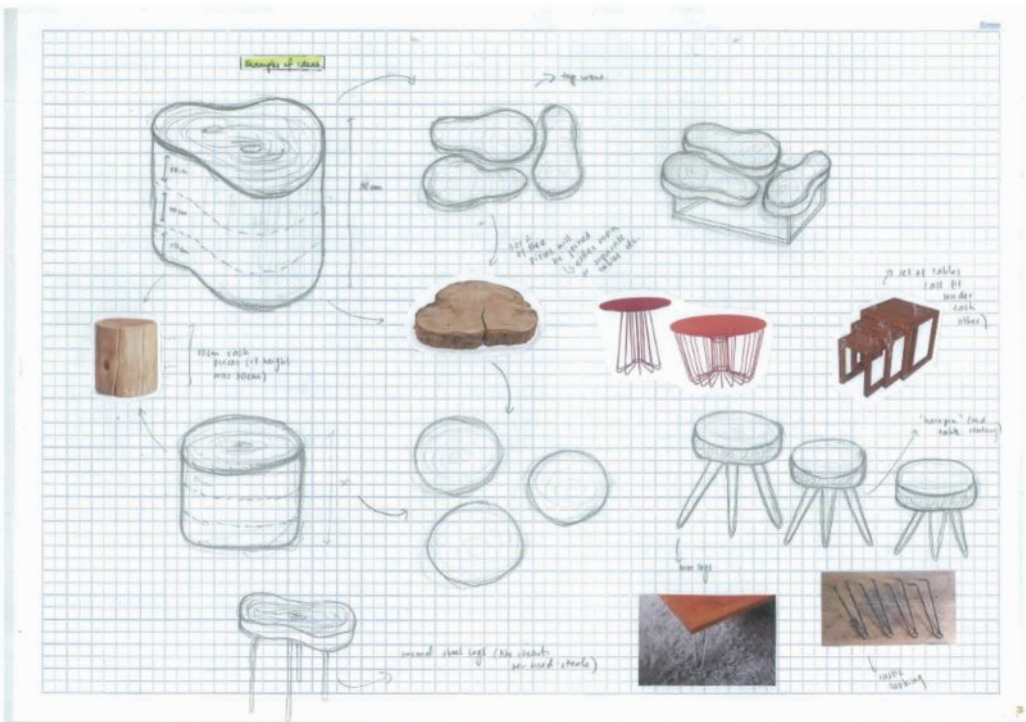

Figure 7.40 Visualisations by student Natalie Dubinski

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Design options (presentation drawings) are skilled, coloured and annotated drawings that show what the product will look like and help the end-user/s decide on the preferred option.

Figures 7.41 and 7.42 show examples of design options for non-resistant materials.

Figure 7.41 Design option by student Katarina Kristo

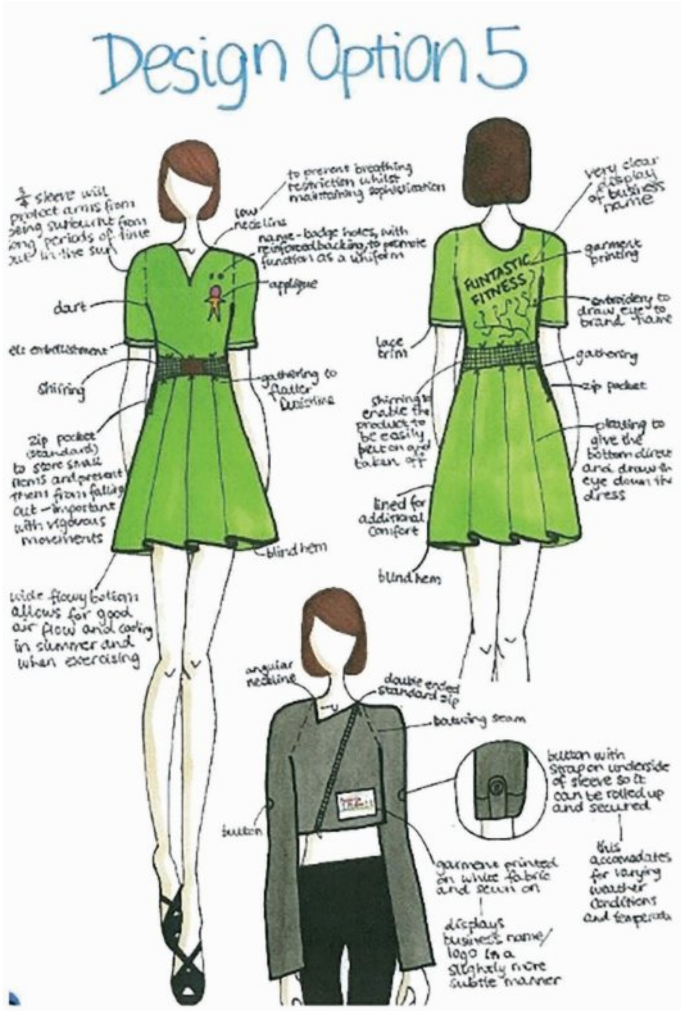

Figure 7.42 Design option by student Madeleine Hosemans

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Figures 7.43 and 7.44 show examples of design options for resistant materials.

Figure 7.43 Design options 1–4 by student Natalie Dubinski drawn using pencil and fineliner

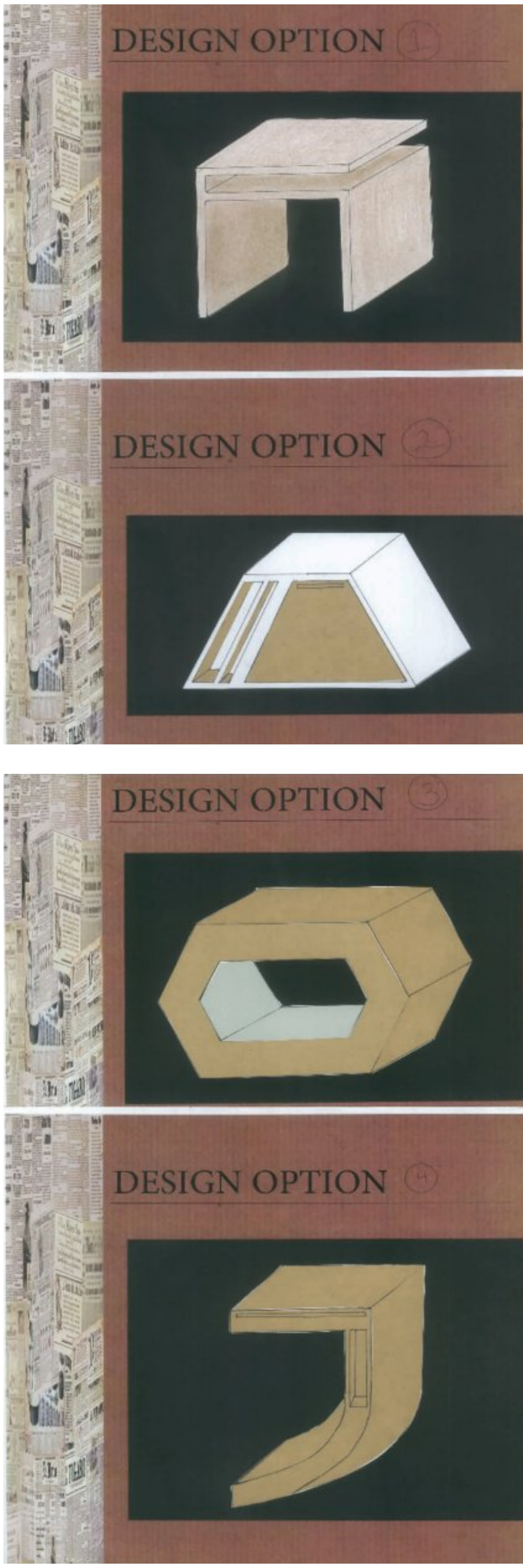

Figure 7.44 Design options by student Monica Ngo drawn in oblique view using pencil and fineliner and overlaid with brown paper to represent wood

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Working drawings are technical drawings that communicate how a product is to be produced. See Chapter 1 (pages 33–4) for working drawing examples for resistant and non-resistant materials.

Figure 7.45 shows an example of working drawings.

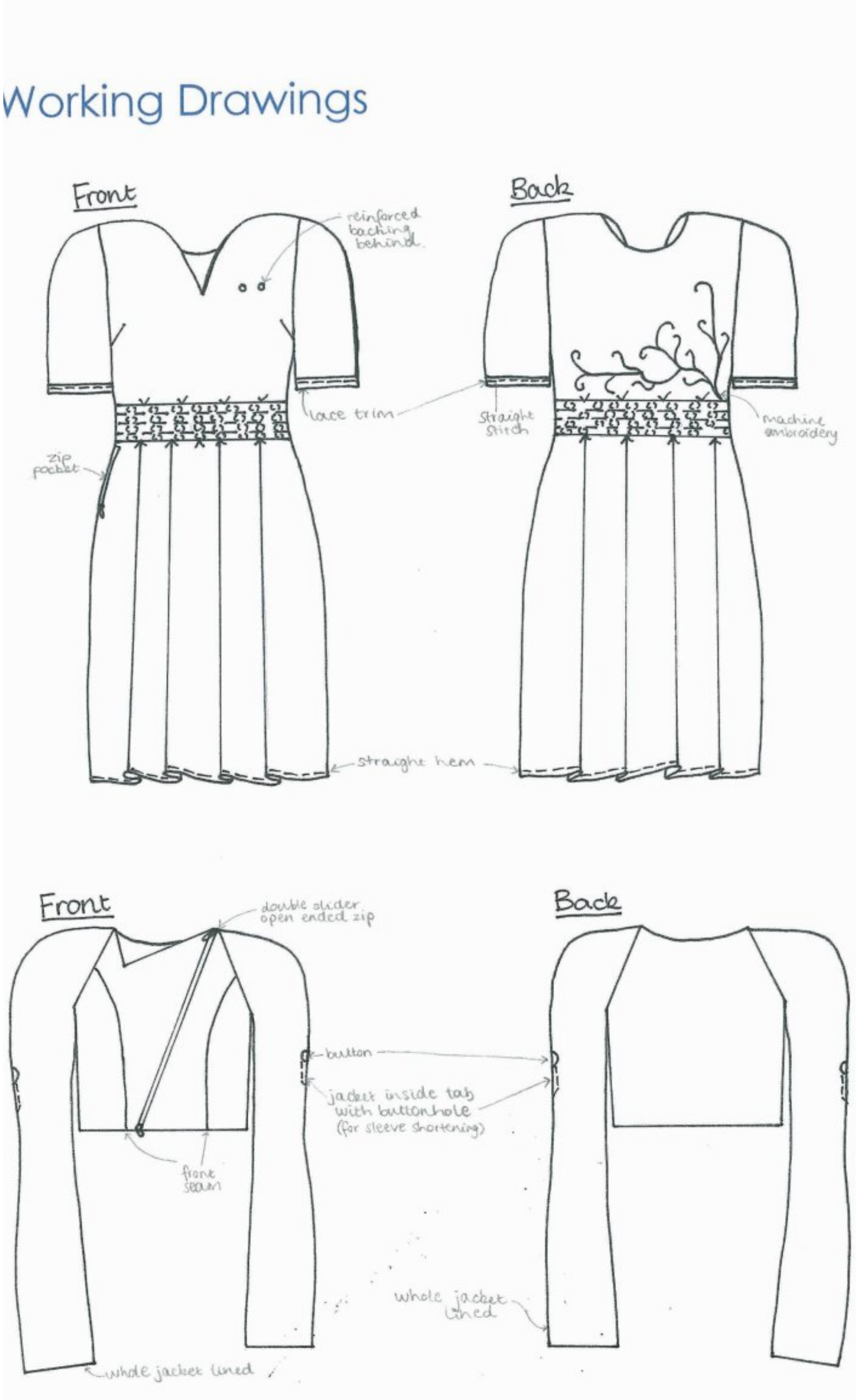

Figure 7.45 Working drawings by student Madeleine Hosemans

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Deciding on and justifying the preferred option

In Units 3–4, you must decide which one of your design options you will produce as part of your SAT. Together with an end-user/s and your evaluation criteria as a guide, you must discuss which design option best meets both the design brief and their needs. (See Figure 7.41, which features a screenshot of a Skype conference with an end-user to gain feedback.)

You then need to justify the preferred option. This is a short statement that explains what design option you will be producing and why. It should include end-user feedback, discussions as to how it best met your evaluation criteria, and why others were not as suitable.

Figure 7.46 Justifying the preferred option by student Madeleine Rosenbrock

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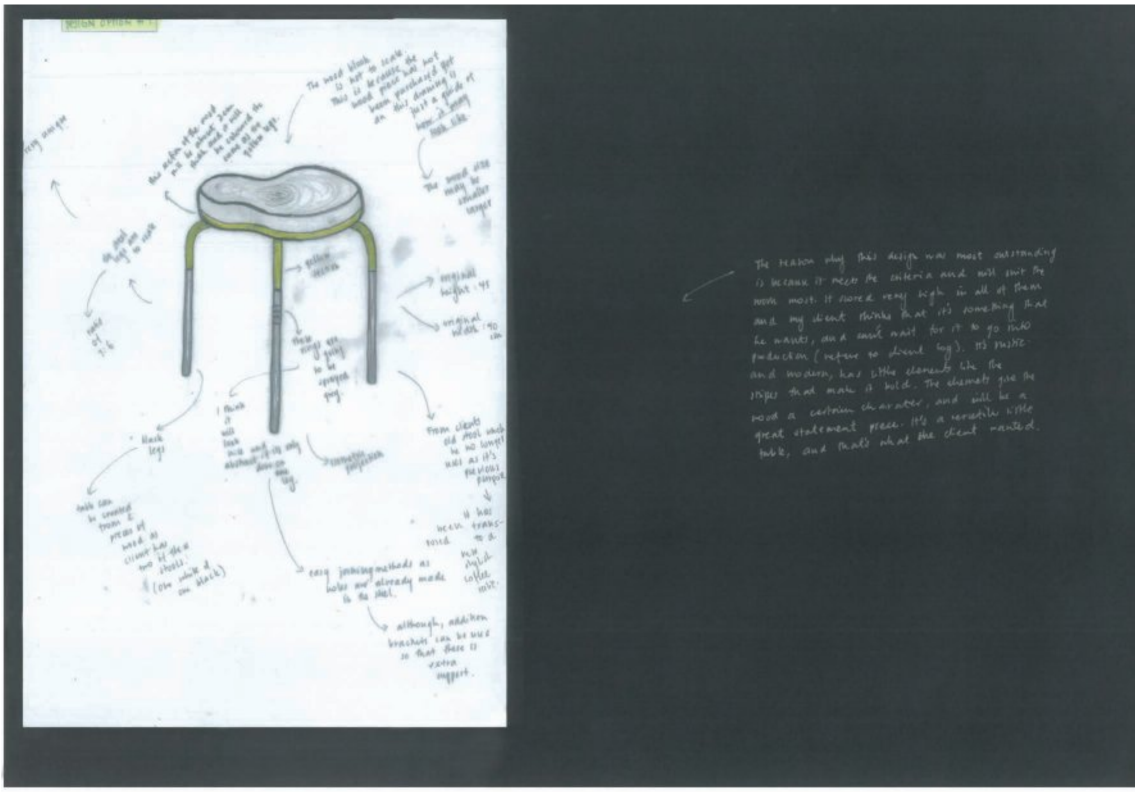

Figure 7.47 Preferred option with justification by student Natalie Dubinski

TIPS

You and your end-user/s may decide to 'mix and match' components of various design options to make up the preferred option, such as the materials and colours of one design combined with the silhouette of another. This is acceptable, but you should redraw your new preferred option and discuss your decisions in your justification of the preferred option.

ACTIVITY 7.8

Justifying the preferred option

1 Meet with your end-user/s and assess each of your design options against your pre-written evaluation criteria.

2 Decide together which one best meets the design brief. This may be a combination of design options (see tips above).

3 Answer the following questions:

- Why is this one the most suitable?
- Why were others not suitable?
- What excites the end-user/s most about this?

4 Sum up the above information and include direct quotes from your client, making direct reference to your evaluation criteria.

- **Complete the justifying the preferred option Activity 7.10 on page 167 of the workbook.**

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7.8 Methods of communicating a product specification in working drawings

Working drawings need to communicate how the product should be constructed. This is a great opportunity in the product design process to really work out how you want your product to come together.

Refer to Chapter 1 (pages 32–5) for detailed information on how to generate working drawings.

Resistant materials

Working drawing

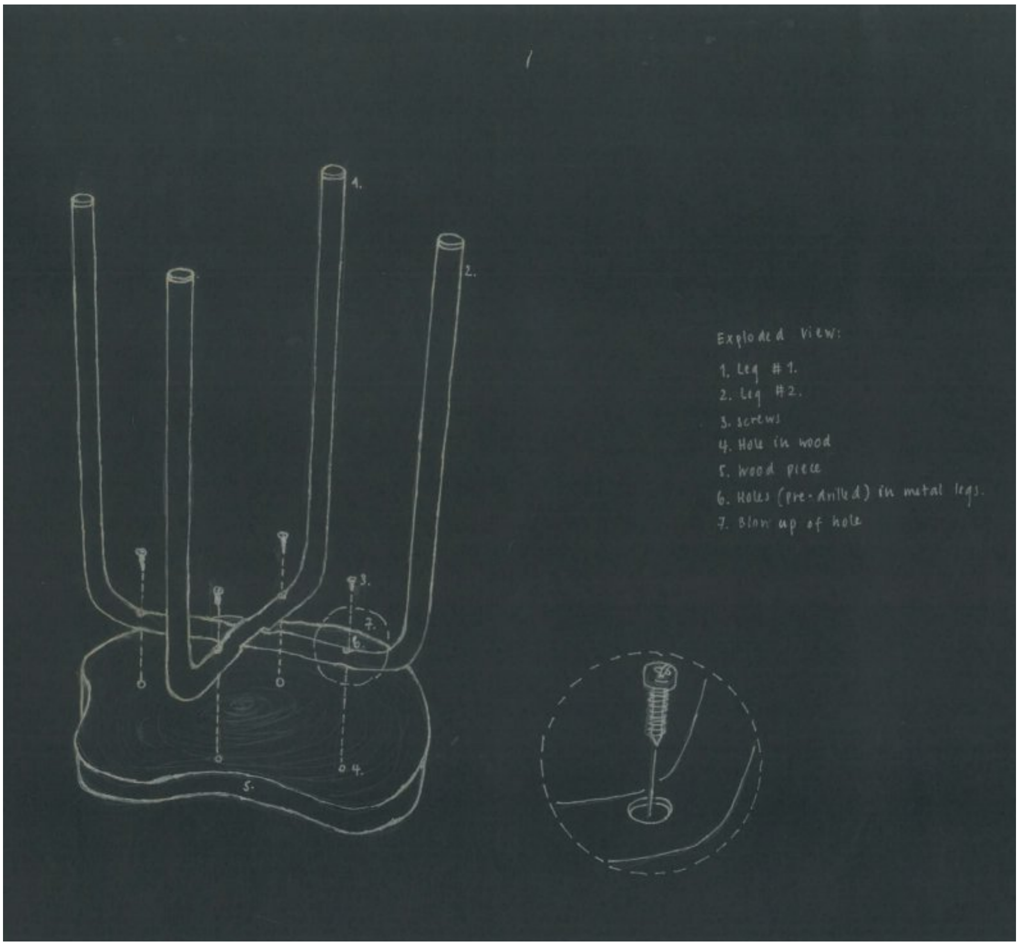

Figure 7.48 This drawing zooms in on the joining method used to join the reclaimed wood to the recycled stool. Drawing by student Natalie Dubinski.

Non-resistant materials

In Units 3–4, it is expected your working drawings for textiles will include:

- technical drawings (see Chapter 1, page 33) of front and back views of your preferred design option, to scale (side views and zoom drawings can be included)
- key measurements to complement the technical drawing (for example, bust, waist, hip, sleeve length, hem size)

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- acknowledgement of any commercial patterns or pattern blocks you use (see Figure 7.50); if using a commercial pattern, you should aim to make a minimum of three changes to it
- documentation of how you are modifying the pattern or block.

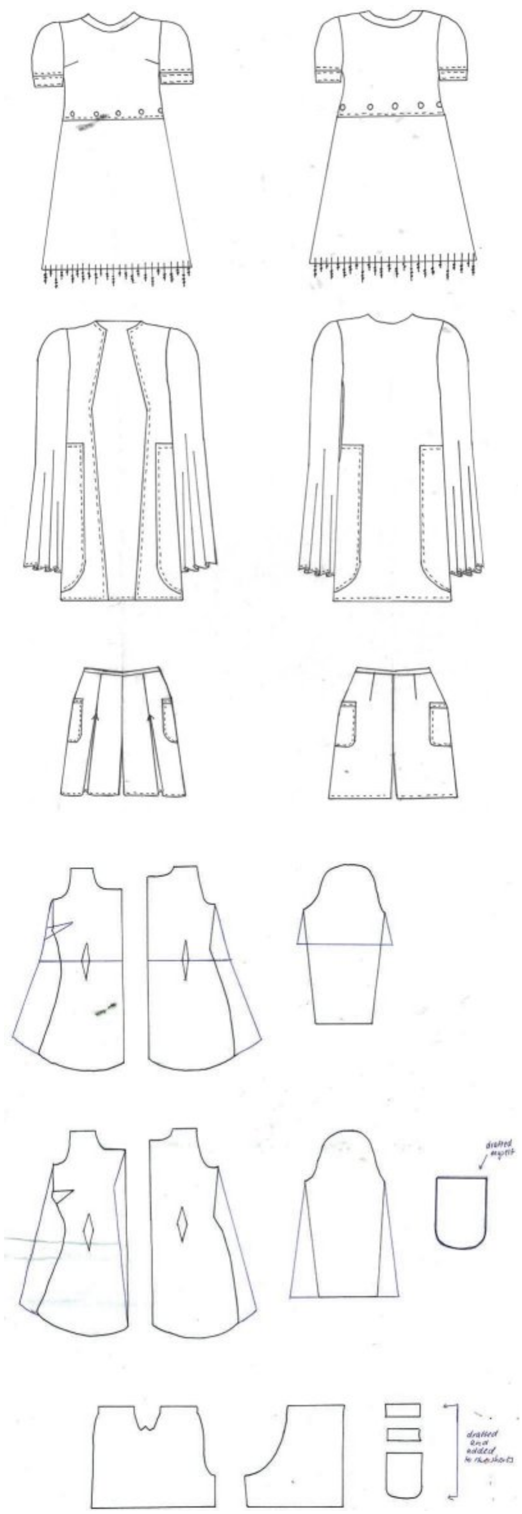

Figure 7.49 Working drawings and pattern drafting by student Katarina Kristo

Figure 7.50 Working drawings and pattern modification by student Madeleine Rosenbrock

TIP

Selecting a pattern is an important step in the production process, as an unsuitable pattern can take up more time.

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7.9 Tools, equipment, machinery, facilities and other factors that influence productivity

It is important to discuss with your teacher your school's resistant materials workshop or non-resistant materials classroom and what tools, equipment and machinery are available according to the production process you will need to work through to complete your product/s.

The more knowledge you have on what is available for you to use, the better you can plan your production steps and develop a risk assessment.

If you need to outsource a production step or process (for example, use of a restricted plant), this needs to be documented.

Chapter 2 (pages 48–53) provides information on a range of tools, equipment and machinery available in most schools.

Resistant materials

Ask your teacher to demonstrate how to use any tools, equipment and machinery you have not used before or are not confident using. Practise production processes on scrap material first to make sure you are familiar and confident with the technique you need to carry out. This approach will mean each step in the production of your product will be done with accuracy and support the development of a quality product. If you rush a process or don't attempt a step with care, this might result in a product that doesn't fully meet the end-user/s' needs and wants. For example, if measurements are not correct from the start, once you finish the product it may not function properly.

Refer to Chapter 2 (pages 51–2) for common tools, equipment and machines used in a workshop to help with the development of a scheduled production plan.

Research

~ TOOLS AND MACHINERY ~

TOOL/MACHINERY:	IMAGE:	USE:
Tenon Saw		The Tenon Saw will be used to cut the pine into required lengths
Jig Saw		The Jig Saw will be used to cut excessive lengths of pine, and may also be used to cut ordinary shapes.
Scroll Saw		The Scroll Saw will be used to cut out lengths of pine. The Scroll Saw is a lot more accurate than the Tenon Saw and Jig Saw, however only small pieces can be cut.
Chisel		The Chisel, alongside the Mallet, can be used to chip out or engrave parts of timber, usually to create joints or designs.
Hammer		Hammer will be used to 'hit' nails into the timber.
Bench Hook		The Bench Hook will allow safe use of the Tenon saw, by securely holding down the piece of wood, it will allow accurate yet safe cutting.
Clamps		Clamps can be used to securely hold glued pieces together, and can also be used to hold down pieces onto the table to refrain them from continuous movement.
Mallet		Mallet will be used to hit the chisel. Its large hitting area, allows a safe yet effective strike.

Figure 7.51 Tools, equipment and machine research by student Dylan Vella.

(Continued)

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Sanding Machine		Sanding Machine will allow me to smooth surfaces and edges of my timber, which will give the final product a great appearance.
Screw Driver		Screw Driver is a manual procedure to turn screws.
Drill		Drill, alongside several types of Drill bits can be used to tighten screws very effectively. They could also be used to drill holes, and pilot holes.
PPE:	IMAGE:	USE:
Working Apron		A working apron will ensure no substances drop onto my clothing, while holding them back to ensure no pieces of clothing get caught into machinery.
Safety Goggles		Safety Goggles prevent substances from entering your eye.
Ear Muffs		Ear Muffs protect the ears from excessive amount of noise.

Figure 7.51 Tools, equipment and machine research by student Dylan Vella. *(continued from previous page)*

- **Complete the weekly production record Activity 7.12 on page 168 of the workbook.**

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7.10 Role and components of production planning

Units 3–4 build on your existing scheduled production planning skills from Units 1–2, but require more detail from you. You must also indicate in your production planning if steps are being completed by someone other than you (such as use of a restricted plant). This also helps when planning for machines that may often be needed by other students at similar times. Your scheduled work plan has multiple components to help you produce your preferred design option.

For more information on how to generate your timeline, see Chapter 1 (pages 38–9).

Production steps, including materials, tools, equipment and machines

Your production steps are your guide during production of the preferred option, and should be frequently referred to. As well as a sequential description of the steps required, you also need to list the materials, tools, equipment and machines needed at each step, as part of your scheduled production plan. You can refer to your research undertaken on tools, equipment and machines to do this.

Tables 7.26 and 7.27 show three stages in production plan steps for a non-resistant materials and resistant materials product.

Non-resistant/textiles example – production steps				
Step	**Description of step**	**Timeline**	**Materials, tools, equipment and machines needed**	**Time estimated to complete step**
1	Modify dress pattern to reflect the preferred option, including adding pockets and design lines.	Week 1	Burda dress pattern Measuring tape Paper scissors Ruler Greylead pencil	3 hours
2	Iron calico and cut out the modified pieces for a toile.	Week 2	Fabric scissors Modified dress pattern Calico Iron and ironing board Pins and pincushion Measuring tape	1 hour
3	Toile the dress pattern, sewing the pieces with a sewing machine.	Week 2	Calico Sewing machine (including thread, bobbin and bobbin case) Thread clippers Pins and pincushion	3 hours

Table 7.26 Example of production steps for non-resistant materials

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Production steps for a flat-pack stool with detachable travel bag – resistant materials				
Step	**Description of step**	**Timeline**	**Materials, tools, equipment and machines needed**	**Time estimated to complete step**
1	Mark out cardboard template onto cedar.	Week 1	Card template Pencil Steel ruler Measuring tape Cedar	30 minutes
2	Saw out wood pieces.	Week 1	Cedar Coping saw Jig saw	1 hour
3	File and sandpaper timber edges.	Week 2	Flat file Half round file 80 grade sandpaper	2 hours

Table 7.27 Example of production steps for resistant materials

Production steps						
Stage or step no.	**Detailed description of stage or step in production/realisation**	**Resources and equipment needed**	**Safety measure**	**Quality checks**	**Approx. time required**	**Actual time required and reason**
1.	The first step is to remove unwanted bark and rotten outside areas using a chisel and hammer.	Chisel Hamer	Gloves Safety Glasses	Make sure the removal of bark doesn't damage the log	3 days	
2.	Then a jack hammer was used to easily remove the rotten sections of the wood.	Jack hammer	Gloves Safety glasses Ear muffs Metal capped shoes	Make sure the removal of the bark doesn't damage the log	10 minutes	
3.	Once that is done, the wood is to be moved (wheel barrow) onto a work bench (correct lifting techniques are to be performed) and clamped, then have the appropriate measurements completed (this is to be done having two even metal posts beside it). This equated to approx. 10cm. The timber off the cuts will be used to keep the wood in place so that the wood doesn't move one cutting it.	Clamps Metal posts Work bench Timber cut off	Using clamps to hold the items in place. Gloves	Make sure that the transportation of the wood doesn't damage it	20 minutes	
4.	The cutting is to begin, using a long saw (approx. 45cm) so that there is a relatively even cut through the wood.	Saw	Gloves	Make sure it's cut evenly	3 full days	

Figure 7.52 Part of a scheduled production plan (timeline is not included) by student Natalie Dubinsi *(Continued)*

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Production steps						
Stage or step no.	**Detailed description of stage or step in production/ realisation**	**Resources and equipment needed**	**Safety measure**	**Quality checks**	**Approx. time required**	**Actual time required and reason**
5.	Once the wood is cut, it will be sanded using a horizontal belt sander with a smoother grit just to get any residue or loose pieces.	Belt sander	Gloves Ear muffs Safety glasses	Use quality tools and good belt	30 minutes	
6.	Then the wood will be strongly secured like at the beginning when cutting the wood. Now to get rid of any large ridges and rough bark on the edges, a hand belt sander with a rough grit will be used.	Hand belt sander 80 grit sandpaper	Gloves Ear muffs Safety glasses	Use wood on either side so that the clamp doesn't damage the wood	1 hour	
7.	If the wood has a hole in the middle (most likely will) the hole will be filled with a plastic mould. This step will be out sourced. It will remain with a bit of a gap, so the rest can be filled with putty.	Plastic mould	N/A	N/A	N/A (approx. 1 day)	
8.	Once the wood is collected from the outsources place, the putty will be filled in, and when it has set it will be sanded for a smooth and even finish.	Putty Orbital sander	Latex gloves	Make sure the putty is evenly spread out and covers all areas	1 day	
9.	The next step is to remove the dust residue using a pad with methylated spirits to remove any dirt and grime as well as the dust.	Pad Methylated spirits	Gloves	Only do it lightly not to damage the wood in any way	20 minutes	
10.	The legs will have matte finish, so will be sprayed, and will have a couple of coats for a good finish.	Yellow spray paint Masking tape Newspaper Measuring tape	Dust mask Gloves Safety glasses Appropriate clothing (no spray paint on clothes)	Even coats with long dry time intervals to reduce uneven sprays	1–2 days	
11.	Next, the metal legs will be sprayed in the yellow section marked out. There will be a couple of coasts so that the legs have a nice finish and quality is at a high standard.	White spray paint Masking tape Newspaper Measuring tape	Dust mask Gloves Safety glasses Appropriate clothing (no spray paint on clothes)	The marked areas for spraying need to be done evenly and the rest of the stool needs to be covered	1–2 days	
12.	Once the spraying is complete, I will go back to the timber, and put a clear coat of high quality polish so that the wood grain can be nicely exposed, and protect the wood from any damage.	Floor polish (durable and protective)	Gloves	Evenly apply the clear coat so it has a nice finish and no air or clumpy sections	2–3 days	

Figure 7.52 Part of a scheduled production plan (timeline is not included) by student Natalie Dubinsi *(Continued)*

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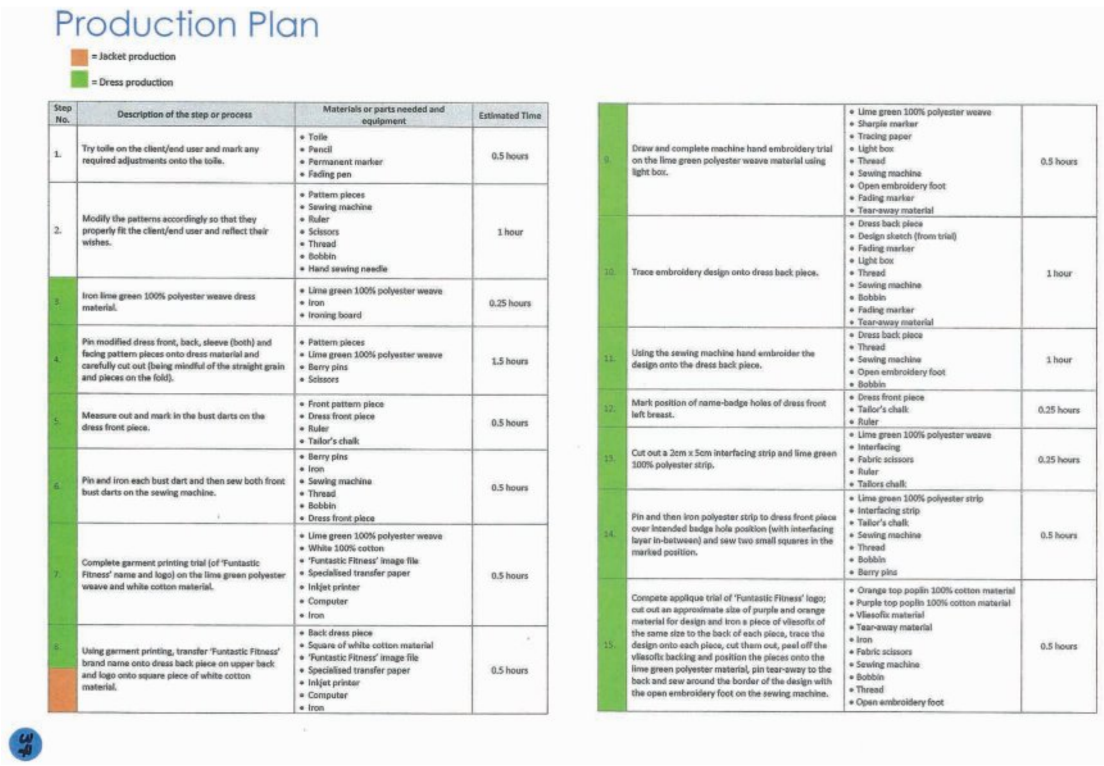
Production steps						
Stage or step no.	**Detailed description of stage or step in production/ realisation**	**Resources and equipment needed**	**Safety measure**	**Quality checks**	**Approx. time required**	**Actual time required and reason**
13.	A section of the side of the wood will be covered with masking tape, 2cm from the base as it will be painted in yellow. The paint will be matched as close as possible to the spray paint. (Spray paint won't be used for this task as there is a high risk of the paint going on the wood, so acrylic paint will be mixed in order to achieve a close colour to the spray paint.)	Yellow acrylic paint	N/A	Evenly mark out the wood with masking tape and find the correct shade of paint for the spray paint	30 minutes for taping, 1–2 hours for painting	
14.	Once, the paint has dried up, the stool will be screwed into the wood.		Gloves	Make sure correct screws are done so that its screw on properly	1–2 days	
15.	For extra support, brackets can be added for additional strength. These can be spray painted black or white.		Gloves Dust mask Safety glasses Appropriate clothing (no spray paint on clothes)	Ensure that it is done correctly and if spray painted it should be done well	1 day	

Figure 7.52 Part of a scheduled production plan (timeline is not included) by student Natalie Dubinsi *(continued from previous page)*



Production Plan

= Jacket production

= Dress production

Step No.	Description of the step or process	Materials or parts needed and equipment	Estimated Time
1.	Try toile on the client/end user and mark any required adjustments onto the toile.	• Toile • Pencil • Permanent marker • Fading pen	0.5 hours
2.	Modify the patterns accordingly so that they properly fit the client/end user and reflect their wishes.	• Pattern pieces • Sewing machine • Ruler • Scissors • Thread • Bobbin • Hand sewing needle	1 hour
3.	Iron lime green 100% polyester weave dress material.	• Lime green 100% polyester weave • Iron • Ironing board	0.25 hours
4.	Pin modified dress front, back, sleeve (both) and facing pattern pieces onto dress material and carefully cut out (being mindful of the straight grain and pieces on the fold).	• Pattern pieces • Lime green 100% polyester weave • Berry pins • Scissors	1.5 hours
5.	Measure out and mark in the bust darts on the dress front piece.	• Front pattern piece • Dress front piece • Ruler • Tailor's chalk	0.5 hours
6.	Pin and iron each bust dart and then sew both front bust darts on the sewing machine.	• Berry pins • Iron • Sewing machine • Thread • Bobbin • Dress front piece	0.5 hours
7.	Complete garment printing trial (of 'Funtastic Fitness' name and logo) on the lime green polyester weave and white cotton material.	• Lime green 100% polyester weave • White 100% cotton • 'Funtastic Fitness' image file • Specialised transfer paper • Inkjet printer • Computer • Iron	0.5 hours
8.	Using garment printing, transfer 'Funtastic Fitness' brand name onto dress back piece on upper back and logo onto square piece of white cotton material.	• Back dress piece • Square of white cotton material • 'Funtastic Fitness' image file • Specialised transfer paper • Inkjet printer • Computer • Iron	0.5 hours
9.	Draw and complete machine hand embroidery trial on the lime green polyester weave material using light box.	• Lime green 100% polyester weave • Sharpie marker • Tracing paper • Light box • Thread • Sewing machine • Open embroidery foot • Fading marker • Tear-away material	0.5 hours
10.	Trace embroidery design onto dress back piece.	• Dress back piece • Design sketch (from trial) • Fading marker • Light box • Thread • Sewing machine • Bobbin • Fading marker • Tear-away material	1 hour
11.	Using the sewing machine hand embroider the design onto the dress back piece.	• Dress back piece • Thread • Sewing machine • Open embroidery foot • Bobbin	1 hour
12.	Mark position of name-badge holes of dress front left breast.	• Dress front piece • Tailor's chalk • Ruler	0.25 hours
13.	Cut out a 2cm x 5cm interfacing strip and lime green 100% polyester strip.	• Lime green 100% polyester weave • Interfacing • Fabric scissors • Ruler • Tailors chalk	0.25 hours
14.	Pin and then iron polyester strip to dress front piece over intended badge hole position (with interfacing layer in-between) and sew two small squares in the marked position.	• Lime green 100% polyester strip • Interfacing strip • Tailor's chalk • Sewing machine • Thread • Bobbin • Berry pins	0.5 hours
15.	Compete applique trial of 'Funtastic Fitness' logo; cut out an approximate size of purple and orange material for design and iron a piece of vliesofix of the same size to the back of each piece, trace the design onto each piece, cut them out, peel off the vliesofix backing and position the pieces onto the lime green polyester material, pin tear-away to the back and sew around the border of the design with the open embroidery foot on the sewing machine.	• Orange top poplin 100% cotton material • Purple top poplin 100% cotton material • Vliesofix material • Tear-away material • Iron • Fabric scissors • Sewing machine • Bobbin • Thread • Open embroidery foot	0.5 hours

Figure 7.53 Part of a scheduled production plan (timeline is not included) by student Madeleine Hosemans

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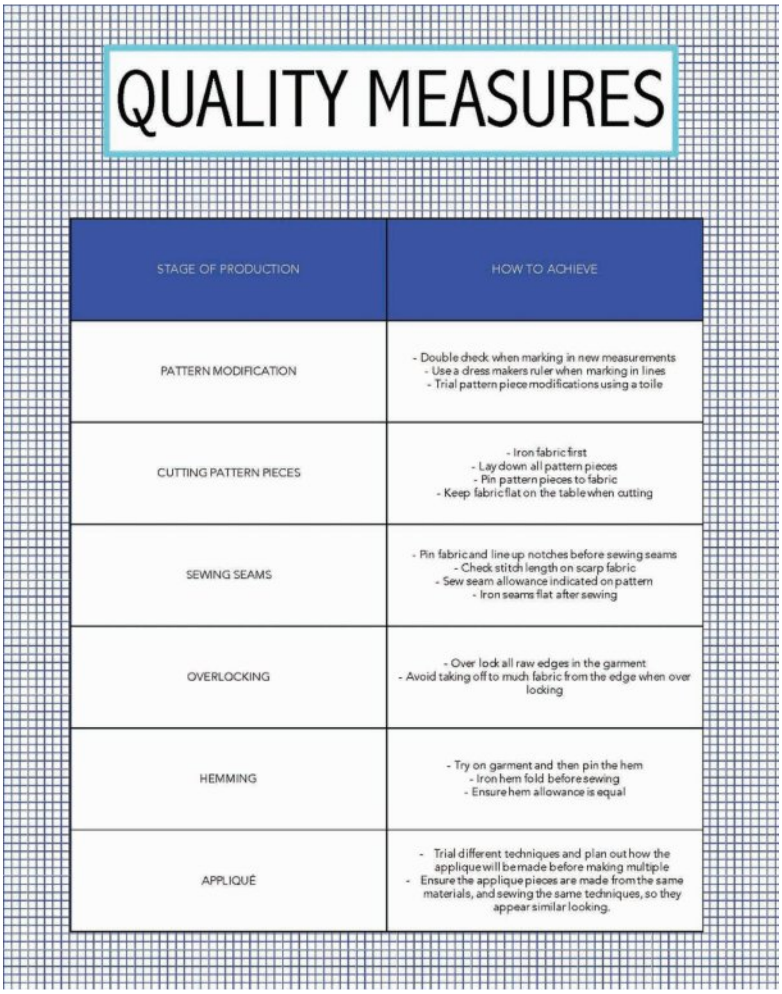
ACTIVITY 7.9

Writing a scheduled production plan

1 List all the steps required to produce your preferred option, in sequential order. (For textiles, your pattern can provide assistance.)
2 Put this information into a table (see examples in Figures 7.52 and 7.53).
3 List all the materials, tools, equipment and machines needed at each step to complete it, and add this to your table.
4 Take a guess as to how much time each step would take, and add this to your table.
5 Highlight any processes not completed by yourself in this table.
6 Copy this table, and create new columns, mapping out the weeks till your SAT is due on the first row of your table.

Quality measures

Quality measures are ways of ensuring the quality of a product during its production. During the planning and production stages of



QUALITY MEASURES

STAGE OF PRODUCTION	HOW TO ACHIEVE
PATTERN MODIFICATION	- Double check when marking in new measurements - Use a dress makers ruler when marking in lines - Trial pattern piece modifications using a toile
CUTTING PATTERN PIECES	- Iron fabric first - Lay down all pattern pieces - Pin pattern pieces to fabric - Keep fabric flat on the table when cutting
SEWING SEAMS	- Pin fabric and line up notches before sewing seams - Check stitch length on scarp fabric - Sew seam allowance indicated on pattern - Iron seams flat after sewing
OVERLOCKING	- Over lock all raw edges in the garment - Avoid taking off to much fabric from the edge when over locking
HEMMING	- Try on garment and then pin the hem - Iron hem fold before sewing - Ensure hem allowance is equal
APPLIQUÉ	- Trial different techniques and plan out how the applique will be made before making multiple - Ensure the applique pieces are made from the same materials, and sewing the same techniques, so they appear similar looking.

Figure 7.54 Quality measures by student Madeleine Rosenbrock

Process	Quality expected	How to ensure this
Marking out	All components fit perfectly	Correct measurements Rechecking Peer or supervisor rechecking
Cutting	Clean straight cuts	Mark out sections to indicate where to cut Request specialist if needed
Accuracy	Perfect fitting and joints Precise cuts Symmetrical – balanced	Detail measurements Markings before any drilling or cuts Clean materials Sanded edges
Surface quality	Smooth and polished surface Clean No dints, bends, cracks or broken parts	Sand all surfaces as required A gloss or polish agent cover Careful and cautious when working with the materials Source durable and good quality materials
Joints	Sturdy and intact Stabilised	Unable to pull apart – permanent fixtures Holds everything together – testing, weight

Figure 7.55 Quality measures by student Tina Tran

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Units 1–4, you must suggest quality measures you are going to apply in your scheduled production plan, and when producing the product you must action them. This must reflect the quality you have specified earlier in your design brief. Chapter 1 (pages 42–4) outlines some steps to ensure quality products for both resistant and non-resistant materials.

Complete the quality measures Activity 7.13 on page 169 of the workbook.

A risk assessment

Risk assessment is vital in all units of Product Design and Technology, to ensure safe production and use of design options. Risk assessment should take the following four steps:

1. Identify the hazards.
2. Assess the risks.
3. Control the hazards and the risks.
4. Check the controls.

See Chapter 1 (pages 40–2) for more details on how to complete a risk assessment for resistant and non-resistant materials and refer to the workbook for a risk-assessment template.

For a risk assessment template, for your SAT, refer to page 65 of the workbook.

TIPS

To ensure that you complete a thorough risk assessment for resistant materials, make sure you know the tools, equipment and machines available in your school's workshop.

Speak to your teacher about anything you are not familiar with and any potential risks.

Remember, your risk assessment should provide an outline of anything you do in the workshop that involves risk.

Your risk assessment should:

- identify hazards and injuries that could potentially occur
- analyse the likelihood of possible injuries and level of each injury, whether it is high, medium or low
- show you have considered and implemented the best way to control, minimise or remove the risks you have identified.

A materials and costing list with fittings and fastenings as required

Units 3–4 require you to list and cost the materials to create your preferred option as part of your planning. Give a detailed description of the item (for example, textiles – fibre and construction of fabric; wood – thickness, length and type of wood), including how much you will need as well as the consumables required to construct your product (for example, glues, thread).

Example of a materials and costing list for non-resistant materials

High-collared dress			
Item description	**Cost per metre/item**	**Quantity required**	**Total cost**
Cavalier gabardine polycotton weave	$11.89	0.8 metre	$9.51
Cotton velveteen, black cotton	$11.89	0.5 metre	$5.94

Table 7.28 Materials and costing list for non-resistant materials – a dress

(Continued)

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High-collared dress			
Item description	**Cost per metre/item**	**Quantity required**	**Total cost**
Polyester chiffon, black	$4.89	0.75 metre	$3.67
Cotton sateen, black	$16.99	0.5 metre	$8.49
40 cm invisible zip	$4.99	1	$4.99
Synthetic fusible webbing	$2.99	0.5 metre	$1.49
Button	$3.49	1 button	$3.49
Gütermann thread, black	$6.99	1 spool	$6.99
Simplicity pattern	$14.99	1	$14.99
		Grand total	$59.56

Table 7.28 Materials and costing list for non-resistant materials – a dress *(continued from previous page)*

Example of a materials and costing list for resistant materials

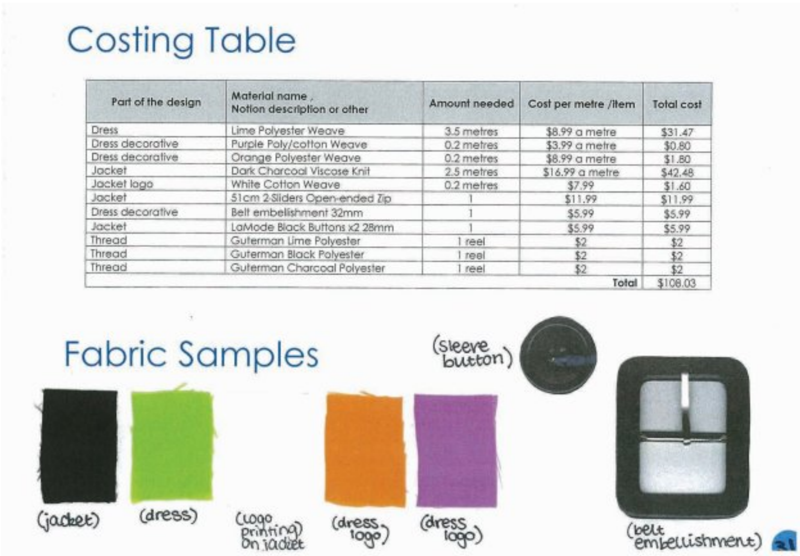
Redeveloped Parsons table			
Item description (length × width × thickness)	**Cost per metre/item**	**Quantity required**	**Total cost**
Plywood tabletop 800 mm × 800 mm × 12 mm	$25.00 per sheet	1 sheet	$ 25.00
Pine legs 850 mm × 60 mm × 60 mm	$12.50 per metre	4 metres	$ 50.00
Marine plywood sheet 2400 mm × 1200 mm × 12 mm	$38.00 per sheet	1 sheet	$ 38.00
		Grand total	$113.00

Table 7.29 Materials and costing list for resistant materials – a Parsons table

ACTIVITY 7.10

Writing a materials and costing list

1. Write a list of all the materials you will need to create your preferred option. Be specific, detailed and include things you may not pay for, such as school-supplied materials.
2. Generate a table in Microsoft Excel like the one in Figure 7.57.
3. Insert your list of materials, estimated quantities and costs, calculating the cost of your preferred option.
4. Update this table with your final costs before submitting your folio for assessment.


Costing Table

Part of the design	Material name , Notion description or other	Amount needed	Cost per metre /item	Total cost
Dress	Lime Polyester Weave	3.5 metres	$8.99 a metre	$31.47
Dress decorative	Purple Poly/cotton Weave	0.2 metres	$3.99 a metre	$0.80
Dress decorative	Orange Polyester Weave	0.2 metres	$8.99 a metre	$1.80
Jacket	Dark Charcoal Viscose Knit	2.5 metres	$16.99 a metre	$42.48
Jacket logo	White Cotton Weave	0.2 metres	$7.99	$1.60
Jacket	51cm 2-Sliders Open-ended Zip	1	$11.99	$11.99
Dress decorative	Belt embellishment 32mm	1	$5.99	$5.99
Jacket	LaMode Black Buttons x2 28mm	1	$5.99	$5.99
Thread	Guterman Lime Polyester	1 reel	$2	$2
Thread	Guterman Black Polyester	1 reel	$2	$2
Thread	Guterman Charcoal Polyester	1 reel	$2	$2
			Total	$108.03

Figure 7.56 Materials and costing list by student Madeleine Hosemans

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Complete your materials and costing list using the template on page 64 of the workbook.

Material	Accessibility	Cost
Timber – wood	Online orders – stores Bunnings Recycled timber junkyards	Approx. range $10 – $23 each slab-piece Depends on the measurements
Aluminium	Online orders – stores Bunnings Local suppliers	Approx. range $6 – $33 Depends on dimensions and quality of the material – properties
Fabric	Textile stores – Spotlight Online order Local supply stores	Approx. range $7 – $20 per metre Depends on the pricing set by the shop
Fibreglass	Online order Manufacturers Metal retailers Recycled/scape shops	Approx. range $5 – $30 Depends on the size and quality
Steel – Flat bar	Online metal stores Recycled metal yards Furniture manufacturing market Junkyards	Approx. range $10 – $20 each Depends on the dimensions and quality – options
Memory foam	Online – Clark Rubber Fabric shops Scrap yards – fabrics	Approx. range $15 – $25 each Depends on size and height
	Total approx. cost	$53 – $151

Figure 7.57 Materials and costing list by student Tina Tran

7.11 Techniques used to record progress and reasons for modifications to the design, planning and production plans

Production of your preferred option should start towards the end of Unit 3. Recording your progress is a vital piece of your assessment in the SAT, and can be completed in the form of a production record. Any changes to your design option, working drawings or production planning must be noted in your production record. See Chapter 9 (pages 279–81) for more details on how to complete this.

Refer to the production record template on page 110 of the workbook.

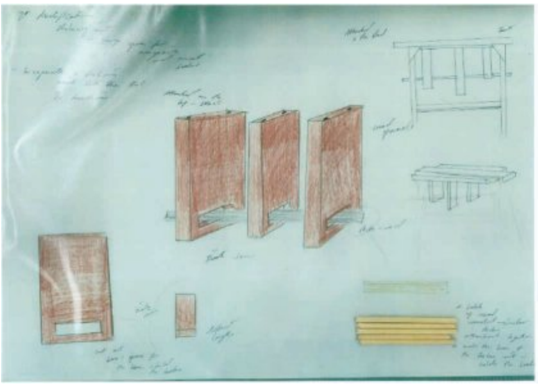

Figure 7.58 Example of modifications made to the product and recorded by student Tina Tran

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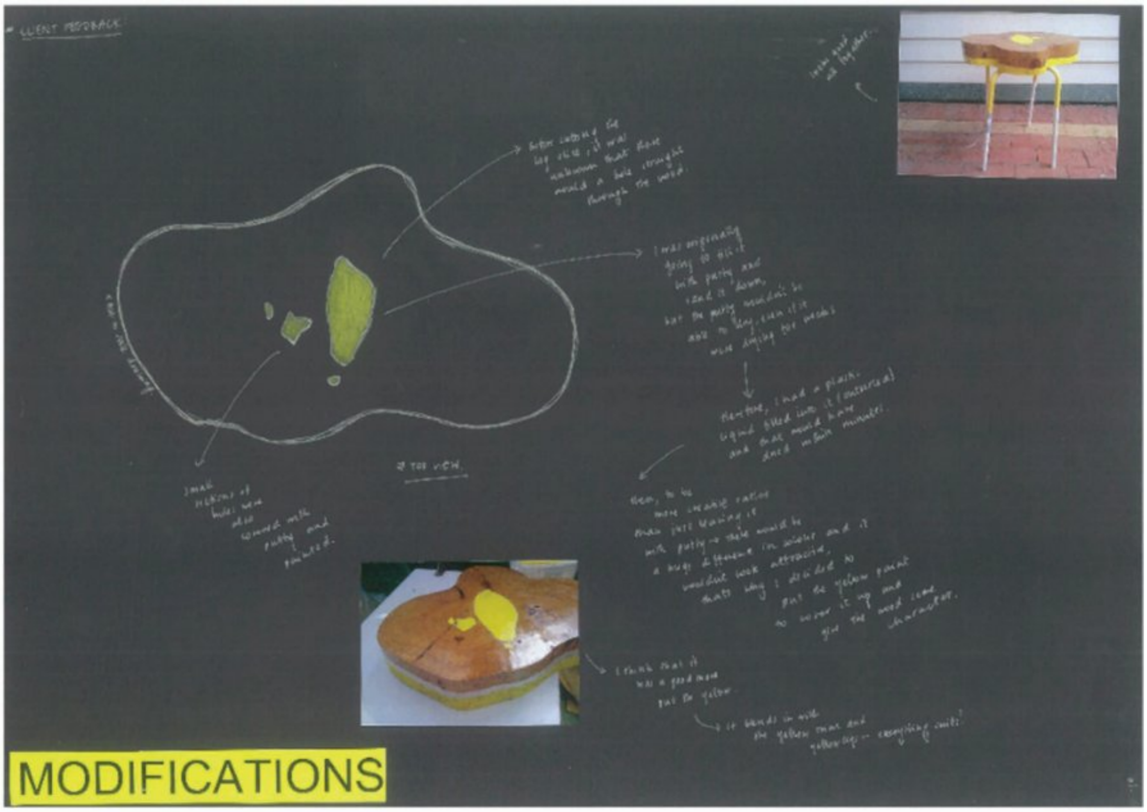

Figure 7.59 Example of modifications made to the product and recorded by student Natalie Dubinski

7.12 Methods of manufacturing in a mass/high-volume production or low-volume setting

In industry, in both low-volume and mass-production settings, often more complex and efficient machinery, equipment and processes are used to produce products of commercial quality. You are required to research how your design options could be produced in a commercial setting. Tables 7.30 and 7.31 show some methods of manufacturing commercial products for non-resistant materials and resistant materials. Some of the terms may be unfamiliar to you and should be investigated. It is also recommended that you analyse existing commercial products similar to the one/s you are making, and research how they may have been manufactured.

DID YOU KNOW?

On-demand manufacturing options are increasing in popularity. It may cost a little more, but many consumers are now able to print books on demand and customise shoes, shirt designs and a large variety of 3D-printed objects.

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Figure 7.60 In 2000, 14 000 Olympic torches were produced in a low-volume setting for the Sydney Olympics.

Mass/high-volume production or low-volume setting

Low-volume setting	Mass/high-volume production setting
Low-volume production happens when a low number of a product are manufactured for a specific situation, such as torches made for the Olympic Games. For the Sydney Olympic Games in 2000, 14 000 torches were produced.	A car is a good example of a product that is mass-produced. The initial cost to set up a factory/production line is high. It is an inflexible manufacturing environment for this reason. Because a product such as a car is produced in mass, the time taken to manufacture it is lessened and the cost is lowered.

Table 7.30 Manufacturing systems

ACTIVITY 7.11

Investigating methods of manufacturing

1. Find an already existing commercial product similar to the one you are manufacturing (perhaps at home).
2. List five similar production processes to your design and the existing product. For non-resistant materials, these processes might include seams, hems and prints. For resistant materials, they might include biscuit joints and routed edges.
3. Note the quality and finish of these processes on the commercial products.
4. Research how these five processes may have been completed in industry, using

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Tables 7.30 and 7.31, internet searches and advice from your teacher.

5 Trial these production processes in the classroom with the resources available to you before producing your final product/s.

Complete the research activity on manufacturing methods on page 170 of the workbook, Activity 7.14.

Manufacturing methods – non-resistant materials/textiles		
	Some methods of production in the textiles classroom	**Some low-volume and mass/high-volume production methods in industry**
Working drawings	• Hand-drawn working drawings	• Generating technical drawings using Adobe Illustrator to send offshore
Pattern drafting	• Modification of commercial patterns and pattern blocks	• Use of pattern blocks • Using CAD/CAM systems such as Lectra and Gerber to generate patterns
Fitting and prototypes/ toiles	• Creating a calico toile to assess fit and design • Custom fitting a garment to a specific end-user	• Generating production samples offshore, and testing them on a fit model • Generating and grading a set of standard size garments for sale (for example, sizes 6–14)
Cutting out fabric	• Using fabric scissors, patterns and pins to cut out fabric by hand, one garment at a time	• Cutting out many layers of multiple sizes of a garment at once • Using a jig-saw • Use of computer-aided manufacturing (CAM) software, and markers to lay out patterns, including matching patterns and working with a nap • Use of CAM, spreading and CNC cutting machines to cut multiple layers of fabric • Laser-cutting multiple layers of fabric
Pattern markings	• Using tailor's tacks, chalk, tracing wheels and so on for darts and internal pattern markings	• CAM marking methods • Use of drill holes to make internal pattern markings, such as darts or pocket placement
Ironing	• Use of a household iron and ironing board	• Industrial steam irons, ironing presses, rollers • Vacuum and blowing boards • Steamers

(Continued)

Table 7.31 Non-resistant manufacturing methods

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Manufacturing methods – non-resistant materials/textiles		
	Some methods of production in the textiles classroom	**Some low-volume and mass/high-volume production methods in industry**
Construction	• Use of mostly domestic sewing machines and overlockers • Hand sewing • One person making all of the product	• Industrial sewing machines specific to the task, such as a straight sewer, cover stitcher, buttonhole machine, bar tack machine, zigzag machine • Single component of a garment completed by one person (for example, one staff member purely sewing shirt collars, another cuffs)
Print and finish	• Hand printing and one-off surface decoration techniques • Hand embroidery techniques	• Screen printing for placement prints • Yardage prints for repeated designs • Digital printing • CAD programmed machine embroidery

Table 7.31 Non-resistant manufacturing methods *(continued from previous page)*

Manufacturing methods – resistant materials Jewellery – pewter cast pendant		
	A method of production in the resistant materials classroom	**Mass/high-volume production method in industry**
Design and development	• Sketching of ideas and development of best idea into a final idea	• Use of computer-aided design (CAD) to create a 3D drawing
Working drawing	• Hand-drawn working drawing	• Generating 'technical style' drawings using CAD
Prototype	• A prototype is made using soft material like clay, which is cast in plaster. • Once the plaster is set, the clay is removed from the mould.	• A computer-aided manufacture (CAM) 3D printer produces a (wax/resin) model of the pendant. • The model is covered in plaster, which forms a mould for casting.
Manufacturing	• Pewter is melted and poured into the plaster mould to produce the pendant.	• An oven heats the plaster mould, burning out the (wax/resin) model. The empty plaster mould is then filled with molten metal to produce a pendant.

Table 7.32 Resistant manufacturing methods

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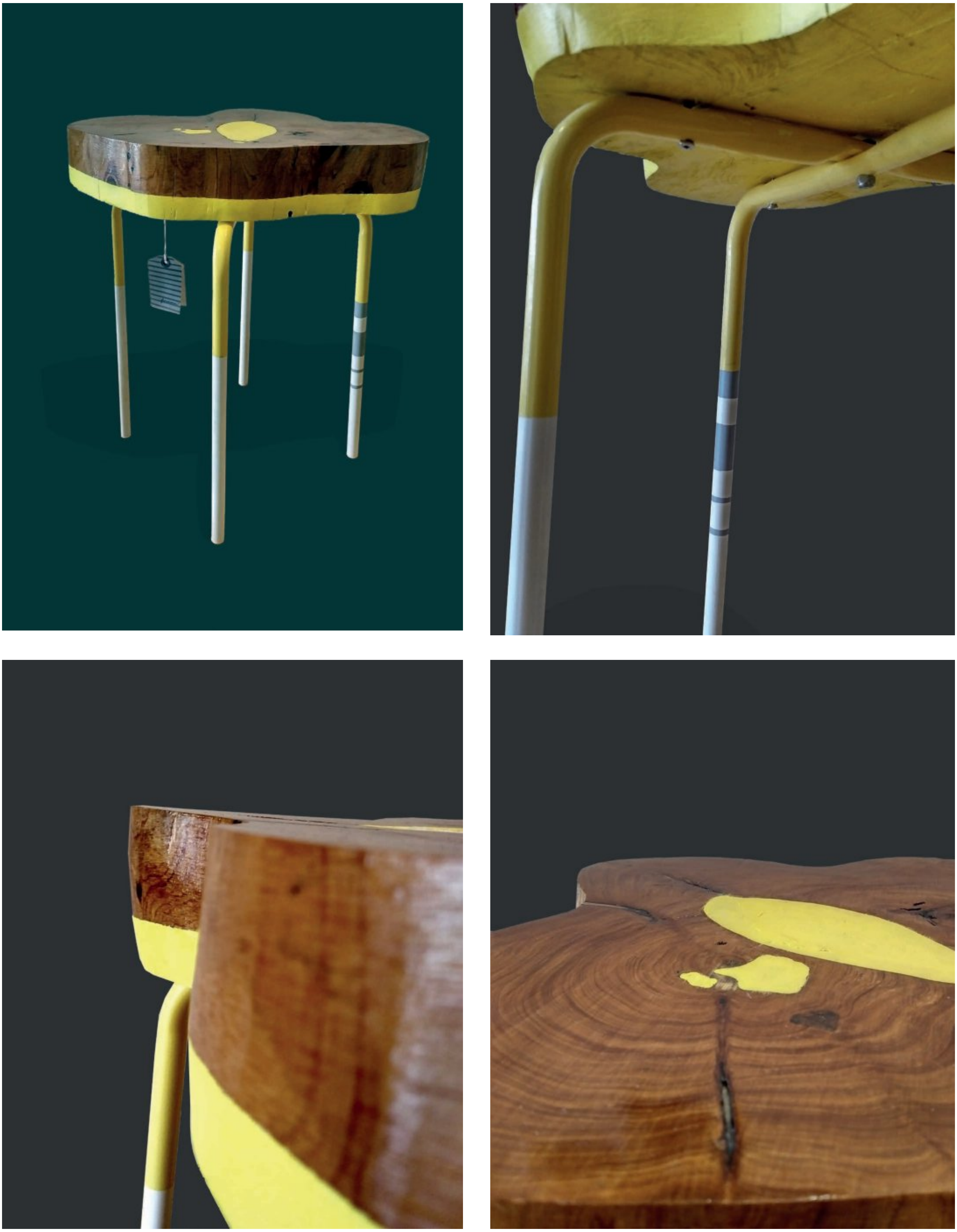

Figure 7.61 Views of a final product by student Natalie Dubinski

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Chapter summary

- The steps in each of the stages of the product design process will form the basis of your SAT in Units 3–4.
- Research will help define the needs of your end-user/s and this information can be presented in a number of ways.
- Your design brief should make reference to your design problem and the product design factors.
- Each evaluation criterion is written to help decide on the preferred option and evaluate the end product/s.
- Research into materials, their properties and processes is necessary to inform the product design process.
- A variety of creative and critical design thinking techniques can be used to communicate ideas to end-user/s.
- Visualisations, design options and working drawings all have different roles in the product design process.
- Working drawings should be appropriate for the material you are working in, and help in the construction of your end product/s.
- The proper use of tools, equipment, machinery and working environments available to you will influence your efficiency.
- The scheduled production plan has many components, including a timeline, production steps, materials, tools, machines and equipment used, estimate of time, risk assessment and a materials and costing list.
- Methods of manufacturing your design option vary from classroom to commercial settings.

Short-answer questions

1 Discuss why end-user/s' feedback is important when deciding on the preferred option.
2 Recall and list the four part evaluation criterion.
3 List three research tasks you could complete to help generate visualisations.
4 List one machine you will use during production, and its purpose.
5 List three quality measures you will undertake during production.

Extended-response questions

1 Explain the difference between visualisations, design options and working drawings.
2 List two process trials you could complete in your research, and the tools, equipment, materials and machinery needed to complete them.

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Unit 4
Product development and evaluation

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Figure 8.1 There are many factors that influence deciding between similar products.

8

Area of Study 1: Product analysis and comparison

INTRODUCTION

This area of study requires you to analyse, compare and evaluate similar products, taking into account a range of factors and using appropriate techniques.

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KEY KNOWLEDGE

- qualitative and quantitative methods of evaluating similar commercial products, including user trials
- environmental, economic and social issues associated with products that may be of concern and consequence to potential purchasers and end-user/s
- how designers, manufacturers, end-user/s and owners prioritise and place value on product attributes and how these values vary over the life cycle of a product
- key factors and aspects that determine the quality of a product.

KEY SKILLS

- explain how attributes of products are prioritised
- compare and evaluate the attributes of similar commercial products
- analyse the sustainability of selected similar commercial products
- evaluate the quality of a commercial product compared to other similar products.

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8.1 Qualitative and quantitative methods of evaluating products, including user trials

Why we compare and analyse products

Before you purchase a product, do you ever:

- read reviews online?
- seek expert opinions?
- compare similar products?
- discuss the product with friends or family?

This comparison and analysis of similar products is a necessary step that all consumers take before making a purchase, both informally and with the use of data and reviews. Modern technology, websites, apps and social media allow us to formalise this process, as well as provide our own opinions on products to a wider audience.

Comparing products allows us to ascertain which one will best meet our needs, within our budget. Data, both qualitative and quantitative, helps inform this decision-making process.

Figure 8.2 Quantitative data helps to inform this decision-making process.

Quantitative and qualitative research

In Chapter 3, you were introduced to the use of quantitative and qualitative research to determine how successful others think your product or prototype is. You can again apply this research method.

Quantitative data is demonstrated in numbers (pie charts, sales data and so on); for example, '70% of customers purchased the white sedan'.

Qualitative data is more subjective and cannot be expressed in numbers, instead needing a quality response; for example, 'Customers felt the red car made them drive faster'.

User trials

User trials involve getting typical users to try out the product, testing out the functions, and to give their opinions to both potential users and to companies to use as market research in the product development process.

Many third-party platforms now exist to share the data gathered in user trials completed separately from the manufacturer, to inform purchasers and to help them compare similar products and decide which one best meets their needs. Choice, which describes itself as the 'leading consumer advocacy group in Australia', reviews a variety of products with the same function and offers an 'unbiased' comparison. Criteria are set for comparison (for example, cost, size, materials, ease of use), and qualitative and quantitative data are provided in the reviews in its magazine and on its website.

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DID YOU KNOW?

Food blogs and apps are becoming a popular way for consumers to use qualitative and quantitative data to inform their eating choices. The blog 'Burgers of Melbourne' uses four key burger factors (bread, meat, display and flavour) to give a numerical (quantitative) rating for each burger the writer eats, as well as a written description (qualitative) of the burger.

Burgers of Melbourne

1090 Burger

97

Burger Order - The Macros

2 x Beef, 2 x cheese, fried chicken, grilled chorizo, mozzarella, 2 x Bacon wrapped jalapenos and shoestring fries, pickles, Mayo and catchup. $26

Burger Rating

Display:	★★★★★ (4.5 / 5)
Bread:	★★★★★ (4.25 / 5)
Meat:	★★★★★ (4.5 / 5)
Flavour:	★★★★★ (4.75 / 5)
Average:	★★★★★ (4.5 / 5)

1090 Burger used to be known just as a food truck in Northcote, but after a few years of trading the boys behind 1090 decided to set up shop on Swan Street in Richmond and this was the best move they could have made!

Now with the ability to use a proper commercial kitchen and the space to fully prep, 1090 Burger have secured a top 10 position on my ladder.

This burger came as a double, but for some dumb reason I decided to add 2 extra patties. You will see below why I ordered what I did, but 2 would be plenty and be much easier to eat.

The patties were soft and juicy, cooked to a medium with a hint of pink, the fried chicken inclusion was fried to perfection and the grilled chorizo, mozzarella and 2 x Bacon wrapped jalapeños were a stroke of genius.

This burger was only available as a special, but I am sure the guys will cook something up if you show them the picture from this page.

If you haven't had 1090 Burger yet, add them to your list and go there now!

Figure 8.3 Burger rating on a food blog

DID YOU KNOW?

The cricket ball has undergone redevelopment in recent years and user trials have been crucial in the development of the pink ball for day/night Test matches. Cricket Australia chief executive James Sutherland's dream to stage a pink-ball Test match under lights came true in November 2015 when skipper Steve Smith's side hosted New Zealand at Adelaide Oval. More than 123000 fans attended the match, which lasted just three days.

While Cricket Australia was pleased with crowd numbers and TV ratings, Smith led calls for further improvement to the ball's visibility level under lights. Batsmen complained that the green-and-white seam was hard to pick up and didn't contrast strongly enough with the pink ball.

Figure 8.4 The pink cricket ball manufactured by Kookaburra

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CASE STUDY

Cricket Australia implements user trials in matches

In late 2016, Australia hosted Test matches under lights against South Africa in Adelaide and against Pakistan in Brisbane. These two matches featured a pink ball with black stitching. The new pink ball with a black seam had been trialled in February 2016 in a round of four-day games in the Sheffield Shield interstate competition, before it was cleared for use at international level.

Cricket Australia had acted upon feedback from the players who overwhelmingly expressed concerns over the pink ball after the 2015 Test match in Adelaide. Cricket Australia worked with ball manufacturer Kookaburra to develop a 2016 version of the pink ball, with an altered shine and a black seam to provide greater visibility of the ball which is sent hurtling towards the batsman at speeds of up to 150 kilometres per hour. Test cricket is usually played in daytime conditions with a red ball that can be changed after 80 overs, each of six deliveries.

The red ball is regarded as too dark for night-time play, while the white ball used for limited overs internationals isn't durable enough to last 80 overs in a suitable condition.

While Test cricket is popular in Australia and England, other Test-playing nations struggle to attract big crowds to rival the popularity of one-day and Twenty20 games.

The day/night concept, which was also introduced in Dubai in October 2016 when Pakistan played the West Indies, is seen as a way to help Test cricket attract new fans.

No batsman was able to score a century in the Adelaide Test of 2015 and the highest innings total was only 224. However, a first-innings total of 383 in the Adelaide Test of 2016, including Usman Khawaja's 145, helped set up Australia's seven-wicket win over South Africa, and also helped make the sounds of batsmen's complaints about visibility issues fade.

Australia and Pakistan produced innings totals of over 400 in the pink-ball Test match in Brisbane in 2016, further advancing the cause of the concept.

Pakistan scored a remarkable 450 chasing 490 to win, which would have been a world record for the highest successful run chase if the touring team had achieved its target.

In an indication of the possible need for further fine-tuning of the pink ball, however, Smith said following the Brisbane Test that the ball was 'incredibly soft' after 60 overs and 'wasn't really doing much'.

It seems that the batsmen are happy but the fielding captain is not. However, it is clear that the pink ball is part of Test cricket's future, even if its design may continue to evolve.

Cricket Australia has announced that one of the five Ashes Test matches in 2017–18 against England will be a day/night match with a pink ball, to be staged in Adelaide in December 2017.

ACTIVITY 8.1

1 Find a product review on the Choice website and print it out. Highlight and annotate any:

- qualitative data
- quantitative data
- product design factors used in the review.

2 Using the product design factors, develop criteria to compare two products with the same function found in the classroom, to determine which one performs better (for example, sharpeners, erasers, pencil cases). Think of the needs of the person using the product; for example, visual, tactile and aesthetic needs of a teenage girl – 'How aesthetically pleasing and on trend is the pencil case?'

3 Answer your questions developed above using both a qualitative and a quantitative response.

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8.2 Environmental, economic and social issues associated with products that may be of concern and consequence to potential purchasers and users

Consumers continue to be concerned with the impacts their purchases may make on the environment, economy and society. The Rana Plaza tragedy of 2013 (see Chapter 1) highlighted the lack of social and economic sustainability in the fashion industry, and such horrible incidents emphasise the need for change, both for companies commissioning work and for consumers to use their purchasing power to be part of the solution. The three pillars of sustainability provide a structure to assist purchasers and users when considering the impact that a product may make in its lifetime. (See Chapter 1 for more issues relating to sustainability.)

Buyers' concerns and issues in relation to the three pillars of sustainability

Pillar	Buyer concerns	Issues
Environmental	• What were the environmental impacts of sourcing and producing this product? • What environmental impacts has this product being shipped to me made? What about its packaging? • What will happen to this product once I am finished with it? Can it be repurposed or will it end up in landfill? An LCA (see Chapter 1) provides good structure to analyse the environmental impacts of a product in its lifetime.	• Use of unsustainable resources, including deforestation, landfill, use of fossil fuels • The impact the product has on the environment during its lifetime • Materials used in the product and their environmental impact • Packaging used for the product and its environmental impact • The longevity of a product and the impact a product with a short lifespan may have on the environment
Economic	• Which economy will this purchase support? • Is the cost of this product sustainable? • Is this product a wise economic choice?	• Buying goods made offshore versus goods made in Australia, or buying from a large retailer versus a smaller designer • The cost of goods versus how much people who made them were paid
Social	• Were the people who made this product paid fairly? • Did the people who made this product have good working conditions? • Were animals treated humanely in the making of this product?	• Ethical considerations, such as country of origin and transparency in production, working conditions of people making the product • Animal ethics, including the use of leather

Table 8.1 Buyers' concerns and issues in relation to the three pillars of sustainability

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Sustainable labelling, transparency and apps – a way forward?

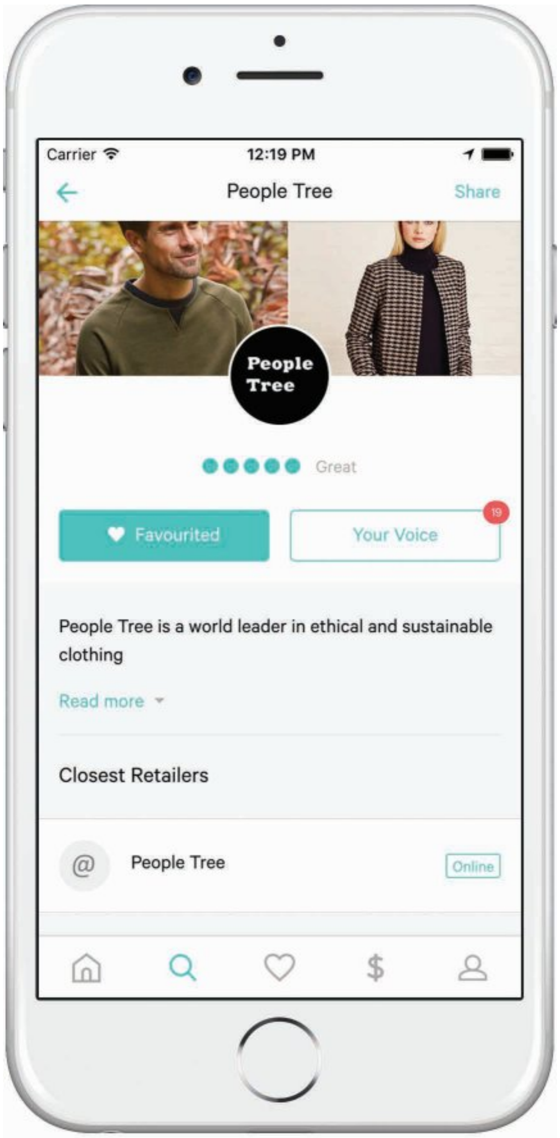

Figure 8.5 Australian smartphone application 'Good on You'

Consumers now have more tools and access to information when it comes to purchasing products and services. Egg labelling is a model of social sustainability, with the method of farming (cage, farm, free range and so on) clearly labelled on the carton, helping customers make decisions in line with their ethics.

Australian smartphone application Good On You, a social and environmental comparison platform, offers consumers quantitative and qualitative data on the ethical and environmental impacts of fashion labels, to assist in making sustainable purchases.

Also paving the way for consumer choice and transparency is Honest By designer Bruno Pieters, who lists the raw costs and manufacturers of every single component that goes into his garments.

What if the environmental impacts of a product during its lifetime, or the conditions or payment of the workers, were part of mandatory labelling? Is this something you could do as a designer?

ACTIVITY 8.2

Design a swing tag for a product that gives a rating system for sustainability, including qualitative and quantitative data. What would be your criteria? How would you judge them? Which issues in sustainability may be a concern for consumers?

Complete the judging a product's sustainability Activity 8.1 on page 172 of the workbook.

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8.3 How designers, manufacturers, users and owners prioritise and place value on product attributes and how these values vary over the life cycle of a product

What are product attributes?

Before you make a purchase of a product, you will already have thought about important aspects (attributes) that you want the product to have. Perhaps you have a school formal coming up and you want a dress that will suit a formal context, will be comfortable, made from a fabric like chiffon, embellished with trimming, preferably purple and an affordable price.

Designers, manufacturers, users and owners all think about a product in a similar way. However, the aspects or attributes that are important to them may vary.

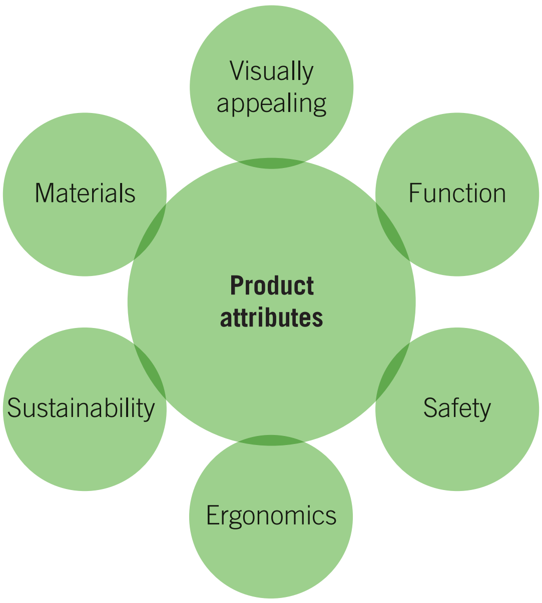

Figure 8.6 Product attributes

Designers have to meet the needs and wants of their end-user/s. They need to have an empathetic understanding of their end-user/s, the age or age group, cultural and religious beliefs, the primary and secondary functions of the product, what parts or components of the design will be of particular importance and draw on emotional and sensory appeal. Designers also need to know what is important to consumers at the time to ensure that among other similar products their product is desired and a success.

Designers need to use their skills effectively, they need to manage their time and costs involved and undertake primary and secondary research that is useful and will support the creative process, from the sketching of ideas, to anthropometric and ergonomic considerations, to the selection of materials and suitable production processes.

Designers need to consider the context or environment in which the product will be used, how its design (style) and function (technical) will be viewed over time (obsolescence), how they can push the boundaries of the product they are designing (innovation) and what will happen to it at the end of its life. Designers also need to be aware of their legal responsibility and intellectual property.

With every job, a designer might place importance on different attributes according to what the end-user/s' needs and wants are and according to the manufacturing processes that need to occur. Perhaps the end-user/s is particularly interested in an eco-friendly material, or perhaps the best result for a product will be achieved using laser technology.

Manufacturers rely on accurate working drawings/flats/trade sketches and technical drawings. Correct tools, equipment and machinery need to be selected for chosen materials. New technologies where appropriate might be preferred for quicker production time, making it more economical not only for the manufacturer but also for the end-user/s.

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Manufacturers also need to consider and provide working conditions that cater for the well-being of employees and are safe.

Efficiency in production methods and profit are of high importance to manufacturers. Like designers, with every job, manufacturers might place importance on different attributes, and these attributes may change over time. A new, similar product manufactured by another company will create competition in the marketplace, and a manufacturer will want to find innovative solutions to improve their product so that it leads the market over its competitor.

Users will place value on a product's attributes differently, depending on factors such as why they need it or what aspects of how it functions are important to them, their age, aesthetic tastes, and cultural and religious background. Users want a quality product that functions as it was intended, draws on emotional and sensory appeal and is good value for money. If a designer and manufacturer are able to meet these needs effectively, the product's position in the marketplace among similar products will strengthen over time and users will be more likely to purchase it. The product will become familiar and be considered a safe choice.

DID YOU KNOW?

There are companies known as 'patent trolls' that purchase patents (rights) of specific products, design aspects or features. They control many patents and use these to take other companies to court, or to demand payments for use of the owned patent, and do not actually produce products of their own.

What product attributes were important for designers, manufacturers and users of the Barcelona chair?

History

The Barcelona chair was designed by Bauhaus school architect Ludwig Mies van der Rohe and architect and designer Lilly Reich for the German Pavilion at the International Exposition of 1929. It is one of the most iconic and revered chairs of the twentieth century and was inspired by the Roman folding chair called the curule chair, which dates back to 1500 BC. The chair's frame was bolted together but in 1950 was redeveloped. The new frame was no longer bolted but was made from stainless steel. This gave the chair a sleeker, smoother quality because the new stainless steel frame was formed from a single piece of metal. The chair was originally covered in light-coloured pigskin. This was also replaced and bovine leather was used instead.

How might designers, manufacturers, users and owners prioritise and place value on a Barcelona chair (its attributes), and how would these values vary over the chair's life cycle? The product design factors cover a range of attributes, from a product's size to its colour and functionality. Using the product design factors is a way of determining what product attributes are important for the designers, manufacturers and users of a product.

Table 8.2 looks at what product attributes were important for designers, manufacturers and users of the Barcelona chair.

How values vary over the life cycle of a product

When a product is new to the market, users may value something that is new, innovative or up to date. However, when a product has been available for many years, users may expect that the product will be reliable and affordable.

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Product attributes and the Barcelona Chair

Product design factors	Product attributes
1 Purpose, function, and context	**Designers** – Mies van der Rohe and Reich • focused on a modern design that was innovative in its appearance, was comfortable and suited its context, a pavilion in Spain **Manufacturers** • produced a reliable sturdy chair that demonstrated quality through construction methods and finish **Users** • wanted a comfortable chair with a modern design aesthetic that appealed to their sophisticated tastes
2 User-centred design (human needs and wants)	**Designers** • considered the ergonomics and anthropometrics of the chair's design and its aesthetic appeal **Users** • wanted a chair that was not only comfortable but improved their well-being, recognised current trends and demonstrated economic status through its modern design
3 Innovation and creativity	**Designers** • valued applying design philosophies from the Bauhaus movement • a contemporary approach to design resulted in an innovative chair with an industrial influence **Manufacturers** • modification of the chair's frame came about through new technology; bolts were no longer needed and its chrome-plated construction was replaced with a complete moulded length of stainless steel, which made it easier to manufacture **Users** • interested in an innovative and new product • interested in an up-to-date product
4 Visual, tactile and aesthetic (design principles and elements)	**Designers** • emerged in the Bauhaus movement; their deep understanding of this design movement's aesthetics allowed them to develop a product that truly expressed their design ideals • contemporary with an industrial edge, the leather seat was durable with a high finish and the chair's stainless steel frame was shiny, with clean lines; all these aspects demonstrated balance, symmetry and beautiful refined proportions **Manufacturers** • used correct tools, equipment and machines to make a high-end chair that was sleek and sophisticated that expressed technical skill and quality **Users** • could enjoy the chair's comfortable design and modern aesthetic
5 Sustainability (social, economic and environmental systems perspectives)	**Designers** • socially, its sophisticated design would have appealed to end-user/s visiting the pavilion **Manufacturers** • used new technologies of the time in the frame's construction and choice of material for the seat cover **Users** • perhaps simply due to its timeless design and aesthetic appeal, the iconic Barcelona chair has become one that many people desire; the idea of it ending up in landfill would shock many lovers of modern design

Table 8.2 Product attributes that were important for designers, manufacturers and users of the Barcelona chair

(Continued)

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Product design factors	Product attributes
6 Economics – time and cost	**Designers** • the use of quality materials and production processes meant cost was not a concern **Manufacturers** • the chair is now mass-produced by many different manufacturers; it is affordable for the consumer to purchase and the manufacturer to produce
7 Legal responsibilities	**Designers and manufacturers** • would need to have been aware of intellectual property • Knoll Inc. registered the trademark for the Barcelona chair, which means that a company called Knoll Incorporated has the exclusive right to use the Barcelona name and the unique shape of the chair • manufacturers would need to produce a product that is safe to use
8 Materials – characteristics and properties	**Designers** • the look and feel of the materials would have been very important to the design of the Barcelona chair, which is all about clean lines and modern quality and shiny stainless steel and rich dark leather **Manufacturers** • want a durable material that is flexible, easy to work with and allows them to achieve a desired high-end result **Users** • want a comfortable seat fabric and a sturdy, well-manufactured chair made with quality materials that are durable and will last
9 Technologies – tools, processes, and manufacturing methods	**Designers** • are aware of the tools and technologies available to manufacture the product • its frame was formed from a single length of stainless steel, and leather replaced original pig skin **Manufacturers** • the chair was hand-built, allowing for quality production processes and an individualised craftsmanship **Users** • a chair constructed from appropriate technologies would be sturdy, durable and long-lasting

Table 8.2 Product attributes that were important for designers, manufacturers and users of the Barcelona chair *(continued from previous page)*

ACTIVITY 8.3

Referring to Table 8.2 and the product design factors, find two products with a similar function and establish what product attributes are of most value to a designer, a manufacturer and an end-user/s.

- **Complete Activity 8.2 on valued attributes of a product by a designer, manufacturer and end-user/s against the nine product design factors on page 174 of the workbook.**

- **Complete Activity 8.3 and compare two products with the same function on page 177 of the workbook.**

Figure 8.7 A reception area showing a floating steel staircase and Barcelona chairs.

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8.4 Key factors and aspects that determine the quality of a product

What is quality?

Quality is 'the standard of something as measured against other things of a similar kind; the degree of excellence of something' (*New Oxford American Dictionary*).

In Units 3 and 4, you have specified quality in your design brief, and written and applied quality measures while producing your preferred design option. Now let's use the product design factors to think about what makes a quality product, including:

- how well the product functions for its desired purpose
- the materials and construction methods used, which then influence the durability
- the aesthetics, which influence what consumers may consider to be a 'quality' product.

The nine product design factors and their influence on quality

Product design factor	Influence on quality
1 Purpose, function and context	How well the product performs the required function can improve the quality.
2 User-centred design	Successfully meeting the needs of the consumer, such as ergonomics, anthropometrics and comfort. For garments – the fit of the product will enhance the quality.
3 Innovation and creativity	The level of innovation and creativity within the product. Does the product use new innovative technology to be produced? Is the product unique and unlike others on the market?
4 Visual, tactile and aesthetic	The aesthetics and visual appearance in the design of the product. How does it look? Is it visually appealing? How does it feel?
5 Sustainability	The durability of the product impacts the longevity of the product, and this can have impacts on both economic and environmental sustainability.
6 Economics – time and cost	A high price does not necessarily mean that a product is of good quality. Customers may have a higher expectation of quality for a product that is a higher price. A larger scale of manufacturing also does not necessarily mean the product is automatically of a poorer quality.
7 Legal responsibilities	The product meeting legal and safety requirements, as well as the design not infringing on the intellectual property of others. Are they any certifications, laws or labels that show the quality of a product (for example, mandatory care labelling on textile goods, or the StandardsMark TM on products)?
8 Materials	The appropriate choice of materials. Are the materials used of good quality? How can you tell? Do the materials help make the product durable?
9 Technologies – tools, processes and manufacturing methods	The methods and technology used to construct the product durably impact the quality of the product; for example, the stitch used in constructing a garment.

Table 8.3 Product design factors and influence on quality

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DID YOU KNOW?

Poor-quality products or service can be reported to the Australian Competition and Consumer Commission. In addition, Choice, a consumer advocacy group, has a yearly award known as the 'Shonkys', where inferior or misleading products and/or services are 'awarded' based on poor quality, misleading claims or unfairness to the consumer.

Commercial products will often go through a quality assurance process before the product is sent to stores. Often this is undertaken by a staff member separate from production, so an unbiased, objective assessment of the product is completed. This can ensure that the product is of sound quality and safe for use for the public.

Products can also include certifications and labelling or may come under mandatory standards that confirm their quality. Australian or international standards may apply to products or components, and these will be labelled to indicate that they meet predetermined standards. International standards (ISOs) also exist to certify the manufacturing processes, including quality, environmental and risk management.

The consequences of a product not being of sound quality can be damaging to a company's reputation. This could result in products breaking down quicker than usual or being returned as faulty, damaging the company's reputation and leading to a loss of sales as well as costs to replace, repair or recall poor-quality products. Of most concern would be a product that causes danger or harm to customers due to its poor quality.

Assess the quality of two commercial products on page 179 of the workbook, Activity 8.4.

DID YOU KNOW?

Mattel Inc. recalled more than 18 million children's toys in 2007. The toy was called Polly Pocket and was manufactured in China. Despite the warning of a choking hazard on the front of the packaging, children had swallowed small toy magnet pieces that had the potential to attract each other and cause an intestinal infection, blockage or even perforation, which could result in death.

Figure 8.8 Polly Pocket by Mattel Inc.

Melbourne-based global bag design company Crumpler prides itself on quality and functionality within its products. Their product development process involves both user trials and lab tests to ensure this. They also offer a lifetime guarantee on the workmanship and materials of their products, and offer a free repair service if the product is found to be defective. This enhances the quality of the products and potentially increases the lifetime, in effect reducing environmental and economic impacts.

ACTIVITY 8.4

Think of the product that you are currently producing in Unit 4 and imagine that you are going to mass-produce and sell the product commercially. List ways you could enhance the quality of your product, including what you could offer once the product has been purchased.

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Chapter summary

- Qualitative and quantitative data can be used to evaluate products.
- The three pillars of sustainability provide a framework to help users assess the consequences of their purchases.
- A product's value may change over time, and designers, manufacturers and owners may value different attributes of the same product.
- The parameters of the product design factors allow us to assess the quality of a product, specifically the function, materials and aesthetics.

Short-answer questions

1 List three factors that contribute to a quality product.
2 Explain the difference between qualitative and quantitative data.
3 Explain why a designer and a manufacturer value different attributes in the same product.
4 Explain how values that users place on product attributes vary over time.
5 List three ways users might trial a product.

Extended-response questions

1 Discuss how the value of a smartphone may change to an end-user the longer it is on the market.
2 Discuss why sustainability needs to be a consideration to consumers when buying products, making reference to two of the pillars of sustainability.

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Figure 9.1 Student work by Thanh Thy Tran

9 Area of Study 2: Product manufacture

INTRODUCTION

This area of study sees the resolution of your ideas from Unit 3 with the production of your preferred design option. You apply quality measures decided upon in your production planning and use appropriate tools, equipment and machines and a variety of processes, with your working drawings, trials and production planning from Unit 3. You record your progress, both in written and visual forms, taking note of any modifications to your scheduled work plan, design option and working drawings, and manage risks, working safely and accurately.

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KEY KNOWLEDGE

- risk management associated with selecting and using tools, equipment, machinery, materials, chemicals and other substances
- a range of processes and techniques involving different degrees of difficulty associated with the manufacture of a specific product
- goal setting, and time and resource project management techniques
- techniques of monitoring efficiency and effectiveness of planning and production activities
- methods used to record and report progress, including decisions and modifications made during the production process.

KEY SKILLS

- apply risk management throughout production
- use tools, equipment and machines, and materials competently and safely
- use appropriate processes safely and accurately
- use quality measures identified in the scheduled production plan to ensure a quality outcome is achieved
- use appropriate techniques to record and report progress and modifications on production activities.

9.1 Risk management associated with selecting and using tools, equipment, machinery, materials, chemicals and other substances

Risk management is key to avoiding injury to yourself and others, as well as the end-user/s of the finished product. Unit 4 requires you to act upon your risk assessment from Unit 3 in your production planning. How well you manage risks forms part of your assessment for the SAT. Your teacher will be making observations, and improper use of tools/equipment/machinery and poor risk management can bring down your mark, and be dangerous to others. See Chapter 1 (page 42) for a list of some potential hazards in your material and work environment.

Some tips for managing risks include:

- following your risk-management advice written in Unit 3
- not allowing yourself to be distracted by others
- making visual checks of the equipment and environment each lesson
- testing machines and equipment where suitable/possible
- reporting to your teacher any hazards or injuries immediately
- making sure you are using the right tools, equipment and machinery for the right processes. Your teacher and your research should help in this area. For example, using a zipper foot when inserting a zip into a garment, as using a plain foot could be dangerous; or for resistant materials, using the right-sized drill bit for a fluted dowel.

DID YOU KNOW?

Risk management should always be considered. Even people who work from home need to ensure that they can do so safely and with a minimal risk of harm.

CASE STUDY

Don't store pins in your mouth

Figure 9.2 A pincushion

Costumier Annie McCarthy gives a word of warning for those who develop a habit of storing pins in their mouth – don't! When working in the wardrobe department for a TV series in the 1980s, McCarthy accidentally swallowed a pin she was storing between her teeth. She didn't feel any pain, but at her employer's insistence she got an x-ray, which revealed that she had actually inhaled the pin and it was in her lungs. This led to surgery, a week in hospital, and loss of some sensation and use of muscles around the lung. What's more, surgeons informed her that, had it been left any longer, it could have punctured her lung or poisoned her. That is one of the reasons we use pincushions. Can you think of any more?

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CASE STUDY

Arc eye or welder's flash

If you intend to or are interested in using metal, welding is a great way to join material. Chapter 2 (page 58) discusses types of welding available. It is a good idea to ask your teacher about your school's welding facilities and only decide to use this production process if you feel it will be a process that you will enjoy and feel confident and safe doing. Welding must take place in appropriate facilities with regularly checked equipment and correct safety gear. Welding is a skill that requires accuracy and steadiness of hand. If your work is not secured properly, you can't take your welding helmet off to steady it while you are welding.

An auto-darkening helmet provides visibility, allowing you to see what you are doing while you are working, as it adjusts to light and shifts from clear to dark as soon as you start welding. Many cheaper and older helmets have lift-up lenses that must cover your eyes when welding and must only ever be flipped up when you stop welding. This flipping up and down of the lens can become frustrating, particularly when you are wearing large protective leather welding gloves.

Why can't you take your auto-darkening helmet off or flip the lens on a cheaper brand to see what you are doing while welding? The terms 'arc eye' or 'welder's flash' are used to describe injury to the surface of the mucous membrane of the eye produced from certain types of radiation exposure from the arc. The effects from this exposure to a person's eyes can result in mild to intense pain, tearing and reddening of the eye and its surrounding membrane, a feeling of having dirt in the eye and oversensitivity to light and difficulty looking at light sources.

These effects will depend on how long the eyes were exposed to the radiation (which might only be a matter of a few seconds), the distance of the eyes from the welding arc, the angle at which the radiation enters the eye and the quality of the welding helmet worn. Remember, always wear your protective welding helmet and keep the welding lens down on an older/cheaper version when you are welding.

Figure 9.3 An auto-darkening helmet is worn by a welder.

ACTIVITY 9.1

1 If you are interested in welding and your school has the facilities, what are the safety considerations you need to think about?
2 Can you think of another unexpected potential hazard in the textiles classroom?

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9.2 A range of processes and techniques involving different degrees of difficulty associated with the manufacture of a specific product

Your design option needs to have a range of processes and techniques with different degrees of difficulty. This requires you to include multiple processes in your designing (including design options and working drawings), and you are encouraged to trial these processes throughout Units 3–4 before attempting them in your final product/s, where possible.

You are encouraged to negotiate this with your teacher. If you have completed Unit 1 and/or Unit 2, a good rule of thumb is that you should have a wider variety of more complex processes than your previous year, as your skills have progressed, and you are completing a year-long project. You are also encouraged to be innovative with your selection of techniques and processes. Some appropriate processes for VCE are listed in Chapter 1 (pages 36–8).

- **Processes and techniques:** A series of steps taken during the construction of your product resulting in a design feature, fitting, fastening, finish and so on within your product. An example for resistant materials might be a mitred corner; for non-resistant materials, an example might be a French seam.
- **Degree of difficulty:** The level of complexity of the process. For example, for textiles, boning a garment would have a much higher degree of difficulty than sewing a dart. For resistant materials, sawing a dovetail joint would have a higher degree of difficulty than sawing a butt joint.

Figure 9.4 Final garments by student Katarina Kristo, Units 3–4 Final Products using Textiles, featuring multiple processes, including zips, darts, sleeve insertion, surface decoration, hemming, buttonholes and bias binding

ACTIVITY 9. 2

What are some other production processes that you are considering that might have a greater degree of difficulty than ones you have previously undertaken?

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9.3 Quality and accuracy

Making an accurate product of good quality not only benefits your end-user/s, it also forms part of your assessment. Quality in your finishing processes, as well as accuracy and precision during production, will also result in a more durable and pleasing product. Some ways to ensure quality and accuracy in production are:

- actioning your quality measures written in Unit 3 production planning (for ideas, see Chapter 1, pages 42–4)
- trialling production processes before you complete them
- asking for feedback from your teacher
- taking time and care when completing your work
- fixing mistakes where possible; for example, for textiles, unpicking a seam with puckers and sewing it again; or for resistant materials, applying and sanding wood filler correctly.

Steps for accuracy with seams and hemming

Non-resistant materials (textiles)
• Ensure that seams and seam allowance are even, with stitching parallel to the raw edge. Line up the raw edge with a marker on the sewing machine, or use a magnet. • Ensure that hems are all the same length, by measuring them, making use of pins and ironing as you go. • Tack seams/processes/zips/hems before completing them, where you feel necessary.

Table 9.1 Steps for accuracy with seams and hemming

Suggestions for working accurately with resistant materials

Resistant materials
General steps for accuracy • Keep your work space clear of clutter, such as hand tools, adhesives and finishing products such as wood stain or paint, so the material/s you are working with are not damaged and you can work efficiently. • Always measure your material twice before you begin cutting. • Use correct measuring equipment and measure in millimetres. • Secure your work when sawing or drilling. • Know how to use wood filler correctly. • Apply adhesives/glues carefully and don't use too much. • Allow time and take care with each production process. If things don't go right at the start, it may be difficult to revisit a production step and make the necessary modification.
Accuracy working with wood • Saw with the wood grain, not against the wood grain. • Wood joints must be the same thickness. • If cutting a number of wood lengths, make a sample piece and use this to measure and mark out the others. • Always check wood lengths are flush. • Know how to use wood filler correctly. • Use the correct grade of sandpaper for the required finish. • When finishing wood, refer to your testing page and practise your chosen finish on a scrap piece before applying.

Table 9.2 Suggestions for working accurately with resistant materials

(Continued)

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Resistant materials
Accuracy working with plastic Acrylic sheets: • Make sure you have selected a suitable thickness. • Keep the protective paper on for as long as possible to avoid scratching the surface. • When sawing using a bench vice, make sure the acrylic is close to the bench to avoid the acrylic flexing and snapping. • Take care when filing and sanding edges. • Before drilling through acrylic, practise on a scrap piece.

Table 9.2 Suggestions for working accurately with resistant materials *(continued from previous page)*

Figure 9.5 This Unit 4 kennel by student Luke Abella demonstrates quality aspects through accuracy of production processes and choice and application of finishes.

ACTIVITY 9.3

Researching quality and accuracy on existing products

Source a product that is similar to the one you are making. Study the product and answer the following questions:

1. Is it of good quality and accuracy? How so?
2. What tools, equipment and machinery may have been used in production?
3. What steps could you take to ensure that your product has similar accuracy and quality aspects?

9.4 Goal setting, and time and resource management techniques

Time is limited in Units 3–4, and it is crucial to manage your time efficiently, to allow yourself to make the best quality product possible. How well you manage your time also forms part of your assessment. Your timeline in your scheduled production plan is your guide for this period of time, and should map out what you need to achieve each week. You are also encouraged to:

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- refer regularly to your timeline, and mark on it what you have completed
- set short-term goals, such as a list of a few tasks to complete in that lesson
- be organised, coming to class prepared and on time, ready to work; this includes sourcing materials when required, and packing up and putting away both school equipment and your own work neatly
- have more than one task to continue with, if you get stuck; for example, working on another garment in your design option, because the overlocker you need is already being used
- use your existing research about processes to complete them efficiently
- not allow yourself to be distracted by others
- make the most of any extra opportunities or time that you might be lucky enough to be offered.

What happens when things don't go to plan?

Things don't always go to plan during production (as you may already know), and production processes may take longer than expected, and mistakes can happen. How well you manage these setbacks can influence your SAT mark. If you notice that you are falling behind in your timeline, you must make adjustments to either your design option or the pace at which you are working, without compromising the quality of your product/s. For example:

- You may no longer have time to fully line your dress design option, but a facing on the neckline will provide the neat finish you are after in less time.
- Rather than French polish your furniture product as you originally intended, you might decide to revisit your test samples and instead choose a clear varnish that will take less time and achieve a similar result.

Communicate regularly with your teacher and end-user/s, and brainstorm together any changes to the design option or working drawing, ensuring that you and other end-users agree on the changes. Most of all, don't panic, and use your creative and critical design thinking skills.

Figure 9.6 To do list

1 Folio work needed

- design option
- working drawing
- material samples

2 Tools, equipment, machines and safety gear needed

- workshop apron
- bench vice
- tenon saw
- steel ruler
- pencil

3 Short-term goals

- What do I hope to achieve by the end of the lesson?
- I need to measure/ mark out and saw eight lengths of Tasmanian oak.

Figure 9.7 To do list for resistant materials – planning and production stage

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9.5 Techniques of monitoring efficiency and effectiveness of planning and production activities

During the product design process, you should always be reflecting on your own effectiveness, seeking ways to improve and aiming to work most efficiently. These insights and reflections can also help when completing your evaluation of your product in Outcome 3. You can always revisit any step in the product design process. For example, when modifying your pattern to make a dress, it becomes apparent you need more detail in your working drawing; or in the finishing stage of a range of acrylic jewellery display stands, the acrylic cracks while polishing one of the pieces. Your production record provides opportunities to monitor and discuss this, and your teacher can also provide feedback.

Using your production record

Your production record provides an opportunity to reflect on your efficiency and effectiveness during production. When completing your posts, you should reflect on whether you are up to date with your timeline and whether you are working efficiently. You can also reflect on the effectiveness of your production planning, and you must note changes that you are making to these documents or your design. For example, hand-sewing the beading was more time-consuming than you thought it would be, so you reduced the amount of beading on your garment; or you reduced the number of hooks on your hanging garden tool storage holder.

DID YOU KNOW?

There are many apps you can use to create timelines and log progress. Some may even create a production record for you, saving you time at the end of the outcome.

If you are using a blog, some blog sites have apps, letting you upload and manage everything straight from your phone.

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Figure 9.8 First steps in the production of a product, photographed and annotated for a production record by student Natalie Dubinski

9.6 Methods used to record and report progress, including decisions and modifications made during the production process

Your production record is a visual and written documentation of your progress when producing your preferred option. It forms part of your assessment for the SAT and can provide evidence of your time and risk management and your knowledge of processes and the tools, equipment and machinery used. It also helps with authentication, providing evidence that you have completed certain processes.

Smartphones and tablet devices make it easier to document your production regularly, but be sure to check with your school and teacher as to what is appropriate.

Your production record needs to include:

- images of production and the date
- a description of what steps you are completing in your production plan (for example, sewing side seams in the bodice, then pressing them with the iron)
- any modifications to the preferred option, working drawing or scheduled

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production plan (for example, running out of your chosen material and making alternative choices)
- acknowledging any work you had outsourced (for example, some fabric you had digitally printed online, or wood being cut with a restricted plant by a teacher/ technician).

It can also include:

- details of any difficulties you are having in production and how effectively you are following your timeline and scheduled production plan
- any feedback you have received from your teacher or end-user/s
- descriptions of how you have managed risks, worked safely and applied quality measures to ensure an accurate product.

Ways to document your progress include:

- taking pictures each lesson, then
- completing a blog or setting up a social media account and posting the pictures with the information above
- putting the pictures into a Word document, PowerPoint or OneNote, creating an ongoing production record
- printing out your pictures and collating them into a handwritten journal
- creating production videos.

ACTIVITY 9.4

Creating your own online production record

1 Choose an online platform that works best for you, your device and data available, and that will make it easy for you to update your production record. There are many free blogs and social media platforms that allow posting images, dates and text. Check your school's internet policies and make sure your account is set to private.
2 Take a minimum of one picture a lesson. Get a friend to help, getting them to take pictures of you using the tools, equipment and machinery, and make sure you are working safely. Also make sure you only include people who have agreed to be in the photo.
3 Post regularly, including a description of what you are doing, the date and any other relevant information.
4 At the end, take screenshots of your online production record and include them in your folio for final submission.

For things to consider when photographing your final product, refer to Activity 9.1 on page 181 of the workbook.

Figure 9.9 There is no one correct way to document your progress, but it must be done regularly.

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RECORD

WEEK 1
23 MAY

This week I cut out my leotard pattern. I had to completely modify my pattern from a one piece leotard to a leotard with mesh inserts and separate top and bottom sections. I also altered the neckline, armhole and shape of the bottoms.
After I cut out my pattern, I traced it and then drew my modifications over the top.
In my timeline I allowed one week to do pattern modification.
To prevent back pain I worked at all wait height bench, that did not strain my back

WEEK 2
30 MAY

After modifying my pattern, I cut out all my pattern pieces and started making my toile. I started off by sewing the side seams of the leotard bottom. After that I sewed the centre panels to the side panels on the torso. After having the bottom half and top half completely constructed I sewed them together at the waist.
I found it really tricky to pin the back curved piece. Once it was all together though it wasn't too bad to actually sew.

WEEK 3
6 JUNE

My leotard toile has been completed. I trialled ways of attaching different types of elastic to the leotard, and trialled different cover stitching methods on the toile. I decided to use bathing suit elastic as it is the most durable and stretchy of the elastics I came across. I also prefer the look of using only two seams for the cover stitching. I found it a bit difficult at first when I was cover stitching. After I kept practising, I feel a bit better that my seam swill be neater on the final garment.
In my timeline I allowed up until this week to finish my toile, but I still have to do my skirt toile.
When cutting fabric I took care with the pins and scissors.

WEEK 4
20 JUNE

I made the toile for my skirt, which consisted of 4 different shapes which will act as layers. I made them quite large and square as I will shape them and change their size once when the skirt is constructed. I was unsure of how I was going to make my skirt, and give it volume. I came up with

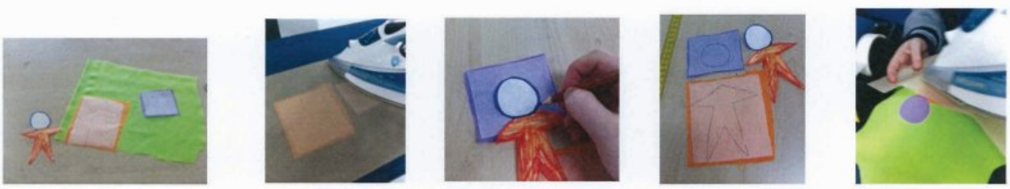
Figure 9.10 Production record by student Madeleine Rosenbrock

Production Week 5: 3/8/15 – 9/8/15

I had to stop work on my jacket this week as the zip that I bought was approximately one centimeter too long. As I have some time to spare in my production plan I decided to hold off work on the jacket until I get a zip of the appropriate length so as to produce a higher quality product. Thus in the absence of work on the jacket I conducted the trials of my embroidery and applique as well as completing the garment printing and machine embroidery on the dress back piece and starting the applique branding on the dress front piece.

The embroidery required much more time and care than I had anticipated and I had to be very careful and sew very slowly; particularly on the curves. This was additionally so as I decided to sew over the design twice in order to make the design more prominent. The applique however was much faster and easier than had anticipated, particularly as I had already designed the branding element (exact size and shape). As I had never completed embroidery or applique before I was incredibly pleased with my efforts and end results with both processes.

(EMBROIDERY TRIAL FRAME ABOVE)



(APPLIQUE TRIAL FRAME ABOVE)

Figure 9.11 Production record by student Madeleine Hosemans

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Chapter summary

- Risk management is key during production and must be a priority each lesson.
- Your product/s should include a variety of processes of different degrees of difficulty that are suitable for your abilities, time frame and resources available to you.
- Good time management techniques are key to success in Unit 4.
- Regular reflection on your timeline is needed to assess your efficiency and effectiveness, and to ensure that your product is completed on time.
- A production record forms a key part of your assessment in Unit 4.

Short-answer questions

1. List the three most difficult processes that you are completing in the production of your preferred option.
2. Identify one quality measure you are applying while producing your preferred option.
3. Identify two communication techniques you could use to record your progress in a production record.
4. Describe one reason why it might be important to discuss any changes to the preferred option that occur during production with your end-user/s.
5. Why is it important to make regular updates to your production record? List two reasons.

Extended-response questions

1. Describe three steps you will take to manage risks during the production of your design option, and discuss the injuries this may prevent.
2. A process you expected to take two weeks has taken four, and you are running behind in your scheduled production plan. Discuss two ways you could get back on track.

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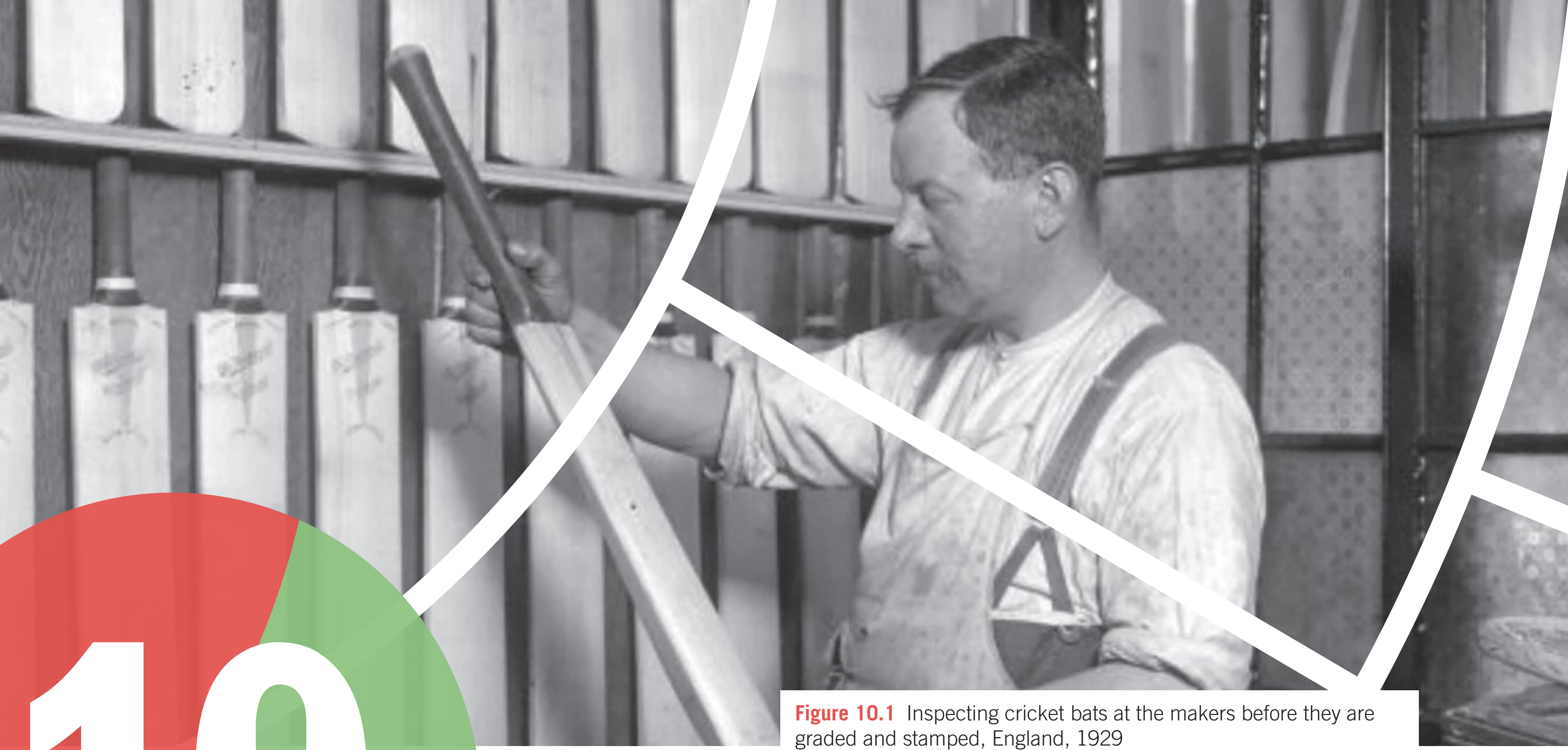

Figure 10.1 Inspecting cricket bats at the makers before they are graded and stamped, England, 1929

10 Area of Study 3: Product evaluation

INTRODUCTION

This area of study sees the culmination of your SAT and the last step in the product design process, evaluation. You will use your evaluation criteria written in Unit 3 to evaluate your end product/s, getting feedback from end-user/s to see how well their needs have been met, as well as test the product in the ways suggested in each of your evaluations. This information will be summarised and you will then suggest areas for improvement, should you go through this process again. A care label and/or user instructions is generated to help end-user/s take care of the product, provide instructions for use and repair, with the intention to extend the life cycle of the product, as well as highlighting features of the design.

Final tasks for your SAT:

- Generate a care label and/or user instructions.
- Gather feedback from end-user/s.
- Test your product against your pre-written evaluation criteria in Unit 3.
- Summarise this information and discuss any areas you could improve on.

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Why do we evaluate?

Evaluating is a critical thinking stage in the product design process and forms part of your assessment. It allows you to clarify your strengths and weaknesses as a designer, and identify areas of improvement. It is important to get honest and constructive feedback at this stage and not claim everything went to plan and met all the needs of the design brief and the end-user/s. This allows you to improve your skills as a potential product designer in the future, as well as understanding the strengths you could bring to a design team. In industry, reflecting on and improving designs is a critical part of the product development process, in order to stay competitive in the marketplace.

KEY KNOWLEDGE

- techniques to gather end-user/s' feedback with reference to evaluation criteria for the finished product
- methods of testing and checking the finished product against evaluation criteria
- methods of creating end-user/s instructions or care labels
- possible improvements to the product as a result of evaluation.

KEY SKILLS

- use testing and/or checking methods on the finished product to explain and evaluate product performance and possible improvements
- gather and summarise feedback from a potential end-user/s in relation to the finished product
- evaluate the finished product to determine the extent to which it meets the needs of the end-user/s according to the requirements of the design brief
- produce a set of instructions or care labels for an end-user/s
- determine and recommend improvements to the product.

10.1 Techniques to gather end-user feedback with reference to evaluation criteria for the finished product

To evaluate your end product, you need to source feedback from end-user/s using the product in its intended setting, with your evaluation criteria written in the investigating and defining stage of the product design process in Unit 3. This allows you to assess how well the product meets the design brief.

Two forms of data you could collect are quantitative (such as a rating as to how well this criterion was met out of 10) and qualitative (such as a written response as to how well this criterion has been met, explaining the previous rating out of 10). Your criterion question and checking method are needed in this step.

Gathering end-user feedback

		Workout jacket (textiles example)	Hanging kitchen wall shelf (resistant materials example)
	Criterion question (Part 1 of four-part evaluation criteria)	Does the product allow for freedom of movement?	Are the shelves wide enough to hold the storage containers it was designed to hold?
	How the finished product could be tested or checked (Part 4 of four-part evaluation criteria)	Have the end-user/s try on the jacket and do some stretches and warm-ups to make sure it allows enough movement.	Have the end-user place the storage containers on the wall shelf to make sure the shelves are wide enough.
Step 1	**Complete testing or checking**	Get the end-user to do the above.	Get the end-user to do the above.
Step 2	**Rate how well this criterion was met** (quantitative response)	7/10	10/10
Step 3	**Get end-user feedback** (qualitative response)	*'The jacket was pretty comfortable, I was able to do stretches and movements in it without much trouble. However, the jacket came up a little at the back when I lifted my arms.'*	*'The shelves are deep enough and all the storage containers fitted easily and securely.'*

Table 10.1 Gathering end-user feedback

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Evaluation – End Product

Criteria no.		Criteria question	How checked/tested on the finished product	How well this was achieved	My response	Client response/quote
Purpose and Function	1.	Is the product appropriate as a uniform?	Discuss with the client what she expects of a uniform during the designing and then show her the product/s and ask if she is satisfied with the aesthetic design of the product/s.	5/10	The overall design of the product is not that of a typical uniform, however the branding elements and name badge holes create a 'uniform-like' product as established with the client earlier in the project.	The dress would be good for a change, but would be required to be worn with bike shorts or leggings. Even still I would be happy to wear this as my uniform.
Economics - cost	2.	Has the prototype been made within the $150 budget?	Keep all receipts of purchases and refer to the budget plan.	10/10	The product cost $104 to produce which was much below the budget provided. This is shown through the materials costing table and the inclusion of receipts.	I am happy of the quality of the product that I received that was also way under budget.
Aesthetics	3.	Does the product clearly display the Funtastic Fitness logo?	Show the product to the client and also stand different distances away from the logo and see how clearly the logo can be viewed and read.	7/10	I had my sister hold the finished dress, and I walked backwards away from her. I could see, and read, the business name on the back from quite far away due to its size, position and white border. The branding on the front could also be seen quite well, due to the bright colours, but not from as far as the name on the back due to the smaller size.	I love the name on the back of the dress! I don't know how you did it but I think it looks great and it is super clear and easy to read. The angle is probably a little steep though, but I like how the embroidery draws your attention.
Economics - timeframe	4.	Has the prototype been completed by late August 2015?	Show the prototype to the client and ask if they are happy with the standard and quality of the product/s.	6/10	As the product was not finished to the standard which I desired by late August, I conferred with the client and decided on a later due date of the 4th of September, which it was completed by, to ensure that the product was of high quality. This was then shown to the client.	Although I am disappointed that the product was not finished sooner I am happy with how it has turned out. I am also still able to wear it to my boot camp class as it is not until the 7th.
Materials/ Technology/ Sustainability	5.	Will the product require only little and/or easy maintenance?	Test the fabrics and construction techniques used in the product to see if they are durable and resistant to wear.	8/10	I created a materials testing table where I tested all of the types of fabrics used in the product against wear, washability, heat resistance and stretch to see how each of the materials would respond. This proved that apart from the lining (that was particularly sensitive, as expected) and a small part from the top poplin, (which only has a small feature in the product) the materials are easily maintained.	Since the materials have all been tested, so I now know their properties, and the products have few embellishments which are not completely secured I think that they will be easy to maintain – particularly the dress which I can just chuck in the wash. Also the jacket won't need as much washing so that's fine.
Tactility	6.	Is the prototype comfortable?	Try on, and also get the client to try on, the dress and jacket to test how comfortable they are and if they have some give/stretch.	7/10	The lining on the jacket makes it very easy to slide on and very comfortable and smooth against the skin, thus why it was incorporated into the design option. The jacket shell, due to its blend, also has a large amount of stretch. The dress is comfortable although not as much as the jacket, despite the shirring being quite comfortable on the waist. I believe the problem is that the waistline shirring a bit too low. The client tried on the products and had not issue with their comfort.	After trying the products on many times, as well as completing a few stretches in them I find them quite comfortable; much more so than my last uniform with a rough scratchy shirt. I would be happy wearing these on a daily basis.

Figure 10.2 Student Madeleine Hosemans evaluating the end product

ACTIVITY 10.1

Collating feedback from multiple end-users

1 Get your pre-written evaluation criteria from Unit 3. Add three new columns to the right for a quantitative response, and two qualitative responses from two end-users (see Figure 10.2). Delete the justification and ways to achieve columns.

2 Get your end product, and end-users, and work through each criterion. For example, is the finished chair comfortable to sit on? This requires end-users to sit on the chair and find out.

3 Take a quantitative response; for example, a comfort rating of the chair is 7/10.

4 Take a qualitative response; for example, end-user number 1 found the chair to be of reasonable comfort and felt relaxed in the chair, but thought the cushion could have been more padded.

5 Collate all this information into a table similar to the one in Figure 10.2.

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10.2 Methods of testing and/or checking the finished product using evaluation criteria

Your pre-written evaluation criteria from Unit 3 provide the structure to evaluate your end product/s. Refer to each criterion's first part (the question) and fourth part (how the finished product could be tested or checked), and more than a 'yes' or 'no' is needed. (See Activity 10.1 on how to gather qualitative and quantitative data from your evaluation criteria.) The product should be tested in the conditions it was designed for, with typical end-users of the product; for example, the calisthenics costume in Figure 10.3 shows the end-user dancing in it.

Figure 10.3 Final product, a calisthenics costume, by student Madeleine Rosenbrock, being tested by end-user Eliza Whitford

CASE STUDY

Adirondack chair

The end-user group pictured in Figure 10.4 are testing the comfort of their Adirondack chairs and the effectiveness of their detachable cup holders and wide armrests, which have been designed to hold hot and cold drinks – in this case, a cup of hot chocolate. The end-user group are outdoors in the elements, the environment the chair was originally designed for. The Adirondack chair dates back to 1903 and was originally designed for comfort and durability with a high back and solid flat armrests for beverages. The original designer had his family test his ideas at home in the Adirondack Mountains (hence the chair's name) before deciding on the one we commonly know today.

Figure 10.4 Students test the functionality and comfort of their Adirondack chairs

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Complete evaluation criteria and an evaluation summary on workbook pages 184–6, Activities 10.1a,b and c.

DID YOU KNOW?

End-user/s' feedback is a great way to discover some aspects of your design that you may have overlooked. It may even help you to consider some user groups that you hadn't considered before.

ACTIVITY 10.2

Summarising your evaluation of the end product/s

1 Test the product in the conditions it was designed for, using steps 1–5 in Activity 10.1.
2 Make a summary of all this information, discussing how effectively you think your manufactured product met the needs of the end-user/s.
3 Discuss some ways you could improve the product, if you were to complete the product design process again.

10.3 Methods of creating user instructions and/or care labels

In Units 3–4, you must provide user instructions and/or a care label for your product/s. This shows end-user/s the features of the product, how to take care of it, as well as any operating, assembly or repair instructions it may need. You can either provide a care label, user instructions or both.

You must:

- provide highlighted features of the product
- provide instructions as to how to use and take care of the product to prolong its life
- provide any safety warnings needed for the product.

You could:

- provide materials or joining methods that could help prolong the product's life (for example, extra buttons or thread for a dress, or extra wood screws or a spare reinforcement bracket)
- provide an instructional video, multimedia presentation or brochure with the required information
- create a swing tag for the product.

Highlighting the features of the product

Providing a highlight of the features of the product identifies to end-user/s the special parts of your design, and how the product both meets their needs and the design brief. The product design factors are a good starting point to highlight the features of the product you have produced, as part of your care label and/or user instructions. This could include (but is not limited to):

- its purpose and key functions
- materials you have used
- creative and innovative aspects
- sustainable design features
- technology and machinery used to create it
- any complex processes of note
- any other design features you would like to draw attention to.

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TIPS

Imagine you are explaining your product to a friend. What are the key features you want to talk about?

ACTIVITY 10.3

Annotating the features of your end product/s with images

1. Take 3–4 photographs of different views of your product.
2. Collage these into a work document, placing them in the centre of the page, and use text boxes around the images (see Figure 10.5).
3. Use the relevant product design factors to annotate the product, discussing its features in the text boxes. For example, what materials and technology did you use to create it?

Figure 10.5 Student Madeleine Hosemans highlighting the features of her end product to her end-user/s

Care label, user instructions and product features highlight

Chapter 1 discusses environmental impacts and approaches used by designers and consumers in relation to textiles and furniture production. One of the ways designers can continue to use sustainable design thinking is not only to design and produce products that lessen the environmental impact, but also to provide the end-user/s with helpful information that will assist in the maintenance and care of a product and hopefully prolong its life, which benefits both the end-user/s and the environment.

For resistant materials products

IKEA products come with care and maintenance instructions and handbooks that end-users should and are encouraged to follow to ensure a longer-lasting product. Flat-pack furniture from IKEA comes with assembly instructions, and if the end-user/s is able to follow the instructions correctly the product will last and function as it should. The problem with flat-pack furniture assembled by the end-user/s is, if they don't assemble a part or component correctly the product may not function as well as it should. This may result in a product that doesn't last, either, because the part or component eventually fails completely or the end-user/s places less value on the product and disposes of it before the end of its life cycle.

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Figure 10.6 An end-user following IKEA instructions and assembling a flat-pack piece of furniture

For Outcome 3, you have the choice of making end-user/s instructions or a care label. They need to highlight features of your product (see Figure 10.7). You may also include methods of caring for the product to prolong its life, and operational, assembly and repair instructions.

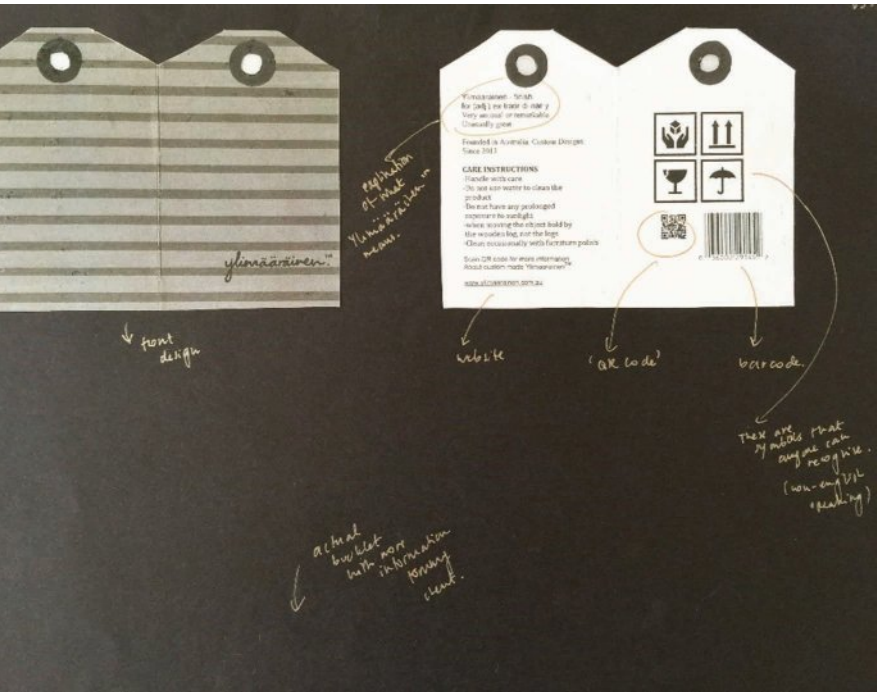

Figure 10.7 Example of a care label (swing tag) that highlights features of the product

Operational instructions for products should be read carefully and followed as directed. If the end-user/s is provided with operational instructions that are easy to follow, they will handle the product the way it was intended and their use of the product will be a positive one. This positive association will encourage them to want to potentially buy that product again.

If you choose to write or it is appropriate for you to write operational instructions, you should take this into account when creating this information. Think about the operational steps carefully, the order in which they occur and whether you need to provide graphic examples to assist the end-user/s.

If you decide to focus on repair instructions, you will need to consider what parts or components of your product are most likely to need repairing if not handled correctly or used in the correct context. Carefully think about the repair instructions and write them in a way that is logical and easy to follow. As with operational instructions, you might decide it is necessary to provide graphic examples of repair instructions to assist the end-user/s.

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ACTIVITY 10.4

Create a set of user instructions, including a highlight of the product's features, for a resistant product.

- Research ways this information could be presented for a resistant materials product.
- Include the feature highlights generated in Activity 10.3.

Complete your user instructions (including a highlight of the product's features) for your resistant materials product on page 187 of the workbook, Activity 10.2.

For non-resistant/textiles products

For the purpose of your SAT, a care label is the most suitable format for instructions for non-resistant/textiles products to help end-users best launder the product, ensuring that your design has the longest life cycle possible. Table 10.2 provides a guide for the type of information you need to include on a care label for the SAT. Chapter 7 (pages 201–3) has details on fibres and how they should be laundered. However, if your garment has multiple fabrics or any features that need special care (such as sequins or a print), your instructions will need to be adjusted to suit. The care label needs to be accurate for the fibre and garment and not be unnecessarily cautious or guesswork (see 'Did you know?', page 292).

Care label and product features guide – non-resistant materials (textiles)

Product features highlight	Discuss the key features of the product using the product design factors (see Activity 10.3).
Fibre content	List the fibres in order, from the biggest quantity to the smallest (for example, 95% cotton, 5% elastane), for each part of the garment (outer, lining and so on). (Tip: this information will often be on the roll of fabric at the place of purchase or on the receipt.)
Wash	At what temperature should this fibre be washed? How should it be washed (hand, machine and so on)?
Bleach	Can it be bleached?
Dry	How should it be dried (line, tumble-dry and so on)? At what temperature can it be tumble-dried?
Iron	At what temperature can it be ironed?
Dry-clean	Can it be dry-cleaned? If so, what type of dry-cleaning?
Any other special instructions	Does your garment have a zip? (If so, your zip packaging may provide extra instructions on how to launder it.) Any special trims that need extra care? Any prints? Can you iron them? Have you dyed the fabric? (If so, it may need to be washed separately.) Should it be stored a certain way? Any safety warnings (such as for children's nightwear)?

Table 10.2 Care label and product features guide – textiles *(Continued)*

Figure 10.8 For the same product, the student provided more detailed care instructions in a different format with a focus on recycled timber and metal.

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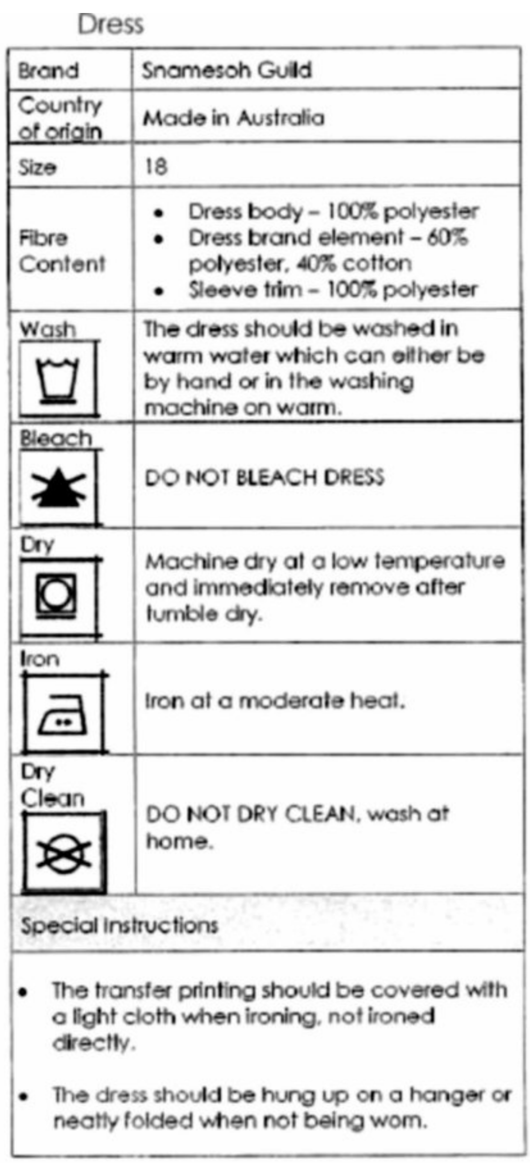
Complete your care label (user instructions) for your non-resistant materials product on page 189 of the workbook, Activity 10.3.

TIPS

Synthetic fibres will need lower temperatures for washing, tumble-drying and ironing than most natural fibres. If your garment has multiple fabrics, washing instructions should be for the most synthetic/delicate fibre, and ironing instructions specific to areas of the garment. Have a look at your classroom iron for clues or read the care label and be sure not to melt your product with an iron that is too hot.



Dress

Brand	Snamesoh Guild
Country of origin	Made in Australia
Size	18
Fibre Content	• Dress body – 100% polyester • Dress brand element – 60% polyester, 40% cotton • Sleeve trim – 100% polyester
Wash	The dress should be washed in warm water which can either be by hand or in the washing machine on warm.
Bleach	DO NOT BLEACH DRESS
Dry	Machine dry at a low temperature and immediately remove after tumble dry.
Iron	Iron at a moderate heat.
Dry Clean	DO NOT DRY CLEAN, wash at home.

Special Instructions

- The transfer printing should be covered with a light cloth when ironing, not ironed directly.
- The dress should be hung up on a hanger or neatly folded when not being worn.

Figure 10.9 Care label by student Madeleine Hosemans

DID YOU KNOW?

In Australia, care labelling is mandatory standard for clothes and textile products: AS/NZS 1957:1998 Textiles – Care labelling. Any company, both here and overseas, wishing to sell garments in Australia must provide a care label with their product, permanently attached where possible. This helps inform consumers when purchasing the garment (such as where a garment was made and how it should be laundered), as well as providing care instructions. Instructions must be written in English (not purely symbols) and provide information on any general care and warnings, as well as washing, drying, ironing and dry-cleaning, as well as the fibre and country of manufacture. The information is usually presented in the order shown in Table 10.3.

Label/designer	'Swim'
Size	12
Country of origin	Made in China
Fibre content	82% nylon, 18% elastane
Washing instructions	Cold hand wash separately using mild detergent. Do not bleach.
Drying instructions	Do not tumble-dry. Drip dry in shade.
Ironing instructions	Do not iron.
Dry-cleaning instructions	Do not dry-clean.
Other general warnings	Rinse thoroughly after swimming in chlorinated pools. Avoid excess contact with suntan lotions and rough surfaces.

Table 10.3 Example care label for bathers

Care labels must also not be overly cautious (such as suggesting dry-clean only when hand washing is also appropriate). Companies can be fined for not complying with mandatory standards, such as putting incorrect information on care labels (up to $1.1 million for companies, and up to $22 000 for individuals), under Australian consumer law.

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ACTIVITY 10.5

Non-resistant materials
Create a care label and product features guide for a textiles/non-resistant product in a swing tag.

- Keep track of all the fibre content of your fabrics during production.
- Using Table 10.3 as a guide, generate a care label for each of your end products, including the fibre content of your materials and the information in Chapter 7 (pages 201–3).
- Discuss all the key features of your design, using the product design factors as a starting point.
- Collate all this information into a swing tag of your own design, with care instructions on one side and product features on the other.
- Collect any spare buttons, thread or trims that the end-user/s may need, and put them in a small zip-lock bag.
- Attach your swing tag and spare notions to the garment.

ACTIVITY 10.6

Resistant materials
Create either a care label or a set of end-user/s instructions.

- Discuss all the key features of your design, using the product design factors as a starting point.
- Collate all this information into a care label (swing tag) or set of end-user/s instructions, and include either methods of caring for the product, operational, assembly or repair instructions appropriate to your product. Refer to the examples in Figures 10.7 and 10.8.

Figure 10.10 Washing care instructions are attached to the inside of clothing items.

ACTIVITY 10.7

Inspect the care label on a garment you are wearing, such as your school jumper or blazer. What fibre is the garment? What care instructions does it provide? Do you follow these instructions? Discuss your answers with your class members.

ACTIVITY 10.8

Inspect user instructions for a piece of furniture or product you have at home. How has the information been presented? How could you use this information to assist with the development of your own care label or user instructions?

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Chapter summary

- Your pre-written evaluation criteria are key to evaluating your end product/s.
- Your end-user/s' feedback will help you to evaluate how effectively the product meets both their needs and the design brief.
- A summary of this feedback provides an overall view of your success in the product design process and can identify areas for improvement.
- Providing a highlight of the product features draws attention to its attributes and how it meets the needs of the end-user/s.
- Providing a care label and/or user instructions helps the end-user/s use the product safely and take care of it, ensuring that it has the longest life cycle possible.

Short-answer questions

1. Summarise the questions that need to be answered in your evaluation of the end product.
2. Describe where you would find ideas to use to establish criteria to check how well your product meets the requirements of the design brief.
3. Your product needs to be cleaned. Identify where your end-user/s would find information on how to best do this.
4. Describe the type of products that come under mandatory care-labelling standards.
5. Propose the information that you might include on a care label or user instructions.

Extended-response questions

1. List three reasons why it is important to create user instructions and/or a care label for an end-user/s.
2. Discuss why constructive and honest feedback is important in the product design process.

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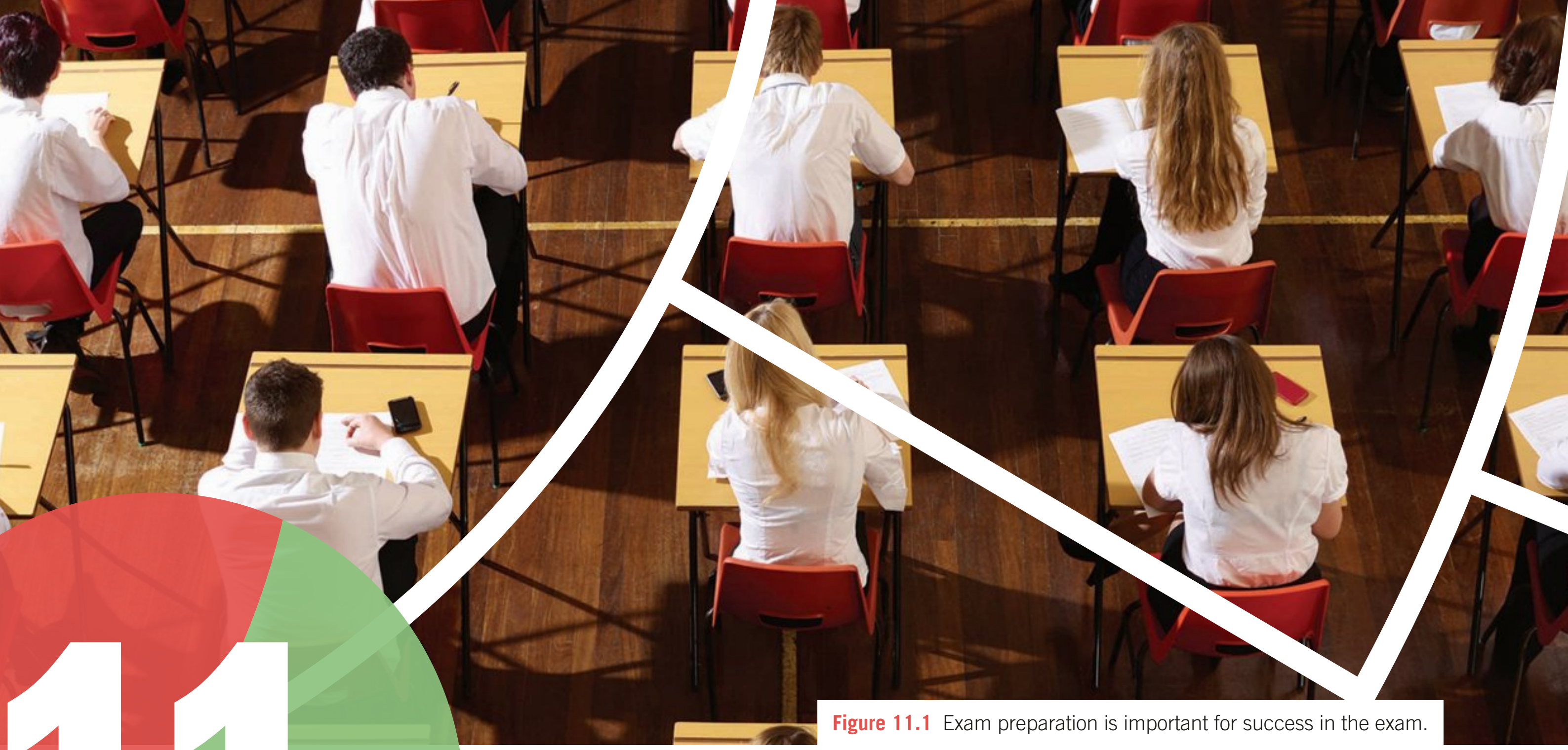
Figure 11.1 Exam preparation is important for success in the exam.

11 Assessment guide for Units 3 and 4

KEY KNOWLEDGE

- General information on the exam
- Summary of areas of revision
- Section A exam advice
- Section B exam advice
- Study tips

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KEY POINTS

- The exam is worth 30% of your study score for Units 3 and 4 Product Design and Technology.
- It is 90 minutes in duration (writing time) and worth 90 marks. This means a mark a minute.
- The exam covers the key knowledge and skills of Units 3 and 4 Product Design and Technology. A strong understanding of cross-study specifications is also recommended.
- The exam is in two parts. Section A is mostly short-answer questions, often with many questions focused on the analysis of an industrial design type object not specific to a material in the study. Often there is one extended-response question. Knowledge of the SAC Outcomes is key in this section.
- Section B is the design section. A pull-out design brief and situation will be provided for all materials, and all questions will relate to this. Students will have to generate a design option based on the brief as well as answer short-answer questions related to their design, the brief and the product design process. Knowledge of the SAT Folio Outcomes is key in this section.
- Students will need to bring their own drawing materials to the exam. The VCAA publishes specific advice for each year; however, pens, lead and coloured pencils, water-based pens and markers, highlighters, erasers, sharpeners and rulers are allowed. Figure templates are not allowed.

REVISION ADVICE

- Revise all your materials from the year, including SACs.
- Have a strong grasp of the product design process and the product design factors.
- Practise your drawing skills under timed conditions. Do not spend more than 20 minutes on the design option question.
- Know how to draw a few processes in the degree of difficulty list and how to annotate them (see past exam advice for answers).
- Use the glossary in this textbook and in the workbook to help with your knowledge of the key terms of the subject.
- Have basic knowledge of materials other than your own (for example, plastics, wood), and their impact on the environment and sustainability. The exam has many questions that are not material-specific and require you to apply general design knowledge.
- Complete as many practice exams as possible, under timed exam conditions, and either self-correct them or seek teacher feedback (see VCAA interactive link). Note: All old exams are from the previous study design.
- Read over examiner reports to see areas of weakness in past exams.

11.1 General information on the exam

Common errors made in past exams

- Not being able to identify key terms from the study (for example, IP) and needing to revise more.
- Misreading the question and providing unrelated responses
- Completing the design option in pen only. Pens are for answering written questions only. Colour is crucial in this question.
- Misunderstanding the use of parameters.
- Not understanding or being able to apply the design elements and principles.
- Lack of understanding of the parameters of the product design factors.
- Not giving enough detail in the response; for example, 3 marks means three good reasons.
- Not being able to list the steps and stages of the product design process.
- Misreading the extended-response question. This is generally worth 6 marks and needs to have 6 marks' worth of content directly answering the question as specified.

- **Review your knowledge before you begin studying and complete an area of revision Activity 11.1 on page 193 of the workbook.**
- **Revise and create notes using the tables on page 194 of the workbook, Activity 11.2.**

During reading time

During reading time, read through each question in detail and pull out the design brief section of the exam. Make a mental note in your head of the following points:

- What knowledge will I need to have to answer that question?
- What is the command term used in the question?
- How am I expected to answer this question?

Plan your answer in your head.

During writing time

During writing time, quickly read through each question again. Think about what you thought about during reading time.

- Use a highlighter to highlight the command term.
- Follow the 1 mark per 1 minute rule. (Don't let the design option question take too much time.)
- Write clearly.
- Do not repeat the question in the answer.
- Attempt all questions.
- Break down the question by expected marks (2 marks = two points).
- Place a wristwatch on the table so you can easily refer to the time.
- Proofread your answers before submitting your paper, if time allows.
- The space you are given is a good guide to how much you should write. Ask for more paper if you need it.

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11.2 Summary of areas of revision

Tables 11.1–11.3 provide summaries of the key knowledge you have covered throughout the year. You should be able to recognise, define and apply all the terms listed. Use these tables to plan your revision.

Refer to the revision Activity 11.3 on applying the product design process on page 196 of the workbook.

The product design process	4 steps		10 stages	
	Investigating and defining		• Identify end-user/s, need, problem or opportunity • Design brief • Evaluation criteria • Research	
	Design and development (conceptualisation)		• Visualisations • Design options (presentation drawings) selection and justification of the preferred option • Working drawings	
	Planning and production		• Scheduled production plan • Production	
	Evaluation		• Product evaluation	
The nine product design factors	1 Purpose, function and context 2 User-centred design 3 Innovation and creativity 4 Visual, tactile and aesthetic (design elements and principles) 5 Sustainability 6 Economics – time and cost 7 Legal responsibilities 8 Materials and properties 9 Technologies – tools, processes and manufacturing methods			
Design elements and principles	**Elements**	• Point • Line • Shape • Form	• Texture • Tone • Colour	• Transparency • Translucency • Opacity
	Principles	• Balance • Contrast • Repetition • Movement/rhythm	• Pattern • Proportion • Asymmetry/symmetry	• Negative/positive space • Surface qualities

Table 11.1 Cross-study specifications

(Continued)

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Materials	Understanding of the properties and characteristics of materials, their influence on the design of products, suitable processes to use with one (or more) specific materials, either: • wood/timber • metal • plastic • textiles/yarns/fibres • polymers (plastics)	
Design briefs	• Outline of the situation • Constraints and considerations • Expected quality	
Evaluation criteria	• A question • Justification and relevance to the design brief • The process used to evaluate the success of the product • How the finished product could be tested or checked	
Sustainability	**Life-cycle analysis/assessment**	• Extracting and processing raw materials • Manufacture • Transport, distribution and packaging • Use, reuse and maintenance • Disposal/end of life
	Three pillars	• Social • Environmental • Economic
	Other models and systems	• Design for disassembly (DfD) • Extended producer responsibility (EPR) or product stewardship • Cradle to cradle
Intellectual property (IP)	• Importance of IP • Forms (design registration, patents, copyright, trademarks)	
Cultural movements		

Table 11.1 Cross-study specifications *(continued from previous page)*

Applying the product design process

Designing for end-user/s in product development	Roles and relationship of the designer and end-user/s Steps, stages and goals of the product design process Influences of the product design factors on a designer Market research for an end-user/s Ways to research a design problem Writing a design brief for an end-user/s' requirements, making reference to the product design factors Evaluation criteria for the finished product Relationship between the design brief, evaluation criteria, research and design development	
Product development in industry	Research and development The product development process New and emerging technologies and their influence on design	• New materials • Rapid 3D prototyping • Laser technology • CAD/CAM • CNC • Robotics

(Continued)

Table 11.2 Unit 3 – Applying the product design process

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	Lean manufacturing	
	Importance of innovation in the product development process	
	Market research in the product development process	
	Sustainability strategies, and how they influence design, production and distribution	• LCA • Cradle to cradle • DfD • EPR/product stewardship
	Planned obsolescence and its problems and benefits to producers, consumers and the environment	• Style • Technical • Functional
	Scales of manufacturing and their suitability	• One-off • Low-volume • Mass/high-volume • Continuous production
Designing for others	Using the product design process for an end-user/s	
	Role of evaluation criteria	
	Materials research	• Understanding materials' characteristics and properties • Materials testing and comparison • Researching processes appropriate to your materials
	Prototypes	
	Creative and critical design thinking techniques	
	Gaining feedback from end-user/s	
	Role of drawing styles	• Visualisations • Design options • Working drawings • Using ICT and CAD in the product design process
	Selecting and justifying the preferred option	
	Generating working drawings	
	How tools, equipment, machinery and facilities affect productivity	
	Production planning	• Scheduled production plan with materials, tools and equipment and machines used • Timeline • Quality measures • Risk assessment/management • Materials and costing list
	Techniques to record progress	
	Production methods in industry	

Table 11.2 Unit 3 – Applying the product design process *(continued from previous page)*

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Product development and evaluation

Product analysis and comparison	Evaluating products using qualitative and quantitative data, and user trials	
	Attributes of products	
	Environmental, social and economic concerns to purchasers of products	
	What designers, manufacturers and users value in products	
	Values of a product during its life cycle	
	Factors of quality products	
Product manufacture	Risk management	1 Identify hazards 2 Assess risks 3 Control hazards and risks 4 Check controls
	Applying processes with different degrees of difficulty	
	Time management in production	
	Monitoring efficiency and effectiveness in production	
	Recording your progress and changes	
Product evaluation	Gathering end-user/s' feedback using evaluation criteria	
	Testing the product/s	
	User instructions and care labels	

Table 11.3 Unit 4 – Product development and evaluation

11.3 Section A exam advice

Section A is typically short-answer questions, often with many questions focused on the analysis of an industrial design type object not specific to a material in the study. Often there is one extended-response question. The key areas to focus on getting ready to answer in Section A are:

- sound knowledge of all key areas in the study design
- understanding exam terminology and command terms
- breaking down questions.

Common areas examined on in Section A in the past include:

- the product design process, including the purpose of its stages and steps
- knowledge and application of the product design factors
- product attributes
- application and understanding of the design elements and principles
- understanding different models and systems of sustainability
- scales of manufacturing
- market research techniques
- forms of obsolescence
- intellectual property.

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Command terms

How a question is asked and what command term is used will determine how you are expected to answer the question. Key command terms usually used in the Product Design and Technology exam include:

- **List** – use bullet points for short answers.
- **Identify** – point out main concepts.
- **State** – write a brief statement.
- **Outline** – define and summarise points.
- **Describe** – give details within the answer.
- **Justify** – give reasons for your answer.
- **Discuss** – state both positives and negatives.
- **Compare** – discuss similarities and differences between concepts.
- **Evaluate** – discuss in more detail in your viewpoint/answer and suggest improvements.
- **Explain** – give reasons for your answer.

Table 11.4 shows how the use of different command terms can change how you are expected to answer a question. It can also affect the marks within the question due to the level of detail required.

Analysing a commercial product

In Section A, you will generally be asked to analyse a commercial product. You will be shown a picture of the product with some basic information. This product will be something you should be familiar with or have general knowledge of.

Before answering the questions related to the product, double-check what questions relate to the product and therefore the answers must refer to the product. This is usually stated above the picture of the product.

When looking at the information supplied, highlight the following:

- any product design factors
- end-user/s (or suggested end-user/s from where the product will be used).

Preparing for this part of the exam is as easy as looking at products around your house and analysing them in greater detail.

List two product design factors (2 marks)
• Purpose, function and context • User-centred design
Explain two product design factors and how they relate to design. (4 marks)
Purpose, function and context is where the product will be used. User-centred design focuses on improving the quality of life of the end-user/s. Together they relate to design, as they are both important in creating a successful product that meets the design problem.
Compare two product design factors and give examples. (6 marks)
Purpose, function and context is where the product will be used. User-centred design focuses on improving the quality of life of the end-user/s. They both relate to the end-user/s, but purpose, function and context is where and how the product will be used. User-centred design is using information such as ergonomics to ensure that the product can be used easily by the end-user/s. For example, an outdoor umbrella can be set up easily by one person. Purpose, function and context is to ensure that the designer will design a product that will function as intended. For example, an outdoor umbrella will be weighed down at the base to prevent it from flying away in the wind.

Table 11.4 How different command terms determine how you are expected to answer a question

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Example – a child's lunchbox

Figure 11.2 The primary function of a lunchbox is to store food.

- **Refer to the revision Activity 11.4 on product development in industry on page 197 of the workbook.**
- **Refer to the revision Activity 11.5 on designing for others on page 199 of the workbook.**
- **Refer to the revision Activity 11.6 on product development evaluation on page 202 of the workbook.**
- **Refer to the analysis Activities 11.7 a,b,c and d on workbook pages 204–207.**

Primary function	End-user/s
Holds food	A child going to day-care or school
Secondary function	**What scale of manufacturing was this product made using?**
• Looks aesthetically pleasing to children • Handle allows it to be carried easily	• Batch/low-volume • Only a small amount of products will be needed on the market at the same time
Product design factors	**Product attributes**
• Purpose, function, context – holds different types of food • User-centred design – designed with a child in mind, easy to open lid, space for hands to easily grab food, handle allows it to be carried • Visual, tactile, aesthetic – shape and colour of an elephant • Materials – made out of safe materials due to holding food; sturdy due to rough handling by young children	• Easy to clean • Clear lid to see if the food has been eaten • The shape of a cartoon elephant • Handle is the 'tail' of the elephant
Sustainability	**Interesting points**
It can be washed to be reused. There is no need for extra wrapping of food.	The shape of the elephant has been used on the lid, with eyes, an ear and toes, adding a 'cute' factor.

Table 11.5 Product analysis of the Boon elephant lunch box. Boon products offer practical, sustainable yet stylish designs for everyday use. To view the Boon elephant lunchbox and other Boon products, visit the Booninc website via the Product Design and Technology VCE Units 1-4 Interactive textbook.

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11.4 Section B exam advice

A pull-out design brief and situation will be provided for all materials, and all questions will relate to this in Section B. You may have to generate a design option based on the brief as well as answer short-answer questions related to their design, the brief and activities in the product design process.

Questions before and after the design option

As well as drawing a design option, you will need to answer questions about the design option and parts of the product design process. In the past, this has included:

- end-user/s information gained from the brief
- generating constraints and considerations from the brief
- turning parts of the brief into evaluation criteria
- justifying your material choices
- applicable materials testing
- discussing design features you have included
- purpose of annotation
- steps of the product design process
- the specific components of a scheduled production plan and their purpose
- risk management during production
- discussing suitable scales of manufacturing of the design option
- product testing and evaluation.

Drawing the design option

You must respond to the brief given. You will be given a scenario that applies to all students, then you will pick the type of product/s you will design, dependent on your material. Sometimes a theme choice is given too. Plan your design option in greylead pencil before rendering and using fineliner. Don't be intimidated by your drawing. This is an exercise in design and not simply in drawing. Front and back views are advised for textiles/non-resistant materials, and an oblique view or isometric view for resistant materials. A suitable plan could be:

- read the brief, highlighting key terms, and generate ideas
- draw the design in greylead in the space provided

(Continued)

Degree of difficulty list			
Wood	**Metal**	**Plastics**	**Textiles**
• Biscuit jointing • Crossed housing jointing • Dovetail jointing • Housing jointing • Mortise and tenon jointing • Rebate/shoulder butt jointing • Routing (decorative edge) • Spline and mitre jointing • Veneering • Wood turning (using a wood lathe)	• Bronze brazing • Cold bending • Folding • Forging • Riveting • Rolling • Silver soldering • Turning (using an engineer's lathe) • Welding	• Blow moulding • Casting • Injection moulding • Riveting • Turning (using an engineer's lathe) • Vacuum forming	• Boning • Buttonhole making • Collar making • Cuff making • Piping • Pleating • Pocket making • Rolled hemming • Sleeve insertion • Surface decoration • Zip insertion

Table 11.6 Processes with a degree of difficulty (from the 2016 VCAA Product Design and Technology exam)

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- then use fineliner for the ‘borders’ of the design (seams and so on)
- rub out the greylead
- render with coloured pencil
- annotate the design
- complete the processes section.

Criteria used to mark the design option

Innovation and creativity in the design option

This is not the time to be conservative. Go crazy and push yourself! Combine materials and use processes in exciting ways. Use colour and shape to create something exciting.

Drawing, in the boxes, communicates how the processes are constructed and includes at least one process from the degree of difficulty list

The exam will contain suggested processes (see Table 11.6), which you need to combine into your design option. You then need to draw and annotate the process being completed (not a drawing of the process) in this section. Imagine that someone who has limited knowledge of your material needs to know how to complete this process. Use visuals and words to communicate how to complete this process.

Function/suitability of the design option for intended use

This is how well your design meets the brief. This can be done by designing explicitly what is asked for in regard to your material, as well as meeting the design brief.

Use of visual, tactile and aesthetic product design factors in the design option

This relates to how well you have implied how the design option looks through colour and texture, and the care taken to complete the drawing. For non-resistant materials, you can imply texture such as pleats, gathers and surface decoration.

Do not use pen or highlighter in the drawing.

Annotations, on the design option, that indicate how the requirements of the design brief have been met

This is where you get to explain how your design meets the brief, and can include:

- phrases and words from the brief (with an explanation to show you are meeting them)
- measurements if they are relevant
- your material choices and reasoning
- use of processes.

Do not annotate things already visually obvious (for example, colours used) or simply explain that something is ‘innovative’. Make your annotations purposeful and succinct.

Clarity and detail of drawing in the design option

This means how clear and detailed your design option is, considering the overall layout and presentation. Make only necessary annotations and don’t clutter the page like you would when developing your folio pages in the SAT.

Refer to the revision Activity 11.8 on design scenario practice on page 209 of the workbook.

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11.5 Study tips

Studying is about taking time out and focusing on the task. Turn off all distractions. No one can multitask when studying. Our brains can only fully focus on one task at a time.

Find or create a quiet space that allows you to study for an extended period of time. The school or local library are quiet and away from the usual distractions found around the house.

Create a study timetable

Before starting your study, create a study timetable.

- Find out the dates and times of all your exams and write them down in a diary.
- Note all the extra things that may need your focus over that time, such as work, sport, family events.

School-assessed coursework and study

Over Units 3 and 4, you have completed school-assessed coursework. These are a great source of information to see if you have grasped the key knowledge taught in the units. It is vital that you are honest in knowing your weak areas, so therefore you can focus on them. Ask your teacher for feedback on the tasks you have completed.

Create a list of the weaker key areas in your school-assessed coursework and ask yourself the following questions:

- Did I study enough before the exam?
- Did I study effectively?
- Did I attempt all the questions or leave some blank?
- Was it the key concept that I didn't understand in the coursework?
- Did I misread the question?
- Do I know the exact definitions of the words?

Table 11.7 outlines how to reflect on areas that need further study.

Reflecting on areas that need further study

SAC	Weak areas	What to study
Unit 3 Roles of end-user/s	I didn't clearly state how the end-user/s is vital to the designer when designing.	End-user/s
Unit 3 Product design process	I didn't remember all the stages and steps in the design process.	Revise all stages and steps of the design process until I can list them without looking at my notes.

Table 11.7 Reflecting on areas that need further study

Refer to the study timetables on page 216 of the workbook to plan your revision time.

Another way of receiving feedback is through practice exam questions. You can access past Product Design and Technology exams on the VCAA website.

Time yourself doing the exams.

- Where in the exam were you spending too much time?
- What were the questions that you struggled to answer?
- Did you understand what was being asked of you?

Study timeline

Studying for an exam needs to start many weeks before the exam date. You can complete study at home while you are completing your product in class. The more time you spend on study, the greater your understanding of the study design will be.

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One month out from the exam

- Look at your weak areas from your SACs. Focus on these key knowledge and criteria.
- Revise your notes and textbook to strengthen your weak areas.
- Rewrite your own notes.
- Find questions in past exams that cover those areas and attempt them.
- First attempt – don't worry about the time, but try to deconstruct the questions and mark allocations.
- Second attempt – follow the rule 1 mark = 1 minute.
- Complete one exam a week and give it to your teacher for marking.
- Deconstruct a design brief from Section B and practise the design options.
- Create cue cards of the key terminology, terms and questions in the study design.
- Look at the terms in the exam questions. Know clearly what each term means and know how you are required to approach/ answer the question.

Three weeks from the exam

- Get friends and family to test your knowledge of key terminology with cue cards.
- Keep a checklist of the key knowledge and skills, tick them off when you feel confident in the terms.
- Write your own questions and create your own exam of key knowledge and skills.
- Practise your drawing skills for Section B.
- Complete one exam.
- Make a list of key knowledge and skills that you need to focus on during study.

Two weeks from the exam

- Keep testing yourself with cue cards.
- Complete one exam and give it to your teacher for marking.
- Revise areas for improvement from past VCAA exams.
- Practise completing a drawing from a past exam brief in Section B.
- Read over your own notes.

One week from the exam

- Complete one exam and give it to your teacher for marking.
- Revise areas for improvement from the exams.
- Create a 'things I need clarification of' list and arrange a time for a meeting with your teacher to discuss them.

Three days from the exam

- Revise all areas for improvement from the exams.
- Practise completing a drawing from the brief.
- Read over your notes and cue cards.

Two days from the exam

- Pack your clear plastic bag with everything you need for the exam. If you are missing anything, see your teacher.
- Read over your notes, exam terminology, and general Product Design and Technology terms.

Day before the exam

- Read over your notes, exam terminology, and general Product Design and Technology terms.
- Place your clear plastic pencil case into your bag.

Day of the exam

- Plan to arrive at school at least 30 minutes before the start of the exam.
- Double-check that you have all of the materials needed for the exam.
- Have a proper breakfast.
- Take a deep breath and attempt every question!

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Chapter summary

- The exam is 30% of your final study score for the subject.
- All the information asked in the exam is covered in the study design.
- Remember the product design process and product design factors.
- Preparation will ensure that you will get the best mark possible in the exam.

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Glossary

3D printing a printing process that typically uses plastic to make 3D models

assembly line a succession of identical products progressively assembled in a factory

basting or tacking large stitches used to hold fabric together before sewing

bespoke product made to order, commissioned or to a particular specification

bio-regionally relating to the ecology, economy and culture of the place where you live

blog a website or web page written in a conversational style, usually by a person or small group of people

by-product a secondary product that is produced as a result of a manufacturing process

clipping removal of some of the seam allowance to reduce seam bulk in a curve of fabric

closed-loop production use of post-consumer waste to create new products

computer-aided design (CAD) software used by designers, architects, engineers and artists to create accurate drawings or technical illustrations

computer-aided manufacture (CAM) the use of software to control machine tools/laser in the manufacturing of products

computer numerical control (CNC) the automation of machine tools operated by accurately programmed computer commands

corner removal removing part of the seam allowance to reduce seam bulk in a corner

cost-effective term used to describe if the product development process meets the constraints of price considering the factors of design and development costs, materials, tooling creation and manufacturing

cradle to cradle the impact a product has through its life socially, economically and environmentally

cutting to cut out pieces from a larger fabric or material ready for assembly

design a drawing/sketch that shows the look, function and the way a product works before it is produced

distribution the movement of products from the manufacturer to the end-user/s

effective completing a task to the desired result

efficient completing a task quickly with minimal waste of time and materials

end-user/s the people who will use or are intended to use a product that has been developed and marketed

equipment an item used for a particular purpose

finishing completing the product to aesthetically achieve the look required by the client or end-user/s

flexible and responsive manufacturing manufacturing that allows a system/machine to adapt to changes

forging a metal shaping technique

Greenguard certification that gives assurance that products designed for use in indoor spaces meet strict chemical emissions limits, which contribute to the creation of healthier interiors

hazard a production process, tool or machine that could cause injury

hemming a finishing technique of sewing the edge of the cloth to stop the fabric unravelling

joining connecting material or parts together

kerfing sawing cuts into a length of wood

knitted fabric fabric formed by knitting loops, often allowing the cloth to stretch

landfill burying of waste material

laser cutting computer-aided design (CAD) that is used to direct a laser that cuts materials

laser technology refers to machines that use a laser (light amplification by stimulated emission of radiation) to complete particular tasks

lean manufacturing the minimisation or elimination of waste within a production/manufacturing system

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machine a device that uses mechanical power with parts that perform a function together to create an item or perform a task

manufacture the making of products either by hand or using tools, equipment and machinery

marking out measuring the selected materials with reference to the working drawing/pattern

maximum stretch the grain (warp or weft) of knit fabric that provides the most stretch, which should be cut across the body

modular design a way of designing that subdivides parts of a product into smaller parts called modules

muda Japanese word for waste

nap a raised surface on fabric, such as velvet or suede

natural fibres fibres sourced naturally, including from plants and animals, such as cotton or wool

negative environmental impact when design does not comply with sustainable design principles

niche market a small group of consumers with specific needs

notches small indentations on pattern pieces that help with matching up seams

notching removing parts of the seam allowance as a guide in fabric construction

obsolescence when a product's style, technology or function becomes outdated and is not wanted any more

planned obsolescence refers to a company planning for either the style, technology or function of a product only lasting for a set time and having to be replaced; it typically applies to technology like mobile phones

product a physical item that has been designed and made with an end-user/s in mind

product development the overall process related to the development of a commercial product (new or redeveloped)

product development process the evolution of a product from the designing phase to manufacture and distribution and, finally, into the marketplace

product life cycle the stages throughout the product life from idea to disposal

production using tools, equipment and machines to produce a product from sourced materials

prototype a high-quality version of a final product that uses substitute materials

quality measures ensure that the product is of the highest quality possible

rapid 3D prototyping requires CAD to fabricate a scale prototype of a part or assembly quickly

raw materials the basic material from which a product is made

recycled when a product or parts or components of a product can be used again or the material is reuseable

research and development (R&D) involves developing innovative ways to improve products and production processes

risk management following a process of working to recognise and control risk

riveting a metal pin with a head at one end that is pushed through two sheets of material with a rivet gun, joining them together

robotics an area of technology that focuses on the design, production, operation and use of robots

routing flexibility when a manufacturing system is able to adapt to changes in manufacturing capacity; this capacity could be an increase in the volume of products being manufactured

safety involves recognising the potential risks working in a textiles classroom or resistant materials workshop and taking appropriate safety measures

seam allowance the distance between the stitch and the raw edge on a garment; this can vary between knitted and woven garments

shaping altering the shape of a material or parts

straight grain the lengthwise warp yarn that runs parallel to the selvedge (finished edge) in woven fabrics

subtraction cutting a method of hollow construction that can be used variously to make men's and women's fashion garments, accessories and interior/exterior products, developed by Julian Roberts

sustainable design thinking awareness and application of user-centred design (product design factors) to promote sustainable design of products by considering social, economic and environmental sustainability

synthetic fibres fibres generated by man-made means, such as polyester or nylon

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tacking a temporary long stitch to assist with sewing; can be done by hand or machine

target market a group of potential customers of the product

tool an implement that is held by one hand to do a certain function

tooling assorted tools acquired for the manufacturing components and machines required for production; aluminium and plastic is generally used for low-volume tools and steel for high volume

trimming removal of some of the seam allowance to reduce seam bulk

under-stitching helps the lining or facings to remain unseen in a garment; the seam allowance is sewn to the facing or lining close to the seam

useability the ease with which the product can be used and understood by the user

vacuum forming heated plastic that is formed over a mould using the force of a vacuum

veneering gluing a thin sheet of wood or other material onto a product to improve its appearance

video blog a form of web television, often referred to as a vlog, where entries are usually an embedded video or video link with supporting text and images

want (in a product) aspects of the design that a user wants that do not relate to its primary function

woven fabric fabric formed by weaving, interlacing two yarns (a warp and a weft) at right angles

zero waste techniques a philosophy that encourages minimal to zero waste of materials in the production of garments

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