Design and Technology:

STAGE 5
SECOND EDITION
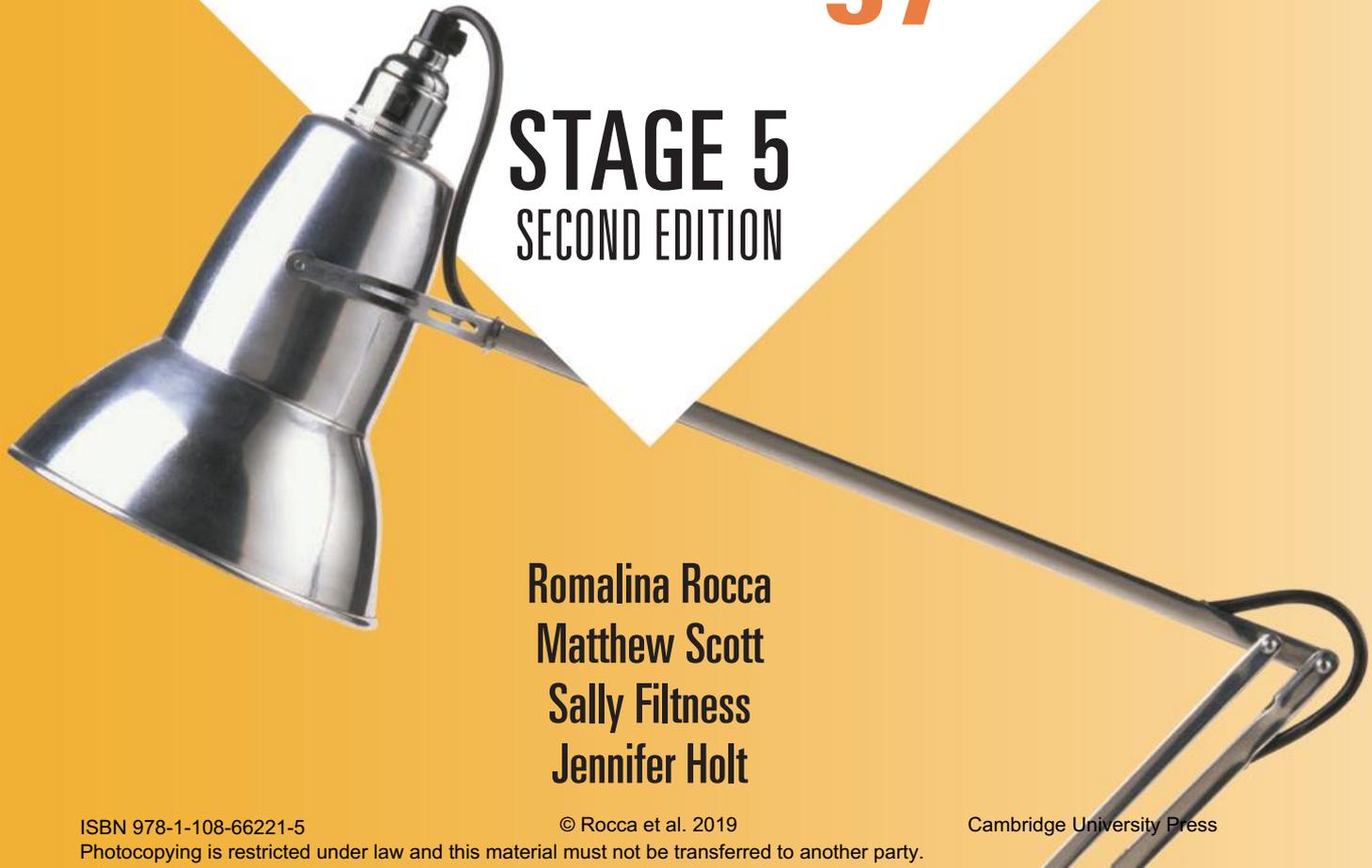
Romalina Rocca
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Jennifer Holt

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*Please be aware that this publication may contain images of Aboriginal and Torres Strait
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terms and spellings may also appear; no disrespect is intended.*

*Please note that the terms 'Indigenous Australians' and 'Aboriginal and Torres Strait
Islander people' may be used interchangeably in this publication.*

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HOW TO USE THIS RESOURCE

Chapter openers introduce the outcomes addressed in the chapter, list **key terminology** and prepare students for the activities ahead. **Core content** icons illustrate which core content area the chapter relates to, and the relevant content items are listed.

A Holistic Approach

Design Processes

Activity of Designers

Numbered chapter headings allow easy navigation between the textbook and the interactive version.
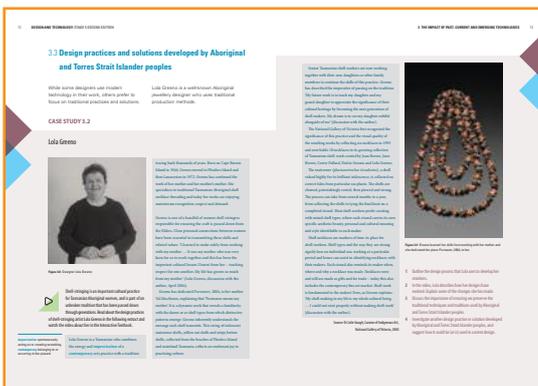
Case studies explore real-world examples that cover a range of concepts, including the processes of designing, producing and evaluating. **Analysis questions** that follow each case study allow students to demonstrate their understanding of the content and prepare them for their assessment.

Learning **activities** explore chapter outcomes, develop skills, build knowledge and understanding as well as encourage creativity. Activities are marked as either **designing** or **communicating**.

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

End-of-chapter material includes chapter summaries and four sets of tasks – define key terminology, review, extension and practical – to test your knowledge through the reinforcement of key outcomes and application of skills.

Further digital resources are available in the **Interactive Textbook**

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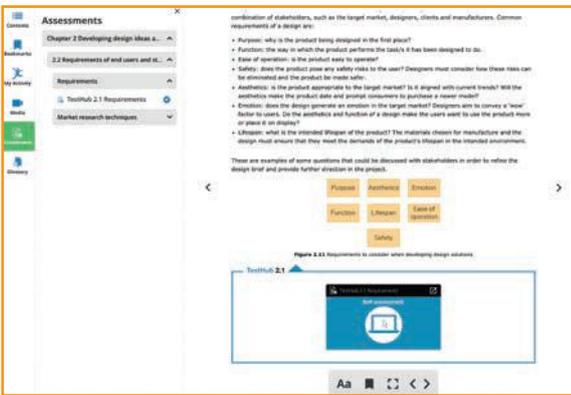
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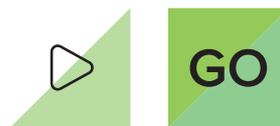
All Activities and Case studies are available as **downloadable Word documents**, which can be accessed from within the Interactive Textbook or via Cambridge GO.

The **offline digital textbook** includes note taking and search functions.

For a list of websites and links related to this book, go to:
www.cambridge.edu.au/designtech52ed

ACKNOWLEDGEMENTS

1 Design concepts and processes

KEY TERMINOLOGY

- Design
- Design process
- Design thinking

- Environment
- Prototype
- Society

- Technology
- Appropriate technology

This chapter introduces the basic concepts of design. It explores the purpose of design, as well as the elements and principles of good design and the design process. The studies in this chapter reveal how modern designers take into account the impact of their designs on both humans and the environment. The interdisciplinary nature of design, the significance of technology and the importance of collaborative methods for designers are all highlighted as essential components for successful design. This chapter explains how members of the design professions continue to adapt existing designs to new situations.

This chapter addresses **Outcome DT5-1** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the content area **The concepts of design**.

1.1 **The nature of design, technology and appropriate technology**

Humans are thought to have been on Earth for more than four million years and we have evidence dating back to this earliest proof of existence of human's ability to **design**. Early humans designed tools to hunt and to prepare food, shelters to protect themselves from the **environment** and symbols and adornments to communicate their common beliefs and rituals. Their **inventions** were aimed at improving the quality of their lives. Since this ancient time, humans have continued to harness technology to design rich, complex environments that can be easily modified to meet constantly changing needs.

Design in today's world is a complex interdisciplinary process that plays a significant role in our daily lives. In the past, design was aimed at providing basic information, shelter, food, and communication, and maintaining health. But in our ever-changing world, new **technologies** have meant that design solutions are now applied to nearly every aspect of our lives. Designers start

Figure 1.1 Throughout history, humans have been designing and inventing products to improve their quality of life.

with identifying a need or opportunity, then create a **design brief** to guide the project, and through bright, imaginative ideas come up with a number of possible solutions. Testing and evaluating proposed solutions to a problem results in the best solution being chosen and manufactured. Today we have the added assistance of technology to communicate, operate machines, collect data, speed up the manufacturing process, and to provide feedback on errors. One design often opens up the possibility of other new designs flowing from just one idea. The rate of new technology appearing is increasing. We have a choice in the kind of technology we use, and must select that which is the most **appropriate**, such as environmentally friendly technology, technology that meets national health and safety guidelines, and technology that considers the responsible use of **resources**.

design an idea, sketch or plan to show the look and function of an object, system or environment

environment one of the outputs of technology processes and/or a place or space in which technology processes operate. An environment may be natural, managed, constructed or digital.
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invention something made through original ideas

technologies the materials, data, systems, components, tools and equipment used to create solutions for identified needs and opportunities, and the knowledge, understanding and skills used by people involved in the selection and use of these
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design brief a statement outlining what has to be achieved

appropriate fitting, suitable to the context

resources assets needed which can include people and/or materials that can be accessed and applied in order for the design to function effectively

ACTIVITY **1.1**

1   Using the information above, write a definition of the following terms in your own words:
     a design   **b** technology.
2   Appropriate technology refers to materials, resources and/or processes that are the most suitable for a product, system or environment to ensure a quality design solution is reached. Provide two examples where appropriate technology has been applied to improve a design solution.

COMMUNICATING

Designers will often look to nature for inspiration, in order to achieve the best possible design solution. Humans and the natural environment are **interdependent** within the ecosystem. Our health, safety and survival of future generations rely on the way each generation is able to care for its environment. It is vital for designers to consider and choose the appropriate technology to be used in any design to ensure that every product's impact on the consumer and the environment is either minimal or beneficial.

interdependent relying on each other

Applying principles when developing design solutions

DESIGN THINKING

Design thinking emerges from a mindset based on a belief that your actions and ideas can make a difference. Design thinking looks at 'what if' and generates a number of suggestions as to how things could be different and better. Design thinkers use all the evidence they can gather to support their various suggestions to form a conclusion for the best possible solution to a problem.

DESIGN PROCESS

The **design process** is the practical application of design thinking. It is a framework used to develop an understanding of the design challenge or the identified problem.

The key stages of the design process are as follows:

- Exploration: exploring the identified challenge to gain a better understanding of what is required. What are the current problems or difficulties that the **target market** faces? The designer **investigates** the needs and wants of consumers by undertaking research, through discussions, observations or surveys.
- Understanding: making meaning of research by drawing conclusions from the data gathered through observations and discussions. This information enables the designer to define the problem or need clearly and to propose new ideas to solve the problem.

design thinking using strategies for understanding design problems and opportunities, visualising and generating creative and innovative ideas, and analysing and evaluating those ideas that best meet the criteria for success and planning.
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design process a framework, or series of stages, used to develop an understanding of the design problem

target market a specific group of consumers at which a product is aimed

investigate students critique, explore and investigate needs, opportunities and information

Figure 1.2 Design thinking begins with looking at the ways products can be different and better.

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- Designing: this stage of the design process requires the research undertaken to act as a launch pad. Brainstorming ideas individually and collaboratively assists in the development of concept sketches and models as ideas start to come to life and progress from 2D to 3D.

- **Prototyping**: this involves testing design ideas and evaluating the designs in order to continue to improve and achieve the **optimum** end result. A prototype can be a working model of the design, or an aspect of the product such as a **mechanism**. Designs can also be tested digitally through the use of simulations.

- Evolution: the final design is never actually the *final* design, as designs continually evolve, change and improve once they have entered the marketplace. The design process is cyclical, and designers return to the exploration stage with new information from consumers to further develop products. Evolution in design is the continual unfolding and development of new products to meet new needs.

prototype a trial product or model built to test an idea or process to inform further design development. A prototype can be developed in the fields of service, design, electronics or software programming. Its purpose is to see if and how well the design works and it is tested by users and systems analysts. It can be used to provide specifications for a real, working product or system rather than a virtual or theoretical one. *Prototype* is derived from Greek terms that, when translated, mean 'primitive form', 'first' and 'impression'.
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optimum a favourable or best outcome

mechanism a system of parts working together

Figure 1.3 Focus groups and discussions are one way to discover what consumers need.

- **Evaluation**: this takes place at every stage of the design process and is continuous. To evaluate means to make a judgement about the design, and decisions are made throughout the design process concerning the suitability of the product to fulfil the established need that prompted the design in the first place.

evaluate measuring performance against established criteria. Estimating nature, quality, ability, extent or significance to make a judgement determining a value.
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process actions or steps taken in order to achieve an end result

Figure 1.4 Constantly evaluating the product helps designers know whether it fulfils its purpose.

ACTIVITY 1.2

1   Draw a diagram to illustrate the steps in the design process.
2   Using an A4 sheet of paper, make a paper plane. Apply the design process to design, make, refine and evaluate the paper plane. Document the process undertaken.

DESIGNING

1.2 **Purposes of design**

aesthetics branch of philosophy dealing with the nature of art, beauty and taste. It is more scientifically defined as the study of sensory-emotional values, sometimes called judgements of sentiment and taste. Aesthetic judgement is concerned with the visual impact or appeal of a product or environment and is influenced by social, emotional and demographic factors.
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ergonomics understanding of the activity of humans within systems or in an environment to maximise the wellbeing of humans and their productive use of those systems or environments
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The overall purpose of design is to facilitate or to assist our lives. The consideration of basic elements such as function, **aesthetics** and **ergonomics** can help to modify and improve life.

A design that makes our lives easier and assists our living, such as an ergonomic backpack to carry our daily essentials to and from school or the work place, would be considered good design. By contrast, a design that hinders or inhibits our lives, such as a leaking water bottle or a poorly ventilated room, would be seen as bad design. The nature of design requires designers to consider humans and both the built and natural environments, as they all impact on each other.

The purposes of specific designs vary depending on the need of the target user.

For example, the design of a baby's toy would have strict safety standards and the toy must be easily washable and hygienic to ensure the health and safety of babies is not put at risk.

Design and the role designers play are vital in assisting us in our everyday lives. Almost everything we interact with from the moment we are born, such as the clothes we wear, the places we live in and the methods we use for cooking, have been designed for a purpose and they all aim to make our lives easier and more comfortable.

A design starts out as a plan or a sketch of how a new product, system or an environment could look and function.

This plan is used firstly to communicate ideas in order to assist designers when discussing, testing and evaluating options for a new way to

Figure 1.5 A water bottle that leaks would not be considered a good design.

Figure 1.6 The design for a baby's toy must adhere to strict safety standards.

make or improve a product. Secondly if a particular design is chosen, the plan will provide a guide for construction.

Focus areas

Designers all follow a similar design process, however they specialise in different areas of design. Common areas of design are outlined below.

INDUSTRIAL DESIGN

Industrial design is the design of products that specifically relate to human usage, such as an office chair, table, microwave oven, or a vacuum cleaner. Industrial designers often work as part of a design team, researching, testing and exploring ideas, concept sketching, prototyping and evaluating.

An industrial designer is often involved in the decision making at the manufacturing stage, and overseeing the development of **tooling** for the production process.

ARCHITECTURE

Architecture involves the combination of the following disciplines:
- art
- science
- mathematics
- technology

Figure 1.7 Industrial designs, such as vacuum cleaners, are products specifically related to human usage.

- environmental awareness in the development of the built environment.

The role of an architect is to **create** the physical environment where people live or work. The design and planning of our towns, cities, park spaces, commercial and residential buildings are the work of architects and as a result, architecture significantly impacts on our quality of life by promoting social inclusion and interaction among society.

tooling the process of acquiring the manufacturing components and machines needed for production
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create develop something completely new; combine existing elements to make a coherent or functional whole; make a new pattern or structure by reorganising existing elements

Figure 1.8 Frank Gehry's 'paper bag' building (the Chau Chak Wing Business School building) at UTS in Sydney is an example of how interesting architecture can change the landscape. The photo on the left shows a model, unveiled in 2010, and on the right is the completed building in 2015.

INTERIOR DESIGN

An interior designer plans and organises the interiors of homes and buildings. They work as part of a design team with architects, builders and cabinetmakers to design or coordinate the following:

- flow of space, traffic flow, furniture
- lighting, flooring
- fabrics and colours for the internal space.

FURNITURE DESIGN

A furniture designer uses their extensive knowledge of ergonomics and the needs of the human form to design and develop furniture. Their work is closely related to that of an interior designer and industrial designer, in that they combine technical skills to create the shape and style of furniture, and the colour and furnishing of the furniture item.

Figure 1.9 Shape and style are key elements in furniture design.

GRAPHIC DESIGN

Graphic design involves the design and development of information through the use of texts, layouts, images and logos for publication. A graphic designer specialises in visual communication to an intended audience. They combine colour, page layout, symbols and illustrations into a final design for physical or digital media.

JEWELLERY DESIGN

Jewellery designers use a range of traditional and non-traditional materials to design and make rings, necklaces, earrings, bracelets, brooches and watches. Jewellery design is often detailed, intricate and tailored to individual needs, styles and personal preferences.

FASHION DESIGN

By designing and creating clothing, accessories and footwear, designers are the drivers of our fashion industry and the trends that direct it.

Fashion designers are heavily involved in the design process of their products from the development of patterns, materials, samples, assembly and manufacturing details to displaying the product ready for consumer use.

Figure 1.10 Fashion designers are heavily involved in the design and manufacturing process of their products.

TEXTILE DESIGN

Patterns, textures, knits, weaves, prints and illustrations for materials and fabrics are the results of the work of a textile designer, and may involve colour matching, complementing or contrasting, together with furniture, soft furnishings and even wallpaper, making textiles into works of art.

All of the listed design disciplines share the same design process. Although the disciplines have different roles and responsibilities, as well as using different materials and technologies in the development of their designs, they all follow the same steps of the design process.

ACTIVITY 1.3

Undertake internet research on one of the design disciplines listed above. Write a job advertisement for a job within the chosen design discipline, identifying the education and training, skills and experience required.

COMMUNICATING

1.3 **Collaborative and interdisciplinary methods**

Collaborative methods

To collaborate means to work together and share ideas with the benefit of achieving a better quality design than one could develop on one's own. When people collaborate, they are working together to achieve a common goal, sharing knowledge, **skills** and building a greater understanding of design. Collaborative methods include using effective communication methods to identify the common goal, gathering different skills from a variety of team members, ensuring that all team members are listened to and respected, and selecting an environment where the team meets, to convey a sense of equality and encourage the freedom to be creative.

skills the specific techniques, strategies and processes in a learning area

COMMUNICATION

Collaboration requires a high level of effective communication in order to achieve a successful productive process. All elements of the project must be communicated clearly so all members of the design team are aware of the common goal the team is trying to achieve and what role each member of the team has to play. When discussing design concepts, it is a good idea to use expressions such as 'I wish', 'How about' and 'What if' as this sort of language provides a platform for further design development in a positive, proactive manner. Listening respectfully to each team member is important to ensure all contributions can be made before the team votes or decides together on the best idea for the solution.

DIVERSITY

When creating design teams, it is a good idea to ensure that there is a range of different design specialists on the design team. People bring different life experiences and areas of expertise, which all contribute to an effective collaboration. For example, in the development of a new car, a design team would consist of an industrial designer, interior designer, automotive engineer, aerodynamic engineer, computer programmer and paint specialist. Each designer brings an area of work expertise to the team to achieve the best possible solution to the design brief.

Figure 1.11 Design teams require a diverse range of people to bring their own expertise to the project.

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SHARING

Successful collaboration requires people to share their thoughts and to be flexible with the ownership of ideas. Intellectual property is important and of course it is necessary to recognise individual ideas and thinking by acknowledging where credit is due. The end result of the ownership of ideas and concepts must be agreed upon from the beginning. Collaboration is all about sharing and that is why it is important to establish these rules before collaboration begins.

ENVIRONMENT

Schools, universities and workplaces are changing the traditional layout of the working space – which conventionally consisted of four walls and rows of desks – in an attempt to encourage greater collaboration between individuals. Rectangular tables are being replaced by round tables, and spaces and rooms are filled with furniture designed to promote discussion and prompt the sharing of ideas to build productivity. Changing the environment can bring fresh new ideas and inspiration by creating equality of positions and giving voices to all stakeholders.

Technology has made collaboration much easier. Design teams no longer have to be restricted to round-table discussions where everyone is physically in the same room. Videoconferencing facilities and shared documents such as Google Docs allow multiple contributors at the same time, promoting collaboration in the workplace. Such technology has allowed designers to interact and utilise each other's expertise on an international scale.

Figure 1.12 Videoconferencing facilities help connect people in a design team from all over the world.

The interdisciplinary nature of design

Design encompasses many disciplines that interact with each other to create a functional and aesthetic product, system or environment. The complexity of the relationship between mathematics, science, fine arts and **humanities** varies in each design. When designers are searching for a **market niche**, they will often explore new technology through the use of science and mathematics in areas such as **materials**, speed, weight and performance.

When designers work to produce a new product, such as a mobile phone, they need to consider the size of the product and how to incorporate current and new technology into it. They should also consider the impact of the new product on the environment. Mathematics is involved when calculating the overall dimensions, weight and amount of materials required to ensure the phone is durable and can withstand daily use. In addition, computer science is required to understand the operations of the mobile phone, from electronic circuits to the writing of computer code software to operate the phone.

How can designers combine all these features into an aesthetically pleasing, market-competitive mobile phone? This is the challenge designers face on a daily basis as they strive to be market leaders.

In recent years, designers and society are becoming more environmentally conscious. The Australian population is more educated today than it was 50 years ago. Greater education and public awareness enable people to realise the detrimental effects our living habits are having on the environment. Designers now play an important role in minimising the effects our lives can have on the environment. The **interdisciplinary** nature of these newly-created fields which focus on both design and sustainability has led manufacturers to change their practices, search for and use sustainable resources, reduce carbon dioxide and pollution levels, as well as assess the impact of products once they have reached the end of their life. As a result of these actions and steps, more and more products are being designed to be **biodegradable**, recyclable or designed for disassembly.

humanities the study of human culture

market niche a specialty area to address the needs and wants of consumers

materials substance from which a thing is or can be made. Natural (e.g. animals, food, fibre, timber, mineral) and fabricated (e.g. metal alloys, plastics, textiles, composites) materials. Materials are used to create products or environments and their structure can be manipulated by applying knowledge of their origins, structure, characteristics, properties and uses.

interdisciplinary the interaction of two or more areas of knowledge

biodegradable able to break down naturally in the environment into chemical components

Figure 1.13 There are many factors to consider when designing a new mobile phone.

GO

Petrochemical polystyrene products are being replaced with products made from cardboard and dissolvable plastics. Traditional white polystyrene takeaway cups are becoming increasingly redundant. One replacement option is cardboard cups: double-lined corrugated cardboard has the same insulating and watertight properties with far less impact on the environment. Society is going one step further by using Keep Cups, which are washed and reused, in the hope that one day we can eliminate the disposable cup altogether.

Figure 1.14 New design policies mean many more products are being made with sustainability in mind.

ACTIVITY 1.4

Refer to the project you are currently studying in class, or another design project you are familiar with.

1   Identify the areas where collaboration has taken place. Discuss the outcomes of the collaboration and the impact it had on the project.
2   In a table like the one below, identify the range of disciplines involved in your project. An example has been done for you.

DESIGN PROJECT	MATHEMATICS	SCIENCE	ENGINEERING	FINE ARTS	HUMANITIES
Bedside lamp	Measurements of the surface area of the bedside table, possible height of the lamp	Research properties of materials and the type of light you are working with, i.e. LED or fluorescent	Design of the lamp to ensure structural integrity, safety of the user, and provide the intended light, e.g. ambient, task lighting	Aesthetic features – colour, shape, design, texture	How do humans interact with the lamp design? Design ergonomics such as operating switch, changing the light bulb

DESIGNING

CASE STUDY 1.1

JAR Aerospace Drone

JAR Aerospace is one of Australia's leading Unmanned Aerial System (UAS) designers and manufacturers. The interdisciplinary design team is a contributing factor to the success of their products. The increased demand for accuracy, greater efficiency and smaller technology in a range of industries such as defence, agriculture, medical, border protection and surveillance have opened a gap in the market for drone technology. JAR Aerospace has designed a range of fixed wing and multi-rotor UAS. The DACELO – specifically designed for the Australian Defence Force – is a vertical take-off and landing fixed wing UAS that can be launched from the front line. It's made from lightweight carbon fibre with a total weight of 2 kg, making it easier for military personnel to carry when on patrol. It is also fitted with a range of sensors such as infrared, Night Aiming Device, object detection and identification. The DACELO has the option to be operated autonomously or piloted manually, making it suitable for intelligence, surveillance, reconnaissance and targeting applications.

The lightweight streamline design has a flying time of 22 minutes and a top speed of 90 km per hour. The agility, speed, compact and easy-to-control design makes the TACHY a sought-after UAS in a range of industries, from film and media to surveillance.

Figure 1.16 The TACHY by JAR Aerospace

Figure 1.15 The DACELO by JAR Aerospace

In addition to the DACELO, the TACHY is a multi-rotor UAS designed for commercial and industrial applications when fitted with accessories such as optical and thermal cameras.

Unmanned Aerial Systems are a result of aeronautical engineers, designers and computer programmers coming together to create an interdisciplinary design team. Utilising the range of expertise in mathematics, science, technology and engineering from each design discipline has ensured a high quality product that is leading the field of UAS in Australia and internationally.

1 Research an industry in which Unmanned Aerial Systems are being used and describe how they are used. What is their purpose? How have UAS impacted on this industry?
2 Describe how the following interdisciplinary areas play a significant role in the development of UAS:
   a Aeronautical engineering
   b Computer programming
   c Industrial design.

1.4 Interrelationship of design with technology

Technology has significantly changed the way we do things at school, at work, for entertainment and in our social connections. Advancements in **Wi-Fi**, **hardware**, **software** and **microtechnology** have enabled technology to be embedded into many products.

Technology within our smartphones, with the inclusion of cameras, calculators, email and other apps, has provided people with far more flexibility and convenience than the use of a mobile phone alone. The combination of multiple devices into one has allowed people to work from home and away from the office. Wi-Fi and other wireless technology enable this flexibility.

High-speed internet promotes rapid communication and collaboration as large files containing designs can be shared and videoconferencing can take place with designers, manufacturers and specialists in the design field from all corners of the world coming together to evaluate and decide upon appropriate designs.

Technology has impacted on all design professions and all aspects of the design process. Traditional skills such as technical drawing are still required to communicate ideas; however, **computer-aided design (CAD)** is now considered to be the industry standard. CAD software allows designers to develop their designs on the computer. This technology has many benefits for the design industry, as designers can easily modify their designs, conduct simulations, experiments and tests, and even estimate the amount of materials required.

Once a design has been developed digitally, a model, prototype or the final product could be created using computer-aided manufacturing (CAM). Factories and manufacturing processes are changing to include technology such as laser cutting, 3D printing, computer numerical control (CNC), water jet and plasma cutting. These manufacturing practices have changed the way products are designed by making the manufacturing process quicker, more efficient with resources, consistent in quality and less labour-intensive.

Figure 1.17 Being able to combine multiple devices into one makes it easier for people to work outside the traditional office environment.

Designers who embrace technology in their products are giving consumers more choice and the ability to customise designs.

The increasing use of **Arduino** technology in textiles allows the wearer to change the colour of their clothing to convey a message or a theme. Wearable technology may also have safety benefits as designers experiment with incorporating **LED** lights and Arduino technology into jackets. This would be suitable for cyclists and motorcyclists, as indicators and brake lights could appear on the rider's back. Technology incorporated into cyclist's clothing increases visibility to drivers travelling behind riders and, as a result, makes it safer for everyone on the roads.

Wi-Fi computer code to allow devices to connect to the internet wirelessly

hardware the physical machines and infrastructure related to digital technology

software programs and operating information required for the control of computers and technology

microtechnology miniaturisation of computer circuits and microchips

computer-aided design (CAD) software used by designers, architects and engineers to create lines, shapes and planes that can be combined, moved, rotated, adjusted and rendered. Measurements and calculations can be included. Computer-aided drawing can be used to create two- and three-dimensional models and drawings such as floor plans, interior and garden designs, and to represent objects and structures.
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Arduino micro-controller based kit used to build devices and interactive objects

LED light-emitting diode which creates high-powered light using a small amount of electricity

Technology does not refer just to digital technologies. Technology can also include materials, tools and techniques used in the design and manufacturing of a product, system or environment. The Australian wool industry has invested significant time and money into developing the uses and applications of wool. Wool is an extremely versatile product that can be made into clothing such as jumpers, high quality super fine suits, and safety uniforms such as those used by the fire brigade. In addition, wool is used for carpet and insulation. Wool's extensive properties and characteristics allow it to be used in a wide variety of products due to its natural breathability, **durability**, stretch and drape, odour resistance, temperature control, fire and static resistance, UV protection and sweat and moisture control. Wool is just one example of how the research and development of materials, tools and techniques have merged together to create sustainable products for our everyday use.

durability the ability of an object or system to withstand or resist wear, pressure or damage over a long period of time and remain in good condition. For example, long-lasting outdoor furniture made of suitable materials and construction methods to withstand rain, heat and light from the sun; a sports uniform made of suitable materials to withstand frequent washing and wear-and-tear from the movement of the sportsperson.

Figure 1.18 Some fashion designers such as CuteCircuit are incorporating technology, like LED lights, in their clothing designs.

Figure 1.19 Wool is a versatile commodity that can be incorporated into many different products.

Aboriginal and Torres Strait Islander design solutions

In order to continually improve our lives it is important to see what has been done historically and learn from both good and bad designs to ensure we don't repeat mistakes. Aboriginal and Torres Strait Islander peoples have been undertaking sustainable design practices for thousands of years. Everything designed and made by Indigenous Australian communities before the colonial era had a core purpose; a *coolamon* (carrying vessel) was used to gather food; canoes were used for fishing and transport. Probably the most famous design item that Aboriginal Australians have given to the world is the boomerang, which was designed by Aboriginal Australians to be a hunting weapon that would return to the thrower.

Figure 1.20 Bark canoes were used for fishing and transport. The image below is a modern replica.

Figure 1.21 Several items made by Aboriginal and Torres Strait Islander peoples, including a *coolamon* lined with paperbark

Technologies and tools used in development

Design and technology are interdependent, as they can no longer exist without each other. Technology is driven by designers searching to find better ways of doing things and designers are driven by technology that makes their life easier. New design specialisations are developing as a result of the advancements in technology, and new and exciting careers and job opportunities are becoming available.

Design today has been significantly impacted and influenced by technology, whether it's during the development and manufacturing stages or its final use.

3D PRINTING

3D printing has fast-tracked the time a product is in the development stages. A rapid prototype can be created and analysed by the design team and design refinements carried out and re-printed.

The quality and finish of 3D printing has significantly improved and can now be used as final manufacture of some products. 3D printing is used in a wide range of industries such as medical, construction and jewellery.

ROBOTICS

Robotic technology has streamlined the manufacturing industry by creating mass production manufacturing lines. Robots have taken over what were once laborious jobs that sometimes required multiple people to perform tasks. Technology has created a faster, more efficient and sometimes 24 hours, 7 days a week operation, only requiring minimal staff to oversee the production plant. As a result, this technology has forced people out of jobs and required retraining and up-skilling of others to maintain the automated technology.

Figure 1.22 Robotic technologies have helped to streamline production, as in this car manufacturing plant.

GREEN DESIGN

Society is becoming increasingly aware of human impact on the environment and is demanding products that are more environmentally friendly, forcing designers and manufacturers to change their practices. Green design assists us to live a healthier life while at the same time reducing our impact on the environment to ensure future generations can enjoy the resources and beauty of natural environments in the years ahead.

Figure 1.23 Green design in buildings makes them more environmentally friendly.

AGRICULTURE

Farmers play a significant role in sustaining us by growing the food we eat and the fibres we wear. The agricultural industry is a key stakeholder in the fashion, architecture and food industries. Farmers must design their properties so that sustainable practices are employed and animal health is a priority. Research and development of sustainable farming practices to better prepare for times of drought and extreme weather conditions is putting increasing demands on the agricultural industry. Technology has assisted the agricultural sector significantly through the use of historical data to model and forecast weather patterns. Drone technology has enabled farmers to monitor crop yields and pinpoint weed control without having to spray the whole crop.

Figure 1.24 Drones are just one new technology being used by farmers to assist them.

CASE STUDY 1.2

Karst Stone Paper

Paper is considered to be an everyday consumable item that can easily be recycled. However, the initial process to make paper involves planting trees, logging, milling, pulping and bleaching. The paper industry is the fifth largest consumer of energy worldwide and 4% of the total energy consumed worldwide is used for making paper. Karst Stone Paper has challenged the paper industry by creating a paper that does not use any trees or water in the manufacturing of their notebooks.

Karst Stone Paper manufactures paper from one of the most readily available resources on Earth: calcium carbonate. An output from the mining and construction industries, calcium carbonate is crushed into powered form and combined with a non-toxic resin to make stone paper. Due to the nature of calcium carbonate, no acids or bleaches are required to make the stone paper white.

Figure 1.25 Karst Stone Paper makes a range of notebooks with their environmentally friendly stone paper.

Disrupting the pulp paper industry by replacing the base material with calcium carbonate, Karst Stone Paper also has the added features of being waterproof and tear resistant, making it perfect for a range of applications. Stone paper is manufactured into notebooks with similar characteristics to pulp paper notebooks: 120 micron thick paper (equivalent to 100 gsm), thread bound and no bleed-through of ink through the individual sheets.

1 List the environmental impacts of Karst Stone Paper.
2 Describe how using stone rather than pulp affects the design of the paper.
3 Discuss some other applications that Karst Stone Paper could be used for.

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ACTIVITY 1.5

You are a member of a design team working on a brief to design a new sports water bottle. Using the design process discussed in this chapter, and the internet or your school library, complete the following questions.

1   Identify the target market.
2   Use a range of communication methods (sketch, model) to begin a new design of the water bottle.
3   Compare your design with traditional methods used by Aboriginal and Torres Strait Islander peoples.
4   How is your design solution affected by the tools used in development?
5   How could you reduce the impact the sports bottle has on the environment?

DESIGNING

1.5 Applying principles of design in new situations and contexts

Good design addresses the basic principles of design well. A successful design carefully considers the elements and principles of design during the design process. The elements and principles of design are often referred to as the foundations of design. The principles of design direct how we apply the elements and ultimately determine how successful the design is.

Elements and principles of design

PRINCIPLES OF DESIGN

Balance
Balance in design can be achieved by the even distribution of objects. Balance is used in design to give structure and stability to the object or environment.

Proximity

Proximity creates a relationship between the elements. It is a strategy used to link elements together, and provides a focal point. This does not mean the elements have to be placed together, but they should be visually connected in some way.
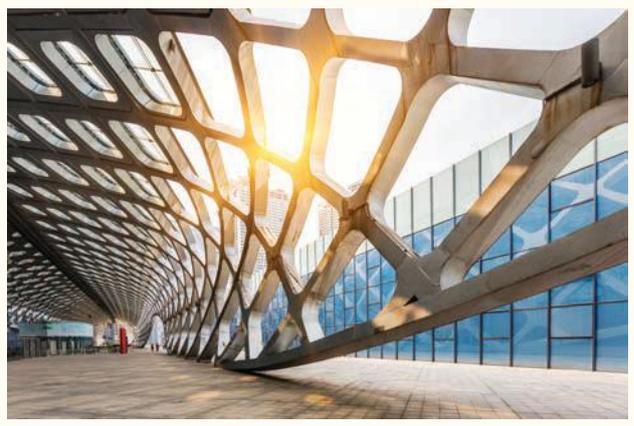
Alignment

Careful and planned positioning of elements creates alignment. Alignment is the visual connection with each element. It assists to create order and organisation in the design.
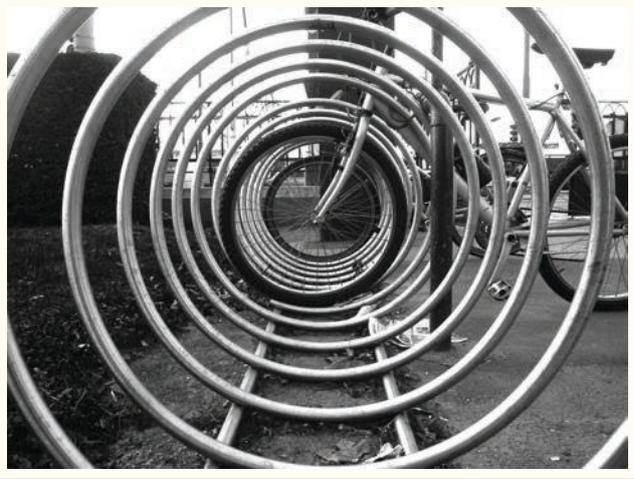
Repetition

Repeating different elements in a design strengthens the design by creating a sense of consistency. Repetition can also create a feeling of rhythm and organised movement throughout a design.

Contrast

Contrast can promote key features of the design. It is achieved by opposing elements, such as opposite colours on the colour wheel, horizontal or vertical direction, the value of light and dark and hard and soft. Contrast can be used to emphasise or draw attention to different elements of the design.

Space Space is an important factor to consider in visual design. The use of positive and negative space, as well as the area around, between, above and below elements, must be considered.	

ELEMENTS OF DESIGN

Line The element of design known as line refers to the use of horizontal, vertical and/or curved lines to create a shape. Line can often create direction and pattern in designs.	
Shape A shape is generated from geometric forms (e.g. squares, circles), or organic, free-flowing natural shapes are used to create a design. Once a shape is formed, a positive and negative shape is automatically generated. Shape is very important for developing a successful design, as it relates to function and aesthetics.	
Colour The use of colour in design can be for both functional and aesthetic purposes. The main characteristics on colour are: hue (the name of the colour, e.g. red, blue, orange), value (how dark or light) and intensity (bright or dull).	

Texture Texture refers to the look and feel of the surface material. Is it rough, smooth, glossy, matte? How has the texture been created? It is becoming increasingly popular to push the boundaries of texture and materials by promoting elements in their raw state.	
Direction Direction is created by the use of lines. The way the lines are assembled dictates the feeling created. Horizontal lines suggest stability and calmness. Vertical lines are used to create a feeling of balance and formality. Diagonal lines suggest movement and action.	
Size Size is simply the amount of space the design occupies. This is applied to individual objects, rooms, buildings and land.	
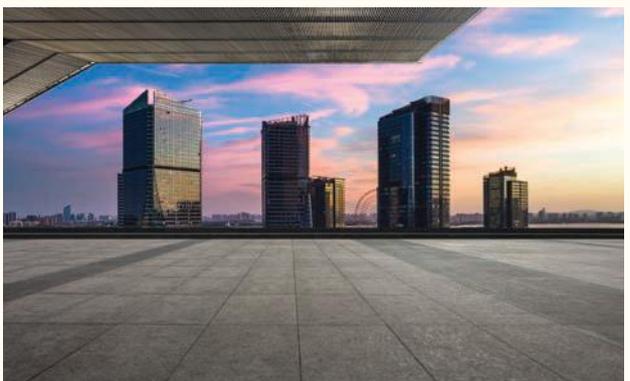
Different design industries place emphasis on different principles. A key principle for architecture is the way humans interact with the space around them and therefore the study of space is a high priority when designing. In comparison, the fashion industry would consider elements such as texture and colour as key features when designing patterns for garments.

GO

ACTIVITY 1.6

A design team has been given the brief to design a new egg carton to hold six eggs.

1   Describe the essential elements and principles of design for a new egg carton.
2   Using the items listed in the table below and three more of your own, design and make a new design of an egg carton.

ITEM	ELEMENT/PRINCIPLE OF DESIGN	IMPACT ON EGGS	IMPACT ON CONSUMERS EXPERIENCE
Aluminium foil	• Texture • Colour	• Not strong enough to protect eggs from bumps • Hard texture • Can easily be shaped into oval form • Material gets hot which could impact quality of eggs	• Increased risk of eggs breaking will force consumers to purchase another product • 100% recyclable
Cotton wool			

3   Experiment with different materials from the list above by making egg cartons. Record your experiment using the following headings:

Aim: To investigate a variety of materials to determine which is the most suitable for making an egg carton.

Equipment: (List)

Method: (What you did to set up the experiment and to test the materials. Number and write the steps. How did you control the experiment? Repeat.)

Results: (Record results, use a table/s, average scores, graphs can be used)

Conclusion: State your conclusion and answer your aim e.g. what was the most suitable material for making an egg carton from the materials tested?

DESIGNING

Developing design solutions

Designers have one of the best jobs in the world! They have the skills and knowledge to bring their ideas to life and to share their solutions with other people. Many people are designers who may not necessarily have studied design. They may have identified a need and worked to develop a solution. Doctors, scientists and mechanics can also be considered designers, as they work to solve problems. The process of developing design solutions can be very simple or very complex, depending on the nature of the problem. Regardless of the complexity, designers all undertake a similar process when developing solutions.

COGNITIVE ORGANISERS

Cognitive organisers help us to connect our ideas and thoughts together. They can be presented in a number of ways, such as through a brainstorm list, a mind

cognitive organiser a visual diagram of interacting ideas, thoughts or elements

project a set of activities undertaken by students to address specified content, involving understanding the nature of a problem, situation or need; creating, designing and producing a solution to the project task and documenting the process. Project work has a benefit, purpose and use; a user or audience, which can provide feedback on the success of the solution; limitations to work within; and a real-world technologies context influenced by social, ethical and environmental issues. Criteria for success are used to judge a project's success.
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map or a spider diagram. Brainstorming involves all stakeholders in the **project** simply coming together and listing ideas that come into their heads about the design brief. Brainstorming is discussed in more detail in Chapter 6.

Figure 1.26 A mind map is an example of a cognitive organiser.
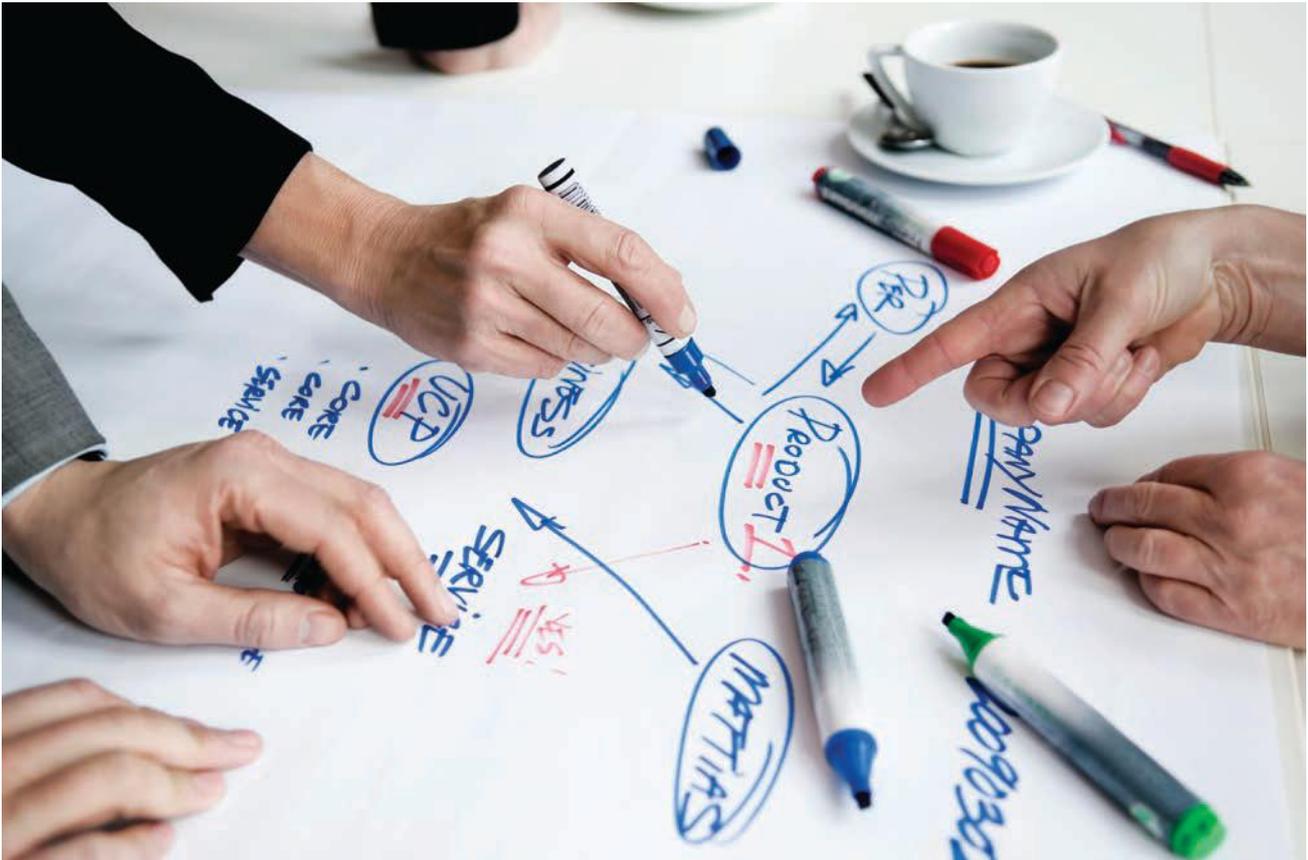
CONCEPT SKETCHES

Concept sketches are a form of communication of ideas through visual diagrams. They are an important stage in the development of ideas, as this is where the design starts to take shape. Concept sketches are discussed in more detail in Chapter 6.

MODEL MAKING AND PROTOTYPING

After some ideas have been developed through concept sketching, small models can be created to visualise the 3D shape and form of these ideas. Models are often made from materials such as cardboard, modelling clay and balsa wood. Model making can also be in the digital form of a **rendered** 3D CAD drawing. Modelling is discussed in more detail in Chapter 6.

rendering drawing that shows a relative relationship of elements or a form of objects using texture, colour, light, shade and tone (lightness or darkness of a colour). Rendered drawings are used, for example, in architecture to show what a building will look like or to show the form and shape of the body of a proposed car design. Rendering can be done by hand, or using computer software such as computer-aided drawing.
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Figure 1.27 Models and rendered 3D CAD drawings help architects show what a building will look like.
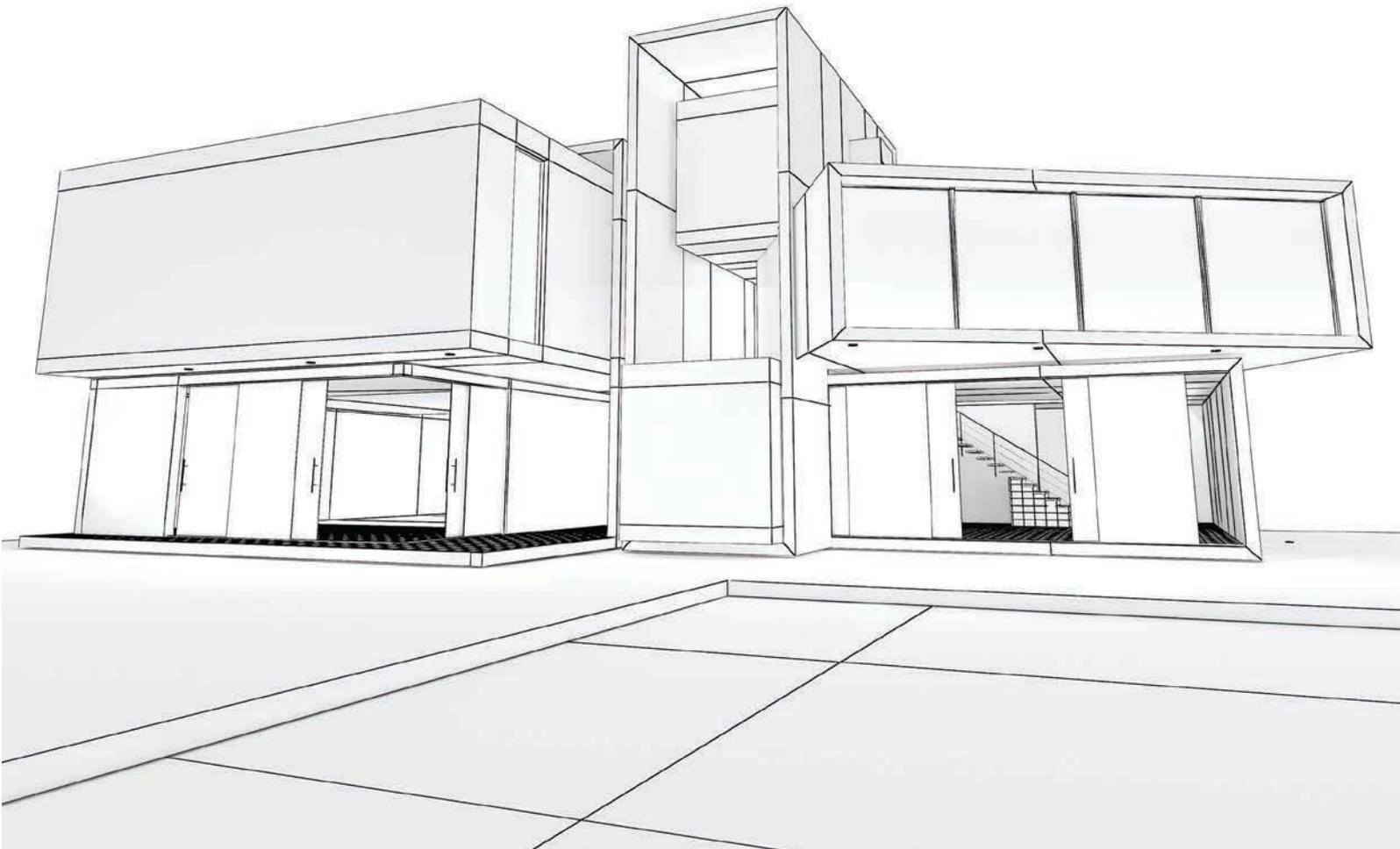
ACTIVITY 1.7

Use a material other than paper or cardboard to try and create your own form of a material to write on.

1 Identify the features required for a writing surface.
2 Research traditional methods used by Aboriginal and Torres Strait Islander peoples.
3 Record your experimentation and testing of design ideas (include photos).
4 Devise and undertake a process for obtaining and recording feedback on your idea (e.g. share and discuss with a partner; place on class Wiki and seek comments). Include photos, annotated sketches and/or a model.

DESIGNING

CHAPTER SUMMARY

- Humans have been designing since their earliest time on Earth.
- Human designs fulfil a need and their purpose is aimed at improving our lives, both physically and emotionally.
- The design process involves working through steps of exploration (research), understanding, designing, prototyping, manufacture and evaluation.
- Good design is based on the principles of design, which direct the way we apply the elements of design.

- Design is interdisciplinary by nature and it draws on other disciplines such as science, mathematics, technology, fine art and the humanities when developing solutions.
- Design and technology are interdependent, as they can no longer exist without each other.
- The design process is collaborative.
- Designs can be applied to new situations.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1 Design
2 Design process
3 Design thinking
4 Environment

5 Prototype
6 Society
7 Technology
8 Appropriate technology.

REVIEW TASKS

1 When did humans begin to design and what is their reason for continuing to design?
2 Research examples of products that best illustrate the elements of design and explain their features.
3 Identify the principles of design and give a brief definition of each.
4 Draw a visual diagram of the key stages of the design process and provide a brief description of each step.
5 Research three design disciplines that have not been mentioned. Describe the

features of the disciplines and identify their similarities and differences.
6 Using examples, describe how designers rely on technology for modern designs and explain why it is important for them to use appropriate technology.
7 Define the meaning of the term 'interdisciplinary' and explain how it applies to the work of designers. Support your response with examples of interdisciplinary design.

8 Who are the stakeholders who would need to collaborate in a design project and how would they assist each other?

9 Explain the importance of collaborative design when developing design solutions.

PRACTICAL TASK

You are to design an aid that will assist a group in society. Use the design process when developing your ideas.

1 Write a paragraph about the group in society you have chosen to assist. What are their challenges?

2 Include annotated concept sketches explaining your design ideas.

3 Produce a 3D drawing of the final design.

4 Create a model of the aid. Use the resources available at school or home.

5 Ask your peers to evaluate your design. Does it address the needs of the target market?

2 Developing design ideas and solutions

KEY TERMINOLOGY

- **Aesthetics**
- **Digital technologies**
- **Emotional design**
- **End users**
- **Life-cycle analysis**
- **Market research**
- **Need**

- **Primary research**
- **Qualitative data**
- **Quantitative data**
- **Secondary research**
- **Stakeholders**
- **Target market**
- **Validity**

This chapter explores how designers apply the design process when developing new ideas for solutions to their design briefs. It describes how designers research the needs of their end users and stakeholders to establish design requirements and set their criteria for success. The chapter also looks at the way designers use tests and experiments, such as prototypes and models, to assess, refine and optimise their solutions.

This chapter addresses **Outcome DT5-2** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the content areas **Identification of needs and opportunities** and **Experimentation**.

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2.1 **Identifying needs and opportunities**

In order to identify a **need**, we must first understand exactly what a need is. New designs and ideas flow from the imagination when sparked by a problem that seeks a solution or a better way of doing things: this is a need. An example of a need would be an inclusive playground for children with disabilities. Until recently, children with disabilities have been unable to participate in what most children get to experience when playing on playground equipment. New manufacturing techniques and designs have enabled accessible play equipment such as wheelchair swings, wheelchair merry-go-rounds, sensory nest swings and back-supporting full-harness chair swings. Due to society's increasing demand for equality and accessibility for all, many local councils are installing a range of play equipment to allow people with disabilities to experience the joy of play.

Figure 2.1 Government councils have improved the variety of equipment in public playgrounds to increase accessibility for every user.

need a requirement by an individual or a group

What the target market wants

In the design industry, a need is what the **target market**, also known as the user, is asking for. This is sometimes referred to as the demand. Ultimately, the target market will determine if a product is successful or not. Identifying the needs of the target market can be done in several ways, including:

- studying market **trends**
- engaging in and analysing target market interviews
- carrying out surveys and questionnaires
- using social media to assist companies in collecting feedback on consumer needs (this is a more recent technique).

Market research clarifies the identification of a need and allows designers to meet the needs of the end user more successfully. Identifying the need is achieved by answering the questions who? what? how? why? when? and where? The information gathered from research enables the problem solvers – the designers – to have a better idea of what the user requires, and this in turn directly affects the design, materials and manufacturing of the end product. The research also tells the designer if there are any products similar to the

target market a specific group of consumers at which a product is aimed

trends the gaining of popularity or a development in the market demands relating to colours, textures, designs in fashion

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one being developed on the market already. This can be very helpful, as the designer needs to decide if there were any improvements that could be made to existing designs that would make the new design more appealing and enable it to potentially capture the greatest share of the market. The designer would have to assess whether it was worthwhile proceeding with the design solution, depending on how much value the new design could add to existing designs.

Everyone's needs vary and therefore products that are considered essential to some may be irrelevant to others. Football boots, for example, are essential for people who play football on grass. The need to ensure the user has a good grip when running on grass that is often wet and sometimes muddy is essential. The all-leather shoes are made with added protection to the toes to provide a smooth kicking surface, which enables greater accuracy when kicking the ball.

A need is often derived from the user's frustrations with an existing product not meeting the current needs, or when nothing is currently available to consumers that addresses their particular requirements. It is important to note that you do not need to be a designer to identify a need and develop a solution. Some of the greatest designs have been developed at home, by people who have been frustrated by a problem and have set about designing and making a solution to their problem. For example, in 1920 Earle Dickson was concerned that his wife suffered many cuts and abrasions while doing housework. To make it easier for her to put dressings on these wounds, he attached squares of gauze on adhesive tape.

Figure 2.2 Improvements have been made to the design and material of football boots over the years.

Figure 2.3 Band-Aids meet the need for an easy dressing to put on small wounds.

Dickson showed his design to his employer, Johnson & Johnson, who liked the idea and put it into production as Band-Aids.

Opportunities for new and better solutions

Opportunities in design often come about as a result of someone developing an alternative to an existing design. The advancement of new technologies assists in the development of new and better solutions.

The existing product could function perfectly well; however, the opportunities for new and better solutions often arise as a result of more efficient manufacturing methods and changes in materials.

Solar panels are becoming increasingly popular in both commercial and domestic use. Current coal-powered electricity is functioning perfectly well, but dwindling supplies of fossil fuels, and the impact of coal mining on the environment, make coal less appealing to many consumers. However, advances in the design of solar-powered electricity has made it easier for homeowners to install solar panels on their roofs and capture their own electricity, reducing the demand for coal-powered electricity.

Figure 2.4 Solar panels are increasingly being installed on domestic homes to help homeowners capture their own electricity from a sustainable source.

Over recent years, there have been changes in the way people think and, as a whole, society is becoming more educated as the internet reaches nearly every corner of our world. This change in thinking is also opening up opportunities for new products and designs. The notions of **market push** and **consumer pull** have an impact on new and better solutions. A current example of consumer pull is consumers demanding more environmentally

market push marketing techniques employed by companies to promote their products

consumer pull interest in a specific product created by a particular target market

design for disassembly
products that can be easily dismantled so that parts can be reused and/or recycled

interface a program that enables the user to operate different technological systems

Figure 2.5 A Tesla Powerwall battery inside the home allows consumers to store power generated from solar panels.

friendly products, such as biodegradable or recyclable products and products with **design for disassembly**. People and designers are always actively seeking alternatives to current practices. With the installation of solar panels, consumers are now looking to be able to be more self-sufficient by installing batteries to store the power they have generated instead of putting it back into the electrical grid. The consumer pull therefore is for batteries that are suitable for domestic use, do not take up too much space, are affordable and can store enough power to operate a home.

The continual improvement of technology has promoted opportunities for new and better solutions. Designers have developed apps that can be used as an **interface** to operate home entertainment technology such TV remote controls, stereos and speakers. In addition, home security systems can be controlled by smartphone technology. These are examples of how when one design changes (phone technology) it opens up many opportunities for other areas of design (home technology).

Figure 2.6 Smart devices are increasingly being used in homes to control security systems.

Identifying opportunities

When developing design ideas, designers must clearly:

- identify all the significant factors that could play a role in making the design possible and successful
- identify the opportunities that may contribute to the design process so that the final design will assist in the development of a quality end product.

The key questions designers ask themselves are:

- what must we do in order to complete the design brief?
- what can we do to make the design different and attractive to the target market?

To address these questions, the design team needs to conduct:

- market research
- materials and technological research
- brainstorming sessions to identify opportunities specific to the design.

Possible opportunities could include:

- the timing of the release of the product
- innovation including **multifunctional** aspects of the design to give a market edge
- emotional design
- the use of new materials
- application of new skills
- use of available and emerging technologies.

TIMING

Timing impacts on a range of areas and could be the factor determining whether the product will succeed or fail. The relationship between timing and materials could be that the design is too advanced and the materials have not yet been discovered. As a result, alternative materials would need to be used and this could also open up an opportunity for manufacturers to develop new materials. Designers must also be able to forecast the future and develop designs that will still meet the needs of the consumer in five or even twenty years. What do designers need to do now to ensure their design will still be useable and in demand in future years?

INNOVATION

Innovation is a result of the work of designers and engineers. They use creative thinking to generate designs, products, technologies and processes that are different from what has traditionally taken place. Designers invent and develop innovations if they cannot find a solution that best addresses the design brief. In the development of innovative products, they may identify aspects of the design that could be used as selling points. Some new aspects may be applied to a range of situations and enable them to gain market share over their competitors.

multifunctional having more than one use or fulfilling multiple needs

Figure 2.7 Innovative designs – such as this Microsoft touch mouse, which allows users to flick, pinch-to-zoom and pan a screen – help companies stand out from the competition.

EMOTIONAL DESIGN

Generating emotion in the consumer upon interaction with the design can have a significant positive effect on the success of the product. Emotional design creates a pleasant experience for the end user. It may generate feelings of fun, relaxation or excitement. Addressing emotions in design can open up new opportunities for both designers and consumers, particularly when promotions are aimed at the target market.

ACTIVITY 2.1

Identify a product you use on a regular basis, for example: lunchbox, backpack, sunhat. Have the product or an image of it in front of you.

1   How could you give the identified product greater emotional design? Sketch your design ideas and include annotations. What innovative materials could be used?
2   What technology could be added to improve your design?

DESIGNING

2.2 Requirements of end users and stakeholders

The final product resulting from the design must satisfy the end users by fulfilling their need. **Stakeholders** include those who invest time, energy, professional reputation and/or brand name in the **project** as well as those who will ultimately buy the product.

Before designing commences, the requirements of the end users must be considered and clarified. Identifying the users' requirements will assist in the designing of the product. Gathering this information takes time and the collection of the information is conducted through a range of methods. Once the information is gathered, the design brief can be more accurately refined, clearly stating the requirements of the end users to the design team. A product will be considered successful if it meets the requirements of the end users well and offers more than any existing designs from competitors.

stakeholder someone who has an interest in something through time, money and/or energy and will gain from the final design

project a set of activities undertaken by students to address specified content, involving understanding the nature of a problem, situation or need; creating, designing and producing a solution to the project task and documenting the process. Project work has a benefit, purpose and use; a user or audience, which can provide feedback on the success of the solution; limitations to work within; and a real-world technologies context influenced by social, ethical and environmental issues. Criteria for success are used to judge a project's success.
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End users

Identifying the needs of the end users is important when developing a design for a product as it helps ensure that the product will succeed once it is placed on the market. Designers need to discuss the proposed product with the end users and discover what their need is, how they would like the product to perform, what special features they would like it to have and what qualities it needs to be better than any existing competitors on the market. If the designer can identify a market advantage by developing the required product, it may then be possible to engage the interest of financial investors, clients, distributors, environmental scientists, advertisers and safety experts, who will collaborate to achieve the best design and most effective promotion to reach the target market.

Figure 2.8 A product which is not easy to operate will be frustrating for the end user.

Stakeholders

The needs of the stakeholders differ and each has a role to play in the success of the project. If it is a small project, such as designing a new desk organiser, the designers may be able to pay to develop the design themselves. If it is a large project, such as a new design for an advanced cochlear implant, more funds will be required to get the project started in order to demonstrate how it can generate a return of funds to the investor.

Each stakeholder has a different motivation for collaborating in the project:

- investors are looking for a financial return
- designers have a creative and intellectual property input, seeking a reward for their efforts and at the same time ensuring that their professional integrity is upheld
- clients who may not need the product but can see a market niche for their retail business will

Figure 2.9 Larger projects, such as a new design for cochlear implants, may require more funding to start development.

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also have special requirements for the designer, ranging from packaging and pricing to guarantees of reliability, durability, built-in obsolescence and refund arrangements

- safety experts will have an interest in searching for any hazards, such as small parts that could be choking hazards in toys, as well as looking at aspects such as ease of lifting without straining muscles. They will also measure risks such as flammability, colour fastness, and toxicity of materials such as the paint on toys which children may chew. Safety experts are important

stakeholders due to the strict guidelines and high standards they maintain in order to achieve their professional reputations. They receive financial rewards for guaranteeing products.

- advertisers are important stakeholders as they make sure that the product is promoted well and reaches a broad cross-section of the target market. They often carry out market research to tap into the smallest details of the needs of the end user to make sure the product is not only fulfilling needs but also exceeding expectations.

Figure 2.10 Advertisers are important stakeholders in the product as they have to know how to sell it to the target audience.

Advertising aims to appeal emotionally to all the senses of the end user through colour, style and sound, and by evoking memories of pleasant experiences such as taste and smell, and to then transfer these emotions to the product being

marketed and make it desirable to the end user. The promotion needs to be memorable so that the advertisement remains in the minds of the target audience and they then seek out the associated product.

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Requirements

A requirement is a factor that is considered necessary or compulsory. This information must come from a combination of stakeholders, such as the target market, designers, clients and manufacturers. Common requirements of a design are:

- Purpose: why is the product being designed in the first place?
- Function: the way in which the product performs the task/s it has been designed to do.
- Ease of operation: is the product easy to operate?
- Safety: does the product pose any safety risks to the user? Designers must consider how these risks can be eliminated and the product be made safer.
- Aesthetics: is the product appropriate to the target market? Is it aligned with current trends? Will the aesthetics make the product date and prompt consumers to purchase a newer model?
- Emotion: does the design generate an emotion in the target market? Designers aim to convey a 'wow' factor to users. Do the aesthetics and

function of a design make the users want to use the product more or place it on display?
- Lifespan: what is the intended lifespan of the product? The materials chosen for manufacture and the design must ensure that they meet the demands of the product's lifespan in the intended environment.

These are examples of some questions that could be discussed with stakeholders in order to refine the design brief and provide further direction in the project.

Purpose	Aesthetics	Emotion
Function	Lifespan	Ease of operation
Safety		
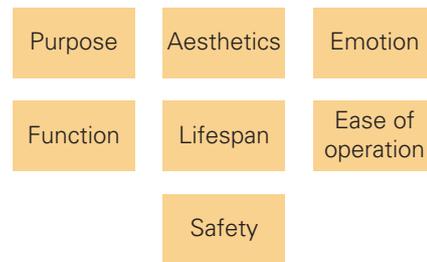
Figure 2.11   Requirements to consider when developing design solutions

ACTIVITY 2.2

GO

Recognising and identifying the end users and stakeholders for a product assists in understanding their needs better. Complete the following table (the first example has been done for you) and discuss your responses with the class.

ITEM	END USERS	STAKEHOLDERS	NEED OF THE PRODUCT
Child car seat	• Children aged 0–7 • Parents/caregivers	• Child car seat companies • Car manufacturers • Parents • Children • National child restraint laws	It is now law in Australia that children aged between 0 and 7 years must be in an approved child restraint or booster seat.
Backpack			
Fitness watch			
Water bottle			
Hair dryer			
Vehicle jack			

COMMUNICATING

Market research techniques

Conducting market research is a way of gathering essential background information for your design. When developing design solutions, it is important to build your knowledge of existing designs currently on the market, as well as researching social trends and consumer needs, and new and innovative materials, tools and techniques.

GO

Market research can be conducted in several ways through both primary and secondary sources.

- **Primary research** is information that is collected directly from the source (e.g. the target market). This could be in the form of observation, surveys or interviews.
- **Secondary research** involves gathering data, reports and studies previously undertaken by another organisation and using this information in the development of your project.

primary research research conducted first-hand

secondary research information already gathered and presented by other people

qualitative data descriptive information, often based on the opinions and emotions of individuals

quantitative data numerical information that can easily be analysed in tables and graphs

Quality market research requires a combination of both qualitative and quantitative data.

- **Qualitative data** is information that cannot be measured in numerical form; for example, people's opinions, points of view, experiences, comments on pros and cons.
- **Quantitative data** can be measured numerically, for example, 50% of people surveyed were not happy with their current toothbrush.

SURVEYS

A survey can be defined as a range of questions used to gather large amounts of data from the target market. Surveys can provide both quantitative and qualitative data that can be presented in a range of forms, such as graphs and tables.

INTERVIEWS

Interviews are conducted with an interviewer and the person being interviewed. The same set of questions is often used for different people to

Figure 2.12 Interviews and surveys can be used to help decide on the materials and fabrics used for clothing.

structure the conversation and increase the validity of the survey. Sometimes only a small group of people is interviewed, in order to gain a more detailed response; however, the larger the group interviewed the more reliable the data gathered becomes. An interview allows for qualitative data and can often lead to ideas and responses that would not normally have been gathered in a survey.

OBSERVATION

Observation is an effective research method, as it allows people to see existing designs in operation, the target market interacting with the product and/or the results of experimentation and testing of materials, tools and techniques. Observation provides real-time feedback with designers and design teams gathering data then and there.

ACTIVITY 2.3

The Australasian New Car Assessment Program (ANCAP) is Australasia's leading independent vehicle safety advocate. ANCAP provides consumers with information on the level of safety individual vehicles have for both occupants and pedestrian's protection.

1   Identify the stakeholders of a new vehicle.
2   What role does a crash dummy play in the research of vehicular design?
3   Describe examples of primary and secondary research collected from a crash dummy.

Figure 2.13 A crash dummy is used to test the safety features of cars, such as the effectiveness of airbags.

COMMUNICATING

CASE STUDY 2.1

Polymer banknotes

The Reserve Bank of Australia recently released new Australian banknotes into circulation. In 2016 the $5 note was released, followed by $10 in 2017 and the $50 note in 2018. Some significant changes were introduced into the design of the new notes for security reasons and to increase accessibility for groups of people in our society.

The year 1992 saw the first Australian banknotes made from polymer. The move to polymer banknotes was made to increase security against counterfeiting which had significantly increased with paper notes due to the advancements of technology and reprographic equipment becoming more readily available. The design of the new banknotes required some elements of the existing designs to remain the same and these elements formed part of the criteria for success of the new banknotes. Criteria such as the size, colour and people represented on the banknotes were maintained for ease of recognition by people and to avoid disruption to businesses. A major development in design is the introduction of a tactile feature on the longest side of the note to help the vision-impaired community more easily distinguish between the denominations of notes.

When developing the new banknotes, a team of people from a range of industries worked together to develop the designs, ensuring security was paramount and consulting with key stakeholders such as banknote equipment manufacturers, retail organisations, financial institutions and the vision-impaired community. The polymer used to make the banknote was a result of the Reserve Bank of Australia working together with the CSIRO to develop the material. By shifting from paper to a plastic banknote it has resulted in a durable, cleaner, more hygienic banknote with the added increased security features such as transparent full-length windows and holographics.

Australia was the first country in the world to convert from paper to polymer banknotes. This significant innovation made an estimated saving of $20 million per annum over paper notes at the time of release.

Figure 2.14 The design of the Australian polymer banknotes were the result of people from a range of industries working together.

1   Visit the Reserve Bank of Australia website via https://cambridge.edu.au/redirect/8482
    a   Read the design process undertaken to develop a banknote. What are the similarities and differences to the design process you follow?
    b   Select a bank note and describe the range of design features on the note.
    c   What happens when a banknote reaches the end of its life?
2   Visit the CSIRO website via https://cambridge.edu.au/redirect/8483.

Using the website, create a timeline of the development of the polymer banknote.

2.3 **Design considerations**

Designing new products requires the consideration of key elements. Every design is different and the considerations for each product vary. These considerations often provide an element of structure for the design development process. Designers must consider the following things.

Purpose

- What is the purpose of the design?
- Why is the design being implemented or manufactured?

- The purpose could be as simple as adding a new colour to an existing range, or more complex such as designing a new and innovative product.

Figure 2.15 The purpose of a new design could be as simple as developing an existing product in different colours to appeal to an extended market.

Target market

- Who is the product aimed at?
- What is the age group/interest group/people in society who will best benefit from the design?

Criteria for success

- How will you know if the design has been successful?
- What tools can be used to measure the success of the product?
- Establishing the criteria for success early in the design brief helps to keep the design on track.

Competition

- Who is the current or potential competition in the marketplace?
- What works for the competition and how can you try to do it better?
- What is the market share of the competition and why?
- Developing a design that can withstand small design modifications to maintain market share is vital in the design process.

Branding

- Giving the design a name will establish the product and give it an identity.
- A good product name that catches the attention of consumers will assist in promotion and marketing of the design when it enters the marketplace.

Life-cycle analysis

- The **life-cycle** of the product must be considered by assessing the environmental impacts associated with all stages of a product's life, from raw material extraction through to processing, manufacturing, distribution, use and, finally, disposal.

life-cycle assessing all stages of production from manufacture to disposal of the product

- The life-cycle will also determine the design and manufacturing process, such as the possible materials that could be used.

Cost

- The financial cost must be carefully planned early on in the design phase.
- A financial plan will determine the amount of money allocated to different areas of the project, from research and development, materials and manufacturing costs to employees wages.
- The cost of making the product will determine the final cost to the consumer.

Time

Timing is a significant factor in the success or failure of a product. Things to consider are:

- When will you launch the product?
- Is it a good time to invest money into developing a product?
- Do consumers have the funds to purchase the product?
- Are there government **incentives** available such as cash-backs or discounts for purchasing the product?

An example of incentive success occurred when the government was providing consumers with financial assistance to install solar panels on their roofs. Increasing the demand for solar panels has resulted in increased manufacture and sales of solar panels.

incentive a payment or concession to motivate or encourage action

Figure 2.16 Knowing when to launch a new product onto the market can be critical to its success.

In the early stages of the design process, the key elements listed must be carefully addressed and prioritised. Every design brief will place the considerations in a different order. A product may require better-quality materials and innovative manufacturing techniques. As a result, this could increase costs and therefore the cost of the product would be higher for consumers. It all depends on what the stakeholders and end users value most as the design brief is explored.

Resource requirements

Gathering resources requires extensive research and can be a time-consuming process. Resources required for the design brief can be classified into human and non-human resources. Human resources refers to all the people who may be involved in the design process. Maximising human resources throughout the design process enables the knowledge, expertise and experience of people to be shared during the development of the design. When architects design a building, they work closely with engineers, who offer a different range of expertise and skills, to ensure the design can be built. Likewise, industrial designers designing a new car body would work closely with the mechanical engineers and interior designers. When undertaking projects, designers need to consider questions such as:

- Who could I go to for help? Who has expertise in the area I am working in?

Non-human resources include physical materials, tools and machines that are required during the design and manufacturing process. A range of possible materials suitable to the product being designed are identified and researched. These materials are put through vigorous experimentation and testing using a range of techniques in the manufacturing process and the intended use of the product. Through research, experimentation and testing, an accurate list of resources is determined and manufacturing of the final product can commence. Effective resource planning will involve:

- Clearly establishing the resource requirements in the design brief to assist in the planning of the whole project.
- An action and time plan to show how long it will take to complete tasks and the estimated time for the design product to be ready for consumer use.
- The financial cost of each step, the materials, the manufacturing process, the marketing and the final cost to the consumer should all be calculated.

Appropriate technology

Throughout every project, a range of technologies is used to research, develop ideas and manufacture the final product. Today, most design firms use a combination of digital technologies and non-digital technologies.
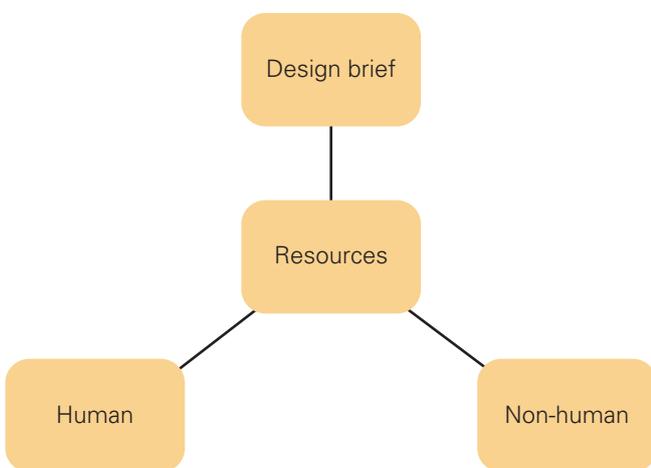
Figure 2.17 Types of resources for a design brief

When determining what technology is appropriate, the design considerations such as purpose, cost, time and life-cycle should be considered. These factors significantly influence the manufacturing processes. **Simulation** of the design can be undertaken to determine possible design flaws, estimation of materials and time it takes to manufacture the item.

simulation model of an action to determine the reaction. Computers are often used to generate a simulation program.

Figure 2.18 Computers can be used to generate a simulation program.

Documentation

It is important to document the requirements and design decisions you have established for a project. As a project develops, it is easy to forget some of these early decisions, and the reasons for them, so you need something to refer back to. You can also use these documents when communicating with teammates and clients.

ACTIVITY **2.4**

Document the requirements and design considerations that apply to the project you are working on in class. You could use the table below to do this, or a different method of your choice such as a Word document or PowerPoint presentation.

ITEM	DESCRIPTION	REASON
END USER AND STAKEHOLDER REQUIREMENTS		
End users		
Stakeholder #1 [identify]		
Stakeholder #2 [identify]		
DESIGN CONSIDERATIONS		
Purpose		
Target market		
Criteria for success		
Competition		
Branding		
Life-cycle analysis		
Cost		
Time		
RESOURCE REQUIREMENTS		
Physical materials		
Tools		
Machines		
Human resources		

DESIGNING

Evaluating the long-term and short-term consequences

During the design process, all aspects of the design must be continually evaluated.

The short-term and long-term consequences can involve the following factors:

- environmental
- personal
- financial
- social
- functional
- aesthetic.

All designs require the initial outlay of financial investment. It is often not until the product is on the market that designers start to be reimbursed for their involvement.

Over recent years, a shift in thinking has made people more aware of their impact on the environment, and designers and manufacturers are undertaking life-cycle assessments (LCAs) before designs are manufactured.

Life cycle analysis involves the study of resources, inputs and outputs required as a result of manufacturing, transporting, using and disposing of the product. This holistic view provides insights into the impact the product may have on the environment.

It is also important to consider any personal and social impacts when designing the product. If a product was to be used over short or long periods of time, it should not cause the user or people in the vicinity pain or discomfort. Therefore experimentation and testing must be undertaken before production, as this would highlight and prevent possible design issues. Evaluating design ideas to foresee possible short-term and long-term consequences will assist in the whole design process and the disposal of the product once it has reached the end of its useable life.

Figure 2.19 Environmental impacts are now a key consideration in the manufacturing and design of products.

CASE STUDY 2.2

BTM synthetic skin

Australian researchers are currently conducting medical trials of a synthetic skin called BTM (Biodegradable Temporising Matrix). The company behind BTM is Polynovo, and it is in their laboratories that BTM was developed as a wound dressing intended for treatment of full thickness wounds and burns where the skin has been lost due to trauma or surgery.

A patient confronted with severe full thickness burns is currently treated with extensive skin grafts and wrapped in bandages to keep the burn area moist and as sterile as possible. As a result of current practices, patients undergo many operations and spend significant time in hospital. A traditional skin graft requires non-affected skin to be removed from other areas on the patient's body and transplanted to the open wound site. This type of procedure leaves patients significantly scarred and can restrict movement due to the tightness of the skin.

BTM has been designed as an implantable dressing to be applied on open wounds and major burns. The innovation lies within the materials and design of the synthetic skin. The top layer, consisting of the sealing membrane, is designed to physically close the wound and eliminate moisture loss. The middle layer, the bonding layer, is a polyurethane adhesive, which bonds foam to the sealing membrane. The third layer is a biocompatible polyurethane foam, with greater than 90% porosity, designed to fully biodegrade. BTM works to both keep the wound sealed to eliminate the risk of infection and to keep moisture in which aids in recovery and reduces scarring.

The three layers that make up BTM encourage the body to generate collagen, which replaces the biodegrading foam with a skin-like layer of connective tissue. When this has happened, the seal can be peeled away and a skin graft used to reconstruct the wound area. BTM degrades over time through hydrolysis, leaving no signs of the synthetic skin in the patient's recovery.

This product has revolutionised the medical industry and the work of doctors, not to mention burns patients, by providing a safer, more hygienic and improved patient care in the treatment of skin trauma and surgical wounds.

1   Describe how BTM synthetic skin has addressed the following design considerations:
    - purpose
    - target market
    - criteria for success
    - competition
    - branding
    - life cycle analysis
    - cost
    - timing.
2   Evaluate the short- and long-term consequences of BTM.

Figure 2.20 BTM synthetic skin has revolutionised the way wounds and burns are being treated.

2.4 Evaluating against criteria for success

Establishing the **criteria for success** in the early stages of the design process generates goals to work towards to ensure the project is a success. The criteria are specific to each project and are usually formulated in consultation with the design team and the client. The criteria for success are usually broken into sections – functional, aesthetic and environmental – and by addressing these headings it is ensured that most aspects of the design are covered.

- Functional criteria refer to the way the design works – how it operates. What actions are required by the user to operate or use the design? Design teams ask questions like this and collaboratively generate answers to the identified problems. In addressing the functional criteria, areas such as ergonomics, durability, quality and user-friendliness are also addressed. Concept sketches and models may need to be created to be able to visualise the basic design and to assist with creating the criteria. Furthermore, as the design progresses, criteria could be added to the list.

- Aesthetic criteria address the visual appeal of the product – the way the product looks. Possible criteria could include shape, colour, texture (such as smooth or rough) and surface finish (such as gloss or matte). In addition, how do these factors come together to create the overall look of the design?

Some criteria are already established through laws and regulations, and must be implemented in the design. For example, building codes are regulations that builders and architects must follow when designing and constructing a building. These codes and regulations are industry standards and/or council regulations. They are usually implemented for safety reasons and/or to protect the environment or local community. Australian consumer product safety regulators are state and federal organisations that make sure businesses

and companies use quality control measures to ensure the safety of consumers. Each of these criteria has further regulations that must be adhered to.

If a company is designing new flotation devices for children, it must apply the Australian safety standards.

The essential functional criteria for flotation aids would be:

- Form: There are several possible forms for swimming and flotation aids, including wearable items, or floats children can sit in. These help children become familiar with being in the water, and so gain confidence and ultimately learn to swim without them.

- Buoyancy of flotation aids: Materials and design of the flotation aid must be resistant to leakage and bursting, abrasion and degradation by chlorinated water and UV light.

- Strength of attachment: Materials such as webbing or tapes, sewed fabric and fastener security must be strong, durable and cannot be easily unclipped by a child.

criteria for success a descriptive list of essential features against which success can be measured. The compilation of criteria involves literacy skills to select and use appropriate terminology.
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Figure 2.21 Swimming and flotation aids have to follow stringent consumer product safety guidelines.

Aesthetic criteria for a flotation device could be:

- Colour: The colour of the float needs to be bright so it can easily be seen.
- Finish: The finish must be smooth and comfortable for the child. Materials used must not rub or chafe the child.
- Shape: The age and experience of the child in the water will determine the type and shape of floatation device used. The more confident the child is in the water, the less flotation coverage is required. A child under the age of one would require much greater buoyancy, such as a full flotation ring, whereas a child 3–5 years old may require the use of floats only on their backs or arms.

The example of the child flotation device clearly shows the strict regulations and standards applied to products. It is vital for designers to be aware of the standards in different industries because if they are not identified as criteria for success early in the development of design, a product may not reach the marketplace and/or a product recall may be required. This would be considered a design failure and could be very costly for companies. The consumer may be put in danger and suffer injuries or even death as a result of the poor product manufacture or lack of clearly identified criteria for success.
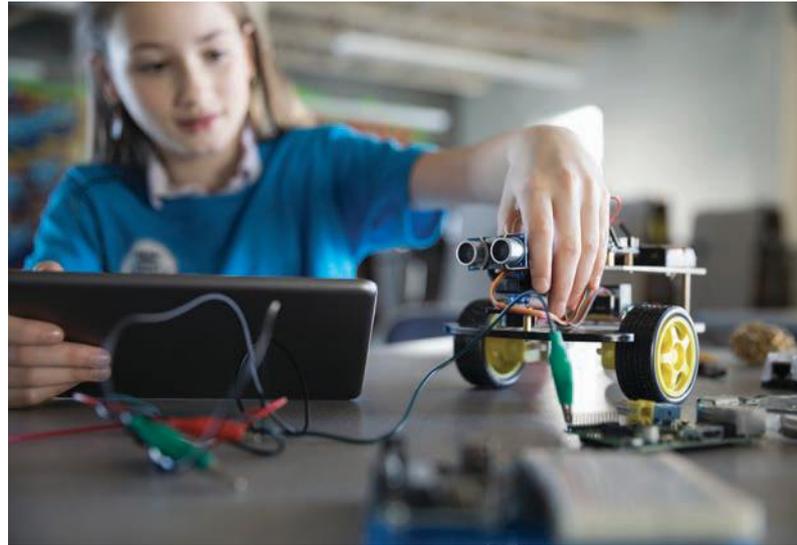
Figure 2.22 Experiments must be conducted to ensure the product meets the design brief.

ACTIVITY 2.5

Identify a common household object, for example, portable speakers, and complete the following:

1   Identify suitable criteria for success which are relevant and specific to the object.
2   Evaluate the identified criteria for success. Remember to make a judgement on how successfully the object has met the criteria.

COMMUNICATING

ACTIVITY 2.6

You have been asked to design a hot water bottle to be used by elderly people in a nursing home.

1   Read the Australian safety standards for hot water bottles, at https://cambridge.edu.au/redirect/8484.
2   List the functional and aesthetic success criteria for your project.

DESIGNING

CASE STUDY 2.3

ikkiworks

ikki is a companion therapy robot designed for sick children undergoing cancer treatment. Children undergoing cancer treatment in hospital face many challenges on a daily basis, such as multiple medications several times a day, monitoring of temperatures as well as the mental strain of dealing with their current situation. ikki has been designed to assist medical staff, patients and patients' families.

Figure 2.23 The ikki companion therapy robot is both a medical device and a form of entertainment for sick children. Watch the video about ikki, available in the Interactive Textbook.

ikki is small, portable and cost-effective interactive device, all features that make it possible for the robot to go home with a child when they leave hospital, while still collecting vital data on the child's health for the medical team. ikki's ability to take the child's temperature and record it enables the medical team to track the health of the child. If ikki registers that the child has a high temperature when at home, the family is alerted and swift action is taken to treat the cause of infection. Early action can prevent infections from becoming dangerous to an already ill child.

In addition, ikki has the ability to remind families when medication is due each day. The medication can be scanned and identified by ikki to ensure it's the correct medication for that time of day. The medication is logged and when the patient returns to the hospital, medical staff are able to download the medication log. They can then accurately determine how effective a medication has been by confirming it has been taken correctly.

Due to ikki's portability, colour and shape it can easily be handled by children and taken with them wherever they go. ikki lets out sounds and can respond to children in 'ikki' language, distracting the child from their current situation. Undergoing cancer treatment can be incredibly frustrating and uncomfortable for children, and ikki allows the child to let off steam and anger which is very important for their mental health. ikki has the ability to respond to this by acknowledging the child's anger. Sounds and stories can also be recorded onto ikki and the child can play these back. They might play back a recording by their parent of their favourite story being read aloud or a message from a friend.

When the day is over, ikki can rest with the child in their bed and provide a soft nightlight, creating a soothing environment to fall asleep in.

The design of ikki is an exceptional example of a product with strong emotional design where it connects with the user. The end user and stakeholders are very clearly identified and have been continually consulted throughout the research and development stages to produce a suitable and effective end product that meets the needs of the target market.

For more information on ikki, see https://cambridge.edu.au/redirect/8485.

1 Write a paragraph addressing the functional and aesthetic criteria for success of the ikki.

Temperature check
Keeps a personal record via ikki smartphone app
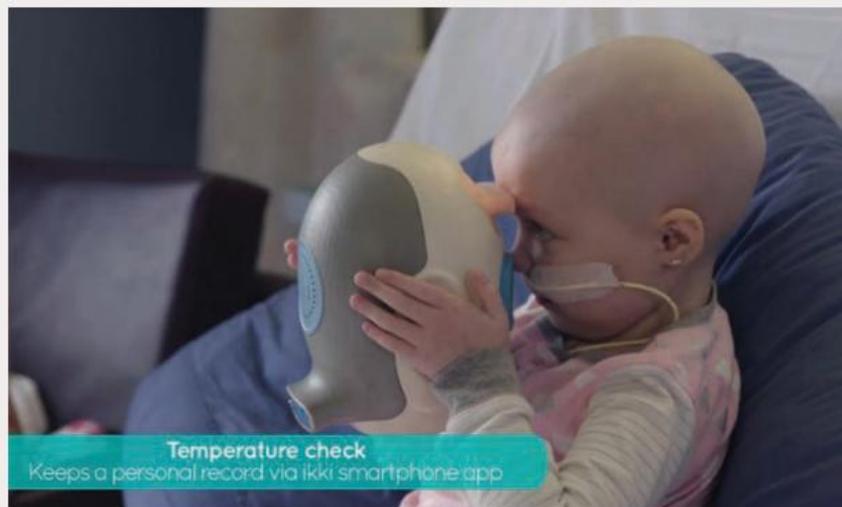
Figure 2.24 ikki's portability, colour and shape makes it attractive and easy for children to use.

2.5 **Experimenting to develop and assess design ideas**

Designers conduct experiments when developing design ideas, and also to assess how suitable their ideas are – that is, to determine how well their product, system or environment works.

Experiments are conducted using a prototype of the product, or part of the product, to be trialled as a way of discovering answers to problems or questions relating to the design. The advantage of experiments is that they can be repeated over and over again and modifications can be made until the prototype becomes more efficient. An experiment allows the designer to observe and measure first-hand how successfully the prototype achieves the design brief. Experiments use the scientific method. Each experiment has a **hypothesis**, the materials used are stated, the method clearly defined, the results are recorded accurately and a conclusion about the experiment is written. Experiments can be conducted under laboratory conditions, in the design workshop or in the shed at home.

Experiments explore a range of different materials, tools and techniques, and results are evaluated to form conclusions about which set of conditions achieves the best design and prototype for the target market brief. Multiple tests can be carried out (that is, the experiment can be repeated many times) and the reliability of the test can be measured by statistics and then reported on with confidence. The reliability of the results for the product can enhance the appeal of the product to the client by increasing their confidence in the fact that their need will be fulfilled. Stakeholders can have greater confidence in their product after testing by experimentation and making conclusions about their product.

Experimentation and evaluation allow all stakeholders to form a decision about the best possible solution for the design brief. The validity of the experiment is important and designers work to **control** the variables of the experiment to ensure that they are measuring accurately what they set out to measure so that results for different designs can be compared.

hypothesis a statement of an intelligent theory with little evidence, which explains how a prototype will work. Experimentation will support or refute the hypothesis.

control in an experiment, control variables stay the same for all tests (e.g. type of hammer, type of nail) so they don't affect the outcome; the independent variable is the factor that you change for each test (e.g. type of wood), and the dependent variable is the outcome that you are measuring (e.g. depth the nail penetrates) to see if the independent variable has any effect

The testing process

The main steps of the testing process include:
1   The hypothesis to be tested is recorded.
2   The aim of the experiment is written up.
3   A list of the materials and equipment needed is made.
4   A written description of the method to be used for the testing is given.
5   The results of the experimental tests are then recorded in the most appropriate form. This may also include images and graphs of the data collected.
6   A written conclusion is presented and some discussion of the possible errors that may have occurred in the testing is also included.
7   Finally, an evaluation of the testing and experimentation is made to decide whether the prototype, or part of the prototype, has achieved the design brief and whether full-scale production should then take place.

AIM

The aim is the intention of the testing and takes the form of an investigation that is to be carried out. In the following example, the aim is to investigate the best shape to use to amplify sound.

This test refers to the shape of an object such as speakers, used to amplify sound. The controlled variables are: the volume of the test sound, the material of the amplifier, the frequency of the test sound, and the size of the amplifier. These variables are kept the same for all tests. The independent variable is the different shape of each amplifier. The dependent variable is the number of decibels recorded for each shape.

Valid tests must refer to the aim and only test one variable at a time while all of the other variables are controlled – that is, kept the same for that test.

MATERIALS AND EQUIPMENT

In the case of the amplification of sound, a range of different shapes would be chosen for testing.

A list of materials would be made as per the following:

- Three different shapes to be tested – cylinder, square and oval, all the same size and material e.g. cardboard – with a groove cut in one side of each in order to place the mobile device.
- Decibel reader to measure the output of sound.
- A song is chosen and the volume set on a mobile device e.g. mobile phone.

METHOD

The method can be written in point form so that the experiment can easily be repeated by you or others who wish to do so at a future time. Since the test has been completed, it is usually written in the past tense.

1 Three different shapes – cylinder, square and oval, all the same size and material e.g. cardboard – with a groove cut in one side to place the mobile device.

2 Each shape was tested by placing the decibel reader 10cm from the open end of the shape. A mobile phone was placed in the groove cut in the shape and the song was played at the same volume setting each time.

3 The decibel reader was observed and recorded.

4 This experiment was repeated six times for each shape. The results were recorded and the average decibels for each shape calculated.

Figure 2.25 You need to assemble the necessary materials and equipment.

RESULTS

The results of experiments can be recorded in a variety of ways. Tables, graphs and charts are useful ways of communicating to stakeholders when they meet to make the final decision for the solution for the design brief.

Tables organise the data recorded and include the units of measurements. Trends can be observed in tables, and maximum and minimum scores noted when comparing materials.

Graphs provide results that can be understood just by looking at the image. Sometimes graphs can be used to make predictions beyond the data collected.

DISCUSSION

The discussion is a reflection on the experiment and raises any errors that may have influenced the outcome of the experiment. Suggestions can be made for improving the experiment if it is to be repeated. The variable that was tested – in this case, the shape of the sound amplifier – is called the independent variable. All the other variables, such as the size of the speaker, distance from the decibel reader, song and volume, should have been controlled (kept the same). Controlling the variables in this way ensures that a fair test was carried out. The dependent variable is the recording made in decibels for each shape and the readings should be different depending on the shape.

Figure 2.26 Discussions can be held to see whether the experiment method can be improved.

CONCLUSION

The conclusion is a statement that relates to the question raised by the aim of the test.

It should answer the question that the test set out to investigate – in this case, 'What is the best shape to amplify sound, from the three shapes tested?' The conclusion could be written in the following way:

> Sample number one is the most suitable shape for amplifying sound, as it was able to project 10.3 decibels, the greatest amount recorded by all samples.

ACTIVITY 2.7

1   Conduct the experiment on the previous pages by writing the scientific method in your workbook.
2   Record your results using the appropriate communication method, such as bar graph, to show the variation in decibel readings.
3   A further experiment could be to evaluate the material from a range of materials to see which produces the highest amplification of sound.

DESIGNING

Figure 2.27 Testing for the amplification of sound is now a scientific process.

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2.6 **Refining and optimising designs**

Refining design ideas to address needs and opportunities

How do designers decide on the final design? After extensive design developments and discussions with stakeholders, a final design is decided upon.

Collaboration with key stakeholders is the client's opportunity to offer feedback to the design team. These discussions provide further direction in the refinement of the design as stakeholders work towards agreeing on a final design. It is important for all stakeholders to have input into discussions in the early stages of the project so that all involved have a very clear idea of the common goals of the design team.

In addition, prototypes and models can be used to get feedback on the design from the clients and the target market. Potential target market end users may be observed using the prototype and surveyed on the model, to gain an insight into their experiences with the design.

ACTIVITY 2.8

1   Reflect on a design you are working on in class. Use a range of resources such as cardboard, hot glue, masking tape and/or a 3D printer to create a 3D model of your design. Seek feedback on the following questions from your peers.
    a   Who is the intended target market?
    b   What could be some possible materials used to manufacture the final product?
    c   What are some potential flaws in the current design?
    d   How could the design be improved? (e.g. safer? recyclable?)
2   Record the feedback from your peers. Using the feedback, sketch some design refinements to improve your final product.

DESIGNING

Figure 2.28 Before designs are finalised, a prototype or model is created to give an idea of what the finished product will look like.
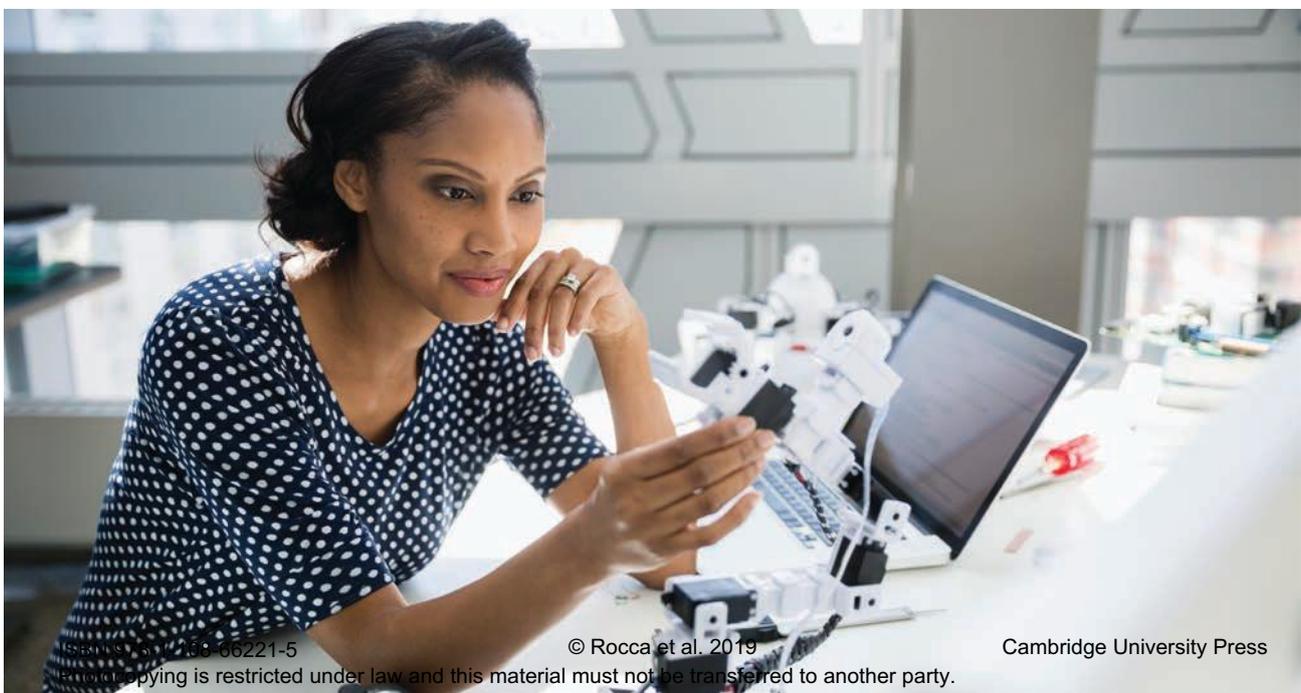
Experimenting to optimise design solutions

To determine whether design solutions are appropriate or not and to investigate whether the design actually performs the task it was designed to do, experimentation and testing must be carried out to optimise design solutions. Possible experiments and tests related to projects include the testing of suitable timber joints and finishes, stitching techniques when working with textiles, and paper folds and page layout in graphic design. Undertaking a variety of experiments with a range of concept designs enables observation and assessment of the design and the most suitable design solution can then be selected with confidence. Documenting this process and the results in a portfolio can be achieved through written scientific experimentation methods, graphing data, photographs, samples and prototypes.

Figure 2.29 Different stitching techniques can be used to test a textile.

ACTIVITY 2.9

Research the website of Polynovo via https://cambridge.edu.au/redirect/8486, developer of BTM synthetic skin (see Case study 2.2).

Explain the experimentation and testing processes undertaken in the development of BTM.

COMMUNICATING

CHAPTER SUMMARY

- The advancement of technology has resulted in new materials and techniques, contributing to better design solutions.
- Stakeholders must be involved in the design process in order for a design to have the greatest chance of success.
- Primary and secondary research is vital in understanding the market opportunities and defining the target market.
- Design considerations include purpose, target market, criteria for success, competition, branding, life-cycle analysis, cost and time.

- Resource requirements can be qualified as human and non-human.
- Simulation is a technique used to determine appropriate technology used in manufacturing.
- Criteria for success enable designers to set goals and then strive to reach them.
- Experimenting and testing are essential for refining and evaluating the design throughout the process to ensure the design brief is achieved.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1 Aesthetics
2 Digital technologies
3 Emotional design
4 End users
5 Life-cycle analysis
6 Market research
7 Need

8 Primary research
9 Qualitative data
10 Quantitative data
11 Secondary research
12 Stakeholders
13 Target market
14 Validity

REVIEW TASKS

1 Identify three ways to determine the needs of a target market.
2 What is the purpose of market research?
3 Who are the stakeholders in the design process and what are their requirements?
4 Define the terms 'primary research' and 'secondary research' and provide examples of each.

5 Explain how new and better designs are developed.
6 What are the design considerations that must be taken into account in the design process?
7 Explain, using examples, the difference between market push and consumer pull.

8 Identify a product that has undergone extensive research and development. Describe the differences between the original product and the revised product.

9 What role does the criteria for success play in the design process?

10 Explain how experimenting and testing of design ideas impacts on the final product.

PRACTICAL TASK

Conduct an experiment/test relevant to your own project. This could be in relation to:

- the development of your design ideas
- the suitability of your design ideas
- refining your ideas to address needs and opportunities
- optimising your solutions.

Use this scientific method as an example when documenting the experiment in your portfolio. You might like to explore different tools, materials and techniques in relation to your project to determine the suitability.

3 The impact of past, current and emerging technologies
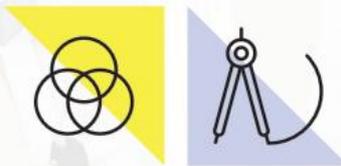
KEY TERMINOLOGY

- Cultures
- Environment
- Historical
- Migration
- Trends
- Ethics
- Globalisation
- ICT
- Emerging technologies

This chapter explores how past, current and emerging technologies have impacted on the individual, society and the environment. It considers the work of past and current designers including Aboriginal and Torres Strait Islander peoples. It also looks at careers in design and manufacture, as this provides insights into the design world. Finally, it considers design and technology trends and how they have influenced the design industry.

This chapter addresses **Outcome DT5-3** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the content areas **The work of past and current designers across a range of settings** and **Trends in technology and design**.

Note that the dot points under **Influence of design on the individual, society and environments** are addressed in Chapters 4 and 5.

3.1 The work of past and current designers across a range of settings

As designers, we need to be mindful of past and current settings that impact on the way in which we design. Events, people and trends are just some areas that have influence on new products, systems and environments as they are developed. Social issues directly influence present-day design and production. In order to appreciate the state of design and technology today, we should consider the influence of social issues over time, such as changing social trends, cultural diversity, the changing nature of work and technological change. Some of the most significant historical factors that have impacted on social trends include the introduction of new cultures (via migration), economics, changing lifestyles and changes in family structures.

Commercial, historical and industrial settings

COMMERCIAL AND INDUSTRIAL

Designing in domestic or home settings usually involves one-off or small-scale production activities. In these settings, manufacturing techniques are usually kept as simple as possible in an attempt to keep production costs low and minimise potential problems. The design approaches need to be effective to produce products that are easy to use and are readily accepted by consumers.
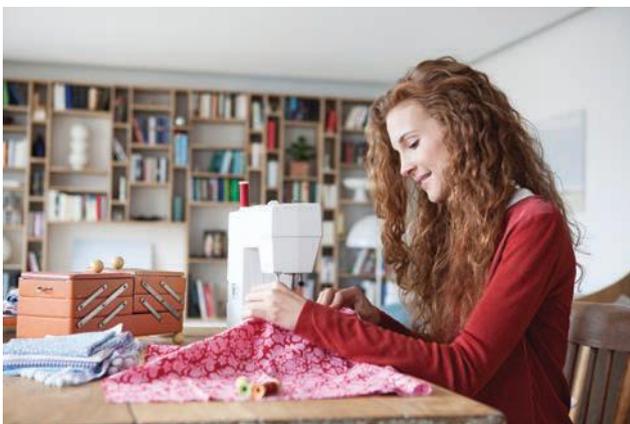
Figure 3.1 Domestic production is usually on a small scale and manufacturing is kept as simple as possible.

Large-scale production of goods is the defining factor in industrial and commercial settings. This usually involves a large number of people in the production process and a variety of manufacturing techniques, as workers engage with large-scale machinery and tools. The products are more economically viable to manufacture, given the scale. Industry, by its very nature, has more funds at its disposal to afford more sophisticated manufacturing processes and thus support heavier production costs.

In industrial and commercial settings, manufacturers tend to use large-scale and automated machinery. When mass production is involved, added costs such as wear and tear on equipment, maintenance and labour need to be considered in the design and production processes.

Items may be designed with a certain life cycle in mind to ensure that more units are sold to recover costs and maximise profits. Replacement products with improvements and new features may be rolled out regularly to ensure sales are maintained. Examples of commercial/industrial design include entertainment systems, vehicles, food products and most other consumer items.

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HISTORICAL

European settlement of Australia occurred from 1788. Prior to that, the traditional owners of the land, the Aboriginal and Torres Strait Islander peoples, had their own social order.

They used the land for their needs, constantly moving to utilise different types of land in different seasons to ensure that their impact on the land was minimised. They took care of their needs without exploiting their land. They produced all their tools and clothing from the local environment. These customs endure today in our Indigenous communities in the Northern Territory, where women continue to dye reeds using ochre and natural dyes found in root vegetables.

Modern immigration to Australia began with the first European settlers. World events and various government policies over the years have focused immigration intakes on people from various countries, with surges occurring during gold-rush eras and after World War I and II and other international conflicts.

Our immigrants have introduced many different customs, foods and cultures into Australian society. Through this migration we have encountered new products and innovations not seen previously, such

Figure 3.2 A basket made by Gutili Ganambarr, using techniques traditional to the Yolnu people of Miwatj (northeast Arnhem Land)

as the electric wok. Today, these rich influences from immigrants are evident in many areas of design, including architecture, fashion and landscaping.

ACTIVITY 3.1

Research one or more of the following.

1 **Commercial**
   Jan Logan is a commercial designer. Using the internet, examine the work she produces and investigate her techniques, materials, designs and finished products.
2 **Industrial**
   Investigate the practices of industrial designers Amigo & Amigo using the internet. Why are Amigo & Amigo's products unique?
3 **Historical**
   Using the internet or your school library, investigate the materials, tools and techniques used by the ancient Egyptians and/or the ancient Romans when creating their jewellery.

COMMUNICATING

ACTIVITY 3.2

Examine and describe the work of three current designers across a range of settings and from a range of focus areas of design. Think of products you have admired the design of from a range of industries (fashion, food, kit-set furniture etc) and find out who designed the product. Research and report on the three designers by answering the following questions:

1   What are the names of the designers?
2   Describe each designer's specialisations.
3   What are the processes the designers go through in order to make their products?
4   What are their sources of inspiration?

COMMUNICATING

Individuals and collaborative teams

Designers can work on their own or as part of a collaborative design team. Collaboration involves a number of different design teams working together to develop a final design. One of the benefits of working collaboratively is having specialist designers work on particular steps in the design process, for example employing a graphic designer to create the digital sketches of a final design. Working collaboratively allows designs to potentially reach the market quicker, as steps can be moved through at a faster pace.

Figure 3.3 Religious beliefs can guide jewellery design.

Cultural factors

Our cultural beliefs are predominantly influenced by the society in which we grew up. Geography, climate, religion, history, traditional practices, cuisine, morals (accepted behaviours) and laws all determine, to an extent, the cultural beliefs that we hold.

Multiculturalism brings richness and depth to a society from a design perspective, given the variety of influences it offers up. Religion can be a factor that determines design in fashion, jewellery, architecture and art. Designers need to show sensitivity to the views of others. The use

of sacred Aboriginal and Torres Strait Islander peoples' artwork in graphic design, for example, may be considered taboo.

Culture may be viewed as a set of spiritual, material, intellectual and emotional features of a social group or society. It can incorporate the art, literature, lifestyles, ways of living together, value systems, traditions and beliefs of these peoples. Cultural rights are part of human rights and enable people to express themselves and participate in the cultural life of their choice.

multiculturalism the presence of a diverse culture made up of various races, religions or other groups

The cultural diversity of Australian society has resulted in the creation of various products, systems and environments based on specific needs of ethnic communities. Each new culture to Australia has brought traditions and customs with them. They have influenced fashion and food, bringing with them their tools, techniques and experiences. It is important that designers are aware of the cultural diversity in our country and that we respect and celebrate cultural differences in our designs.

The way we conduct our day-to-day lives, from work time to leisure time and the composition of families has changed considerably over time. With these social shifts come opportunities for creation and design ideas to suit new situations. The women's liberation movement saw women take more varied and prominent positions in society. Women obtained greater access to jobs, politics and education. The number of women returning to work after childbirth has increased, and the age of women having their first child has risen. The percentage of women not having children has also increased. Family structures have changed with extended families, single parenting, grandparent and kinship parenting, and same-sex parental households all increasing. We have also seen the cost of living rising and average working hours increasing.

Advancements in communication technologies have enabled people to work from home (telecommuting), and for some people to choose part-time work as a lifestyle choice. All of these changes in the social fabric of our society have led to design opportunities.

Consider the rise in divorce rates and single-parent households in our society, for example. As care providers, many single parents have to work and have less time at home. This has created a need for convenience products and time-saving devices. Any number of designs cater to these needs.

Figure 3.4 Advancements in technology mean more people can work outside the office, leading to new design opportunities in the home.
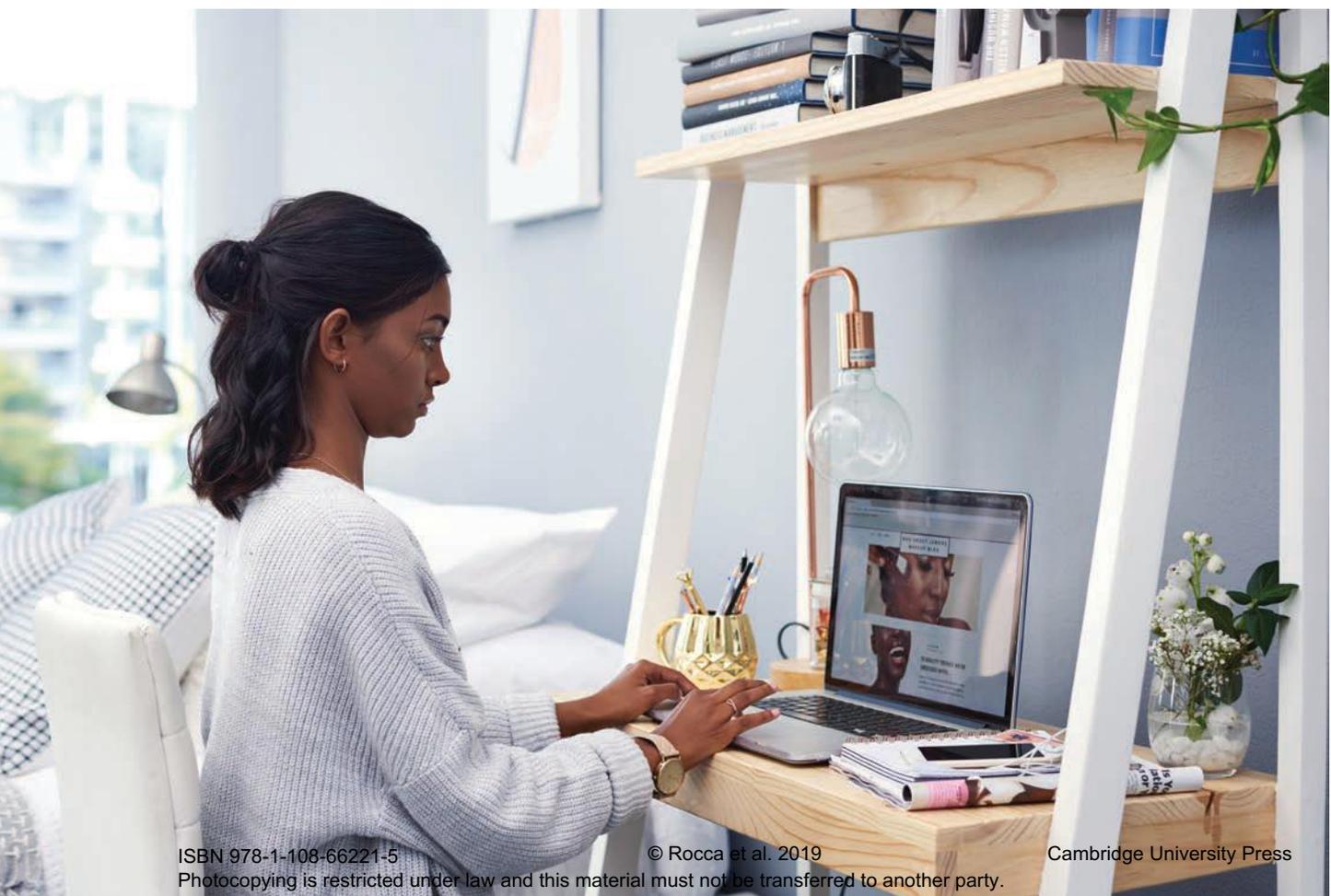
ACTIVITY 3.3

1   Identify one type of jewellery or adornment developed by each of the following cultures:
    a   English
    b   French
    c   Indian.
2   Outline the beliefs or meaning the jewellery represents.
3   Identify the tools and processes used to develop the adornment.
4   How has the work of these cultural groups influenced the jewellery worn today?

COMMUNICATING

ACTIVITY 3.4

Assume you have been commissioned to create a design for a wall tile that best represents your own cultural context.
Draw your design and describe how it meets the brief.

DESIGNING

Diversification of design

It is important to investigate the work of designers across a range of settings. You need to research a variety of areas to have a greater understanding of different designers' work and how they achieve successful designs.

Let's focus on jewellery design for a moment. Jewellery design is a form of product design.

JOB DESCRIPTION

Jewellery designers primarily design and create body adornments with a range of materials, including (but not limited to) gemstones, diamonds, silver and gold. Jewellery making is one of the oldest crafts and each piece of jewelery can possess sentimental value and symbolic meaning, on top of any market value. Designers must understand and relate to their clients in order to design the correct

Figure 3.5 Jewellery designers work with a range of materials to create their products.

piece according to design specifications. In addition to this, designers are expected to have mastered the practical skills needed to manufacture the piece.

TYPICAL WORK ACTIVITIES

The types of skills a jewellery designer utilises include:
- Designing: using computer-aided design (CAD) to produce mock-ups and reference visuals of how a finished piece of jewellery will look
- Mounting: manufacturing the framework for the item; this involves handling, forming and drilling metal, and making cavities in which the gems will sit
- Stone setting: adjusting the mount to ensure the stones or other accents fit correctly; this can be very delicate work, as it requires removing tiny fractions of metal
- Model making (casting): using a mould to create an object or decorative detail; moulds can be made from materials such as sculpted wax, plaster, metal or sand
- Stamping and presswork: using a machine to shape coil or sheet form metal to precise specifications; the process can include embossing, bending, trimming, blanking, drawing, and/or piercing the metal with a die
- Chasing: creating a raised pattern on the metal surface
- Electroplating: creating a layering of one metal on top of another, with the upper layer typically being a precious metal
- Enameling: creating coloured patterns and pictures by fusing powdered glass to metal in a kiln

- Welding: joining pieces of metal together
- Engraving: carving lettering or patterns into metals; this can be done by hand or computer
- Polishing: finishing off the piece by cleaning and polishing it.

When a designer is employed by a company, a distinction is made between the design and the production. All the key skills listed previously are delegated to various roles within the organisation.

Client-based activities differ from company-based ones. Client-based activities may include:
- Consulting with potential clients
- Identifying options available to the client, and suggesting original ideas
- Using sketches and 3D imaging to assist the client in visualising the finished design.

Promoting the business and ensuring that it grows is essential for success as a jewellery designer. Designers can increase their reach and popularity by networking, entering design competitions, managing a stall at a market or design fair, all in order to display that they have been producing original work to a high standard.

Jewellery designers may also spend time consulting with galleries, store buyers and suppliers, and researching the latest trends, other designs and the world of fashion to ensure their designs remain relevant.

Figure 3.6 Designers must know how to present their ideas during meetings with potential clients.

CASE STUDY 3.1

Nicola Cerrone

Nicola Cerrone set up his first jewellery store in Leichhardt, Sydney, in 1972. He now has three stores in Sydney, and one in Melbourne, and employs artisans from a range of backgrounds who offer different techniques and cultural influences.

Cerrone creates handcrafted, bespoke jewellery, and the entire process is conducted in-house, from initial design visualisations to final setting and polishing. Cerrone's workflow runs as follows:

- The client meets with a designer who produces sketches based on specific requests, or to provide inspiration to the client.
- To assist the client in visualising the final product, 3D models are created from the sketches.
- A solid piece of gold is melted into the desired shape, and then jewelers work on it by hand. Expert craftspeople are involved throughout the process.
- The piece then goes to the setters who carefully insert the gemstones. This precision work involves the use of microscopes.
- Technicians polish the finished piece, using motor powered polishing machines with both hard and soft buffs.

Go to the Interactive Textbook and watch the video about Nicola Cerrone's artisan workshop before answering the following questions.

1   Describe the important role aesthetics play in the designs of Cerrone.
2   Describe how Nicola uses collaborative approaches in his designs.

Figure 3.7 A jewellery design by Cerrone Jewellers

3.2 **Impact of design on the individual, society and the environment**

As designers, we need to be aware of the impact that is associated with the design of products, systems and environments on the individual, society and the environment. It is extremely important that designers consider the positive and negative consequences of their work now and any consequences that may arise in the future, as the effects could potentially be far-reaching. Consideration must be made through both the design and production processes.

ethics moral principles that govern a person's behaviour or how they conduct an activity

Designers often respond to community pressures and highlight their eco-friendliness or their **ethical** beliefs, which may also result in the work being more marketable.

A product, system or built environment may impact on the individual, society or the natural environment. Some factors you may consider before beginning a design are:

- Impacts on the individual and society: personal values, individual needs, cultural beliefs, equity, safety and health, economic factors, community needs, employment
- Ethical impacts: the consumer, advertisements, intellectual property, privacy, testing
- Environmental considerations: life-cycle analysis, pollution such as waste, landfill and noise, sustainability, energy, global warming.

In considering the impact a design may have on the individual, society and the environment, let's take one example and see what the potential impacts may be. The table below shows the advantages and disadvantages of Instagram.

GO

Table 3.1 The advantages and disadvantages of Instagram

ADVANTAGES	DISADVANTAGES
TO THE INDIVIDUAL	
- You can upload and share personal photographs and videos, as well as links to other sites. - You can potentially contact users and be contactable yourself 24 hours a day. - You can message people instantly. - You can control access to your personal information by deciding who sees what of your profile. - You can express yourself by leaving comments on other people's posts as well as your own. - You can keep up-to-date with news about your friends, their interests and relationships. - You can use the inbox provided for private conversations. - You can make public comments on issues and topics that interest you through your posts. - You can develop a large group of contacts, with varied interests and expertise. - You can contact large groups of people at once to share information or to gain support for a cause. - You can express your creativity and share with others.	- Other users can try to contact you 24 hours a day. - You cannot control access to some personal information and photographs that other users put on the site. - You can be exposed to undesirable people or online predators. - As users can see some of your activities on the site, as well as photographs, you can lose your privacy. - As you can see the activities of other users on the site, you may develop social insecurities if your posts are not liked or commented on. You may also feel that others are living a better life than you. - You can develop addictive behaviour, or dependence on the site. This may lead to loss of personal time, and the replacement of face-to-face relationships. It may also detract from study and work time. - You can become a victim of online bullying. Other users can leave negative comments, upload inappropriate material or send abusive messages in private. Bullying behaviour also extends to isolating users through blocking. - You may feel pressured to follow other users with whom you would not otherwise have chosen to have contact with.

Table 3.1 *(continued)*

ADVANTAGES	DISADVANTAGES
TO SOCIETY	
• Users with common interests are brought together. • Users in remote areas are able to participate and access information they would not otherwise be able to. • Users have an effective means of mass communication. • Users may be able to communicate with others more often. • Images of important events can be shared more widely and rapidly than through traditional media. • Businesses are able to directly target their demographic through advertising and marketing, and boost their online profile.	• Employers are able to spy on their employees, finding information about their non-work related activities and relationships. • Users may be conditioned to use Instagram, which leads to changes in social behaviour and etiquette. • Users may not develop healthy interpersonal skills. • Users can have their accounts hacked and their personal data used for criminal activities. • Posts can alert potential burglars if users are on holiday or about recent purchases. • Children are at greater risk of grooming and attacks by online predators. • Some social media groups promote racist, sexist, homophobic, violent or other anti-social behaviour. • Users can violate intellectual property rights by uploading content that is not their own. • Users may not be aware when an individual's posts have been sponsored by a business.
TO THE ENVIRONMENT	
• Instagram is a communication means that does not require paper. • Environmental groups can be formed, and support for environmental causes rallied quickly online.	• Instagram uses a range of quickly developing technologies, such as computers and smartphones, which may encourage materialism, become obsolete quickly or add to landfill.

ACTIVITY 3.5

Ethical designers will think through the impact their design may have on the individual, society and the environment.

In a table like the one shown, list some of the advantages and disadvantages of each technology listed below for the individual, society and the environment.

- location services
- electric car
- a new bridge

	ADVANTAGES	DISADVANTAGES
Individual		
Society		
Environment		

COMMUNICATING

3.3 Design practices and solutions developed by Aboriginal and Torres Strait Islander peoples

While some designers use modern technology in their work, others prefer to focus on traditional practices and solutions.

Lola Greeno is a well-known Aboriginal jewellery designer who uses traditional production methods.

CASE STUDY 3.2

Lola Greeno

Figure 3.8 Designer Lola Greeno

Shell-stringing is an important cultural practice for Tasmanian Aboriginal women, and is part of an unbroken tradition that has been passed down through generations. Read about the design practices of shell-stringing artist Lola Greeno in the following extract and watch the video about her in the Interactive Textbook.

improvisation spontaneously acting on or creating something

contemporary belonging to or occurring in the present

Lola Greeno is a Tasmanian who combines the energy and **improvisation** of a **contemporary** arts practice with a tradition

tracing back thousands of years. Born on Cape Barren Island in 1946, Greeno moved to Flinders Island and then Launceston in 1972. Greeno has continued the work of her mother and her mother's mother. She specialises in traditional Tasmanian Aboriginal shell necklace threading and today her works are enjoying mainstream recognition, respect and demand.

Greeno is one of a handful of women shell-stringers responsible for ensuring the craft is passed down from the Elders. Close personal connections between women have been essential in transmitting these skills and related values: 'I learned to make solely from working with my mother … It was my mother who was very keen for us to work together and this has been the important cultural lesson I learnt from her – teaching respect for one another. My life has grown so much from my mother' (Lola Greeno, discussion with the author, April 2004).

Greeno has dedicated *Purmaner*, 2004, to her mother Val MacSween, explaining that 'Purmaner means my mother'. It is a dynamic work that reveals a familiarity with the dozen or so shell types from which distinctive patterns emerge. Greeno inherently understands the message each shell transmits. This string of iridescent maireener shells, yellow oat shells and stripy button shells, collected from the beaches of Flinders Island and mainland Tasmania, reflects an exuberant joy in practising culture.

Senior Tasmanian shell-workers are now working together with their own daughters or other family members to continue the skills of this practice. Greeno has described the imperative of passing on the tradition: 'My future work is to teach my daughter and my grand-daughter to appreciate the significance of their cultural heritage by becoming the next generation of shell-makers. My dream is to see my daughter exhibit alongside of me' (discussion with the author).

The National Gallery of Victoria first recognised the significance of this practice and the visual quality of the resulting works by collecting six necklaces in 1995 and now holds 10 necklaces in its growing collection of Tasmanian shell-work created by Joan Brown, June Brown, Corrie Fullard, Dulcie Greeno and Lola Greeno.

The maireener (*phasianotrochus irisodontes*), a shell valued highly for its brilliant iridescence, is collected on correct tides from particular sea plants. The shells are cleaned, painstakingly sorted, then pierced and strung. The process can take from several months to a year, from collecting the shells to tying the final knot on a completed strand. Most shell-workers prefer creating with mixed shell types, where each strand carries its own specific aesthetic beauty, personal and cultural meaning and style identifiable to each maker.

Shell necklaces are markers of time-in-place for shell-workers. Shell types and the way they are strung signify how an individual was working at a particular period and hence can assist in identifying necklaces with their makers. Each strand also reminds its maker when, where and why a necklace was made. Necklaces were and still are made as gifts and for trade – today this also includes the contemporary fine art market. Shell-work is fundamental to the makers' lives, as Greeno explains: 'My shell-making in my life is my whole cultural being … I could not exist properly without making shell-work' (discussion with the author).

Source: Dr Julie Gough, Curator of Indigenous Art, National Gallery of Victoria, 2004

Figure 3.9 Greeno learned her skills from working with her mother and she dedicated the piece *Purmaner*, 2004, to her.

1   Outline the design process that Lola uses to develop her creations.
2   In the video, Lola describes how her designs have evolved. Explain some of the changes she has made.
3   Discuss the importance of ensuring we preserve the traditional techniques and traditions used by Aboriginal and Torres Strait Islander peoples.
4   Investigate another design practice or solution developed by Aboriginal and Torres Strait Islander peoples, and suggest how it could be (or is) used in current design.

3.4 **Career opportunities and pathways**

We are all designers. Each day we explore possibilities and make decisions about what we will wear, how we will travel to our destination, how to organise our time for homework and sport, and what tactics to use to score points in a game. We work through a design process to reach a solution. This process will differ according to the situation but will have many things in common. We will always consider different ideas. We will develop our solution and continue to evaluate throughout the process.

Both men and women have influenced the design world. It is crucial that as a society we do not stereotype or pigeonhole a certain sex within any design industry. The same goes for people from diverse cultures and backgrounds who all have experience and perspectives to bring to the design process.

Professional designers work in different ways. Some design in response to a need, be it personal or commercial. Some are inspired by a new material and envisage different uses for it. Others are employed by a client to design a product, system or environment for a specific purpose. A designer may also be part of a larger design team and be responsible for only one section of the final design.

From your study of technology, you will be aware of areas of study within the context of designers. Some relevant areas of study are outlined next.

Figure 3.10 There are many different career opportunities for a diverse range of designers.

Built environments

Environments are an important part of society. An environment heavily influences the way people live and behave. While some environments are natural, they can also be created, modified or constructed. The design of environments has important factors to consider, including functional, physical and material properties, as well as aesthetic, ethical, environmental, socio-cultural, human form and

scale, and safety requirements of the design. Some careers in built environments are:

- architectural design
- structural design
- interior design
- landscape design
- environmental design.

Figure 3.11 Landscape design is a key part of a society's built environment.

Products

Products are consumed, used, purchased and distributed in large numbers every day. A product may be an object, system or artefact that has been designed and manufactured. The creation and sale of products is an important part of the economy. Products may be niche items or mass-produced. When designing a product there are a range of important factors to consider, including aesthetics, material properties, ergonomics, environmental impacts, socio-cultural impacts, safety and functional outcomes of the development. Some careers in designing products are in:

- fashion design
- food design
- industrial design
- agricultural design
- jewellery design.

Information and communications

Information and communications refers to various forms of data and information such as text, images, audio, video and statistics. The purpose of such data and information is to communicate a message. This communication involves using various forms of media, including verbal, written, graphical and digital, to access, process and transfer information and ideas. Audio and visual communication is as important as written and spoken communication.

When a designer works with information and communications solutions, they consider the aesthetic, socio-cultural, ethical and functional outcomes of the design in careers that include:

- communications systems design
- information systems design
- promotional design
- digital media design
- software design.

Figure 3.12 A digital tablet, such as an iPad, involves both product design, for the physical device, and software design, for the apps.

ACTIVITY 3.6

Research the following occupations, and copy and complete the table.

DESIGN OCCUPATION	JOB DESCRIPTION/NATURE OF WORK	TYPES OF PEOPLE THIS CAREER PATH WOULD SUIT
Architect		
Craftsperson		
Fine artist		
Fashion designer		
Graphic designer		
Industrial designer		
Interior designer		
Production designer		
Multimedia and web designer		
Photographer		
Digital visual effects		

COMMUNICATING

ACTIVITY 3.7

In a table, like the one below, complete a summary on the designers profiled in this chapter or that you have studied in class. You may need to complete some further research online.

DESIGNER	STYLE	INSPIRATION	MATERIALS	CAREER PATH

COMMUNICATING

ACTIVITY 3.8

Select a design career path and a designer within that field. Research the designer and their work and complete the following.

1. In approximately 150 words, describe the designer, referring to their work, designs and materials.
2. In approximately 100 words, justify how this designer inspires you; refer to their concepts and ideas and how you may take inspiration from them to utilise in your own work.
3. In approximately 100 words, name and describe the techniques, processes and materials the designer appears to use in the design and production of their work.
4. Include at least two graphics (pictures or sketches) with annotations. Remember to reference your images.
5. Include a bibliography with at least five entries.

COMMUNICATING

Cambridge University Press

3.5 **The impact of trends on society**

As designers, it is important that we monitor trends. Keeping up-to-date with trends will ensure that designs can meet the target market's needs. It is also important to be aware of historical and cultural influences that have shaped design and production.

Social, cultural, global, political, economic and environmental influences directly and indirectly affect trends and in turn impact on design and production. Environmentally conscious design is an increasing trend in contemporary society. Companies such as Bird, a climate neutral design company based in the Byron Bay hinterland in New South Wales, have strived to keep waste to a minimum while creating design solutions. Bird was founded by Rachel Bending, an ethically and environmentally conscious designer who saw the Bird brand as a means to create awareness about sustainability among consumers. Bending's designs include fabrics, fashion, gifts and homewares. These form a collection of 'luxury eco products for those who appreciate quality and style, and care about the planet on which they live'. Bird works 'towards sustainability' through a policy of reducing impact, reusing and recycling, using renewable resources and offsetting carbon emissions.

Social issues

'Social issues' is an umbrella term that encompasses sub-topics such as multiculturalism, social class, egalitarianism and social conscience. As we consider each of these more closely, we will come to understand the importance and relevance of social trends and their impact on design and production.

MULTICULTURALISM

A large percentage of Australians or their parents were born overseas. There are many cultures represented in our population. The trend to cater for our multicultural society has impacted on design and production activities. Although English is the national language, numerous other languages are spoken throughout the country. Instructions on products may need to be written in a number of languages. In the workplace, safety instructions are presented in graphical form so that workers of different backgrounds can understand them. If you were designing a new school uniform, you may

Figure 3.13 Workplace safety instructions are presented as graphics so all people can understand them.

need to include clothing that respects the cultural requirements of traditional followers of a number of faiths. Multimedia products will sometimes have a warning that images of deceased people may be present, in respect of the beliefs of Aboriginal and Torres Strait Islander peoples.

SOCIAL CLASS

A person's socio-economic status is determined by the interaction of their social and economic situations. An indication of socio-economic status is the amount of disposable income an individual has. People in higher socio-economic groups have more funds to allocate to non-essential and luxury items. People in lower socio-economic groups have to allocate most of their funds to basic needs. Difficulties arise when there is social pressure to purchase products beyond a person's means.

In some countries, class structure may be based on race or religion.

EGALITARIANISM

Egalitarianism adheres to the principle of equal rights and opportunities for all. Minority groups, including people with disabilities, non-English speakers and underprivileged people, deserve products, systems and environments designed and produced to ensure that their needs are met and that they are accessible in both affordability and practicality. Not only must minority communities be catered for, but the impact on such communities of all products, systems and environments should be assessed to ensure no further marginalisation is created.

SOCIAL CONSCIENCE

Social conscience refers to values and the sense of right and wrong individuals and society feel in reference to the well-being of the society and community. Individuals, depending on their

social, environmental and political persuasion, support different causes and some seek to ensure that these causes remain on the social agenda. Sometimes groups in society have moral or ethical opposition to some innovations (for example the Catholic Church is morally opposed to cloning as they believe only God can give life). It is helpful for designers to be aware of this, and to assess the ethicality of their designs.

GLOBALISATION

Globalisation is often described as the process of the world becoming a smaller place. Designers are both affected by and contribute to that process. Technological advancements have created easier, quicker access to distant or remote places, making trade, communication and travel much easier. Satellite communication via phone, fax, email and even online conferences provide faster and simpler means of communication between nations. Teams in different countries can undertake design and production projects cooperatively.

globalisation the process of economic, financial and cultural interaction and integration around the world

Figure 3.14 Technological advancements have created easier, quicker access to distant or remote places.

Commercial and industrial practices

With the introduction of commercial and industrial practices, we have seen a change in the way we produce some design projects. For example, the traditional method of making dovetail joints by hand has been replaced with finger joining by using a finger jointer. The traditional methods of cutting wood, such as using a hand-held saw or scroll saw, have seen advances in equipment used in commercial and industrial settings such as the laser cutter or the CNC router.

Figure 3.15 Laser cutters on wood are now more often seen in commercial and industrial settings.

ACTIVITY 3.9

You are a furniture designer and have been commissioned to create a wooden bench for a family home.

1   Describe the process you would undertake to design and produce this bench
2   Outline the tools, techniques and materials that can be used in the development of this product.
3   Explain how the impact of commercial and industrial practices has impacted on the development of the bench.

DESIGNING

Entrepreneurial activity

Entrepreneurs are people who make money by starting their own business when they see an opportunity. Entrepreneurs take big risks in hope of big gains. In design industries we have seen entrepreneurs push and stretch designs to create new and wonderful innovations.

An example of an entrepreneur is James Dyson. A video of his story is available in the Interactive Textbook.

CASE STUDY 3.3

escaVox

escaVox is a data exchange company, which means that its products enable data to be shared between different computer programs. In the case of escaVox, the data being shared relates to agricultural produce: they track food items from the farm all the way to the end purchaser. This means that the entire supply chain is visible, which allows areas of waste and inefficiency to be identified, and it also means that consumers can see exactly where their food has come from.

escaVox's founders, Luke Wood and Nicola Sanderson, are entrepreneurs. As you will see they have had a number of different career opportunities before they arrived to where they are right now.

Figure 3.16 escaVox logo

Luke Wood

Director and Founder – escaVox
Previous roles:

- Director – Australasian Supply Chain Institute
- Head of Supply Chain Systems Strategy and Innovation – Woolworths
- Director and Founder – TrigPoint Solutions Inc
- General Manager – TrenStar Inc

Luke graduated from the University of Huddersfield (UK) in 1996 with a BSc (Hons) in Transport and Distribution Management. He moved to Australia in 2001, deploying technology into industrialised settings through various start-ups, consulting and smaller companies. He spent a number of years in the US after founding an RFID based supply chain and asset management technology company for the oil industry. Returning to Australia, Luke joined Woolworths as Head of the Supply Chain Systems Strategy and Innovation, also taking a board role with the Australasian Supply Chain Institute (ASCI). His current role is Director and Founder of escaVox, a company that uses Internet of Things (IoT) to manage food waste by creating real time visibility of fresh pallet movements.

Nicola Sanderson

Director and Founder – escaVox
Previous roles:

- Project Manager – Woolworths
- Lean 6-Sigma black belt, process optimisation – Eli Lilly
- Master Data Steward – Eli Lilly

Nicola Sanderson has 20 years experience in manufacturing and supply chains in the UK, maximising process efficiency and minimising waste in pharmaceutical and retail businesses, saving over $50m in the process. Nicola lead the development, design and trial of the cold chain tracking solution in Woolworths. Her current role is Director and Founder of escaVox, a company that uses IoT to manage food waste by creating real time visibility of fresh pallet movements.

The evolution of escaVox

escaVox was developed in three stages. Beginning with a vision of tracking cartons of strawberries, so that customers who purchased them could find out exactly where the strawberries had come from, escaVox expanded to a commercial model that could serve the whole industry.

ITERATION 1 – Give the customer the full history of the food they eat

Deliverable: The history of a carton of strawberries

- Luke and Nicola wanted to track every carton of produce to every store so each customer could know the full providence of their product, believing this would be of great value to the retailer and the consumer. Their first iteration used a hand-built prototype device to 'prove we could gather and collate the data'. This was successful. At the same time, they tested if customers wanted the data.

Equipment:

- Luke and Nicola hand built a GSM (Global System for Mobile Communications)/GPS/temperature/humidity/light/motion sensing device
- They put a simple website together to view the results.

Results:

- Yes, they could collect data in real time
- The supply chain was more complex and unpredictable than previously thought
- Temperature and time abuse in the chain was causing loss and damage; light, humidity and motion were not as important
- Customers were not that interested in the data.

Unexpected result:

- The supply chain participants were very interested in the data which gave Nicola and Luke a new perspective.

Conclusions:

- The data was very valuable to members of the chain
- Customers would not view the availability of this data as a major advantage.

Next action:

- Track more cartons, more efficiently, and in a way that supports supply chain participants, not just end consumers.

ITERATION 2 – Track efficiently and present actionable data

Deliverable: A data and financial model that proves the value of tracking produce at a carton level

- Luke and Nicola researched more commercially available devices and spoke to a lot more members of the supply chain. They attended conferences and met with key industry bodies; technical, operational. They then devised a larger project to place a big number of devices.
- They engaged a much larger team and collated a group of senior stakeholders and created a brand for the project.

Equipment:

- Luke and Nicola bought a large number of different devices from different manufacturers
- They put a more complex data model together to view the results
- They took data from other sources to enrich the end state data model.

Results:

- The data has enormous value to all members of the chain
- The supply chain can be shown to users via this method and changes can be made; these changes will result in consistent quality for the consumer and less waste in the chain
- Temperature and time abuse in chain was causing loss and damage.

Conclusions:

- The data was very valuable to members of the chain
- The data needed to be shown in very different ways to different users due to the commercial sensitivities – suppliers should not be able to see other suppliers' data
- This data could help all channels of the chain but could not be owned by any single one of them; it would need to be independent.

Next action:

- Commercialise the model and create the independent collector and curator of the data.

Figure 3.17 escaVox's Data Exchange Platform was very useful to every user.

ITERATION 3 – Create the commercial model

Deliverable:

- A commercial model/company that can deliver the data and service from iteration 2 to the whole industry
- Luke and Nicola built a number of models that studied financial implications of different scenarios; optimising for one where cost and value were optimised for participants as well as the company. Luke and Nicola searched for partners, technical and operational.
- They created a company, escaVox
- They secured all the relevant legal positions (IP, etc.) and wrote a prospectus to attract direct private investment.

Equipment:

- They commissioned the design of a custom device from manufacturers
- Luke and Nicola put a more complex data model together to view the results
- They hired a team to start developing the software and hardware

- They created a marketing and direct sales campaign to promote the product.

Results:

- Luke and Nicola have contracts with significant growers and retailers
- Full deployment started in February 2019.

Conclusions:

- The data was very valuable to members of the chain.

1 Describe how Luke and Nicola's past experiences might have inspired them to create escaVox.
2 Using a mind map, document the processes that Luke and Nicola went through in order to have a product ready for deployment.
3 In your own words, explain why there was a change in focus after Iteration 1.

3.6 **How designers use ICT and emerging technologies**

As discussed in previous chapters, technological change has had a vast historical and cultural influence on design and production. We can trace that change from times when production was completed using basic tools and equipment, and every product was made by hand. The Industrial Revolution, and the later introduction of assembly-line manufacturing, allowed designers to increase their production output. The digital revolution of the last two decades has increased that output, and reduced the costs and time in which production is completed.

The changing nature of work

Technological change has not only impacted on production, but also on the way in which designers work. Until recently, office workers were required to be physically present at their workplace five days a week. Information and communications technologies (ICT) now permits working from home or other locations. These technologies allow instant contact between colleagues, even if they are time zones apart. Technological change has had an impact on virtually every aspect of our modern lives.

Figure 3.18 New information and communications technology allows people to reach colleagues straight away to garner feedback on their designs.

Many designers have embraced technological change in their work, and all designers need to be aware of its impact.

The nature of work for many designers has changed too due to new technologies, saving the designer time and money. For example, industrial designers can now create 3D models of their intended product to see if there are any issues before tooling up for large scale production.

Modelling of designs

In many fields of design, making models and prototypes of a product is a key part of the design process, allowing concepts to be communicated and tested.

Modelling used to be a manual process, but ICT has streamlined this. The increasing accessibility of 3D printers, which have reduced in price and increased in functionality, have revolutionised the world of physical model making.

In addition, the increase in computer processing power, and the development of a range of graphical and simulation software packages, have made virtual modelling and rapid prototyping options available to all designers. Models can be generated using the software, and be rapidly and easily adjusted without the need to physically rebuild the model from the start.

The sophistication of these packages have made it possible to test different designs in a virtual environment, simulating different conditions that might be difficult or dangerous to achieve in the real world, such as the performance of a car on a wet surface.

Using ICT for collaboration and development

Everyone involved in the design process no longer has to be located in the same room. Design meetings can occur using various ICT software that can connect a manufacturer in China with a designer in Australia. This allows for efficiencies in the design process.

The development of new ICT software and advancing technologies has assisted designers, producers and marketers in many ways, saving time, money and resources. Without the use of these technologies, people that were involved in any aspect of the design process or production were required to meet in one space to go through the designs. These days a designer can be in Sydney and production in China and communication can occur through Skype or other videoconferencing apps. The use of graphic software has ensured that designs can be shared to production people effectively and accurately. Emails, videoconferencing and other communications software have ensured that design production can occur whilst different people who are part of the design process are in different locations of the world.

ACTIVITY 3.10

Research the work of an architect. Identify how ICT applications have impacted on their work. Be specific in your response.

COMMUNICATING

CHAPTER SUMMARY

- Design occurs in and is shaped by its historical and social context.
- Changing social trends (such as migration, economics, lifestyles and family structures), increasing cultural diversity, the changing nature of work, and technological change all influence the design of new products, systems and environments.
- Design career opportunities include working on built environments, product design, and designing solutions for information and communications.
- A variety of factors impact on the way in which a product, system or environment is designed and produced. These include:
  - personal values
  - cultural beliefs
  - safety and health
  - community needs
  - individual needs
  - equity
  - economic factors
  - employment.
- All products, systems and environments impact on the individual, society and the environment throughout the production and design stages.

- Ethical considerations include:
  - impact on the consumer
  - protection of intellectual property
  - advertising of designs
  - privacy
  - exposure to undesirable people
  - minority groups.
- Environmental considerations of design include:
  - life-cycle analysis
  - landfill
  - energy consumption
  - recycling
  - use of sustainable materials
  - waste disposal
  - pollution, noise, air, water, etc.
  - ozone layer
  - renewable/non-renewable energy sources.
- We must all work towards using ecologically friendly devices in the home, school and workplace.
- Industries must work towards reducing their impact on the environment.
- ICT and emerging technologies have had an enormous effect on the way designers communicate, collaborate and construct models.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1 Cultures
2 Environment
3 Historical
4 Migration
5 Trends

6 Ethics
7 Globalisation
8 ICT
9 Emerging technologies

REVIEW TASKS

1 Construct a mind map to show the impact that drones have had on individuals, society and the environment.

2 Outline how designers ensure that they are considering the social impact of their designs.

3 Describe how new technologies have improved the way in which designers can communicate their design ideas to the clients.

4 You are a product designer and have been given the following brief: Design and produce a new lunchbox which fits a cold drink and a snack.

   a List and describe the main design issues and the constraints to be considered before designing the lunch box.

   b Sketch the front and back views of your initial idea and clearly label the design features.

   c Explain three features that address the issues and constraints listed in the brief.

5 Describe how the design trend of globalisation has impacted the way in which we communicate.

6 As a contemporary designer, it is important that you are aware of the consequences of using particular materials in your designs. Research bamboo as a material and the consequences of using that material.

7 Discuss the importance of ICT to designers today.

8 Evaluate the consequences of immigration on Australian society.

9 Describe three design jobs that are available in the built environment design specialisation.

10 Analyse the effects of one of your design projects on the individual, society and the environment.

EXTENSION TASKS

1 Visit 'The House That Mike and Heather Built' at https://cambridge.edu.au/redirect/8518. Prepare a report describing how Mike and Heather save water and electricity in their home. Discuss how an average Australian can save water and electricity in their home.

2 Visit 'Australia Innovates' on the Powerhouse Museum website (see https://cambridge.edu.au/redirect/8520). Choose three innovations that you think address social issues. Evaluate the design and production processes used in these innovations.

PRACTICAL TASK

Figure 3.19 In 2018 SMEG collaborated with Italian fashion designers Dolce & Gabbana to design a range of small appliances.

SMEG has collaborated with your graphic design company to create a collection of kitchen equipment that represents the Australian culture.

Provide the following information:

1 List and describe the main Australian icons that you would use as part of your new range.

2 Sketch the front and back views of your initial ideas for the different items, and clearly label the design features. Use a design software program if you have access to one.

3 Present your final designs in colour and provide a detailed marketing campaign for these products.

4 The work and responsibility of designers

KEY TERMINOLOGY

- **Contemporary**
- **Discrimination**
- **Environment**

- **Equal Employment Opportunity**
- **Society**
- **Work health and safety (WHS)**

This chapter explores how designers work in designing and producing, and considers the factors affecting this. Planning for these factors ensures that the final product, system or environment will be successful. Factors considered include design and industrial practices, ethical responsibilities, workplace legislation, environmental sustainability and the needs of individuals and society. The chapter also looks at creativity and problem-solving techniques.

This chapter addresses **Outcome DT5-4** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the content areas **Factors affecting a holistic approach to design and production, Influence of design on the individual, society and environments** and **Creativity and problem-solving techniques**.

However, note that the dot point on project outcomes and preferred futures, are covered in Chapter 5.

4.1 **Design practices and factors affecting design and production**

When designing, there are a number of factors that will affect the outcome of the final product and production. It is important that designers consider these factors before they begin designing their product.

As designers, we need to ensure that we think about how we will respond to each factor and address it. Not all factors relate to a particular design, and factors can be ranked. For example, if you were selecting a dress or suit for the formal, aesthetics might be the first factor you would consider, followed by cost; whereas in selecting a kettle you might consider functionality first, then aesthetics and cost.

Design and production of project solutions

When you are analysing the factors affecting design, you must consider how each factor affects the design of your project and/or production of your project.

FUNCTION

Function refers to how well a product, system or environment works. It is vital that the finished design meets the brief and its intended outcome.

Some questions to consider are:
- For what reason is the product being made?
- Who will use it?
- Does it suit the user's age and abilities?
- When will it be used?
- Is it suitable for use during the intended time of year or day?
- How often will it be used?
- Does it need to be cleaned regularly?
- Is it durable or does it need extra care?
- Where will it be used?
- Is it suitable for use in a specific location?

Figure 4.1 Functional design requires the product to be able to be used for its intended purpose.

FORM

configuration the arrangement of elements in a particular form, figure or combination

Form refers to the shape, appearance or **configuration** of an object. To capture the eye of the market, a product should be seen not just as functional, so form should also be considered. Take the example of a toaster. Recently, industrial designers and artists have collaborated in developing toaster designs.

Some questions to consider are:
- How will the shape and function of your product, system or environment affect the form of the design?
- Consider the proportion of your design. Do you want it to appear heavy and solid or light and delicate? How will this affect your designing of the product?

AESTHETICS

Aesthetics refers to the beauty and appearance of a product, system or environment.

Some questions to consider regarding aesthetics are:

- Will the user expect the product to look a certain way?
- Does the method of decoration suit the overall end product?
- Do the colours suit the product?
- Should the decoration act as a point of focus, or should it mask an unattractive base design?
- Can the decoration be placed at structural points to strengthen the design?
- Will the decoration stay in place?

Figure 4.2 An unusual design may be interesting and aesthetically pleasing but the product must also be able to fulfill its function.

ERGONOMICS

Ergonomics refers to the relationship between the design of a product, system or environment and the intended user. The relationship between the human and the end design is important. Designers need to consider how we will interact with the design, and need to ensure that this factor is addressed in order to ensure that the design is functional.

Some questions that you may want to consider:

- How will ergonomics affect your design? Why must you consider this?
- Do you need to consider a range of alternative body shapes and sizes?

- Describe the relationship between you as the designer and the tools, techniques and materials that you use throughout the production process. What ergonomic considerations do you need to take into account during this process?

QUALITY

Quality refers to a design or finished product that not only meets its specifications but also delivers in terms of performance, finish and reliability. Quality may refer to strength, durability, reliability or ease of use.

Some questions to consider regarding quality are:

- How will the selection of materials, choice of components, choice of construction processes, level of finish and the way in which design elements are combined affect the quality of your design?
- What is the expected life of your product? How will this factor affect the designing and producing of your product, system or environment? What will you need to consider?

TRENDS

Social, cultural, global, political, economic and environmental influences directly and indirectly affect trends which in turn impact on design and production. When developing your design, consideration of trends is vital.

Some questions to consider regarding trends are:

- How will my design impact on **society**?
- Is my design culturally sensitive?
- Is my design economically viable?
- Have I considered the design's environmental impact in both the design and production stages?

ergonomics understanding of the activity of humans within systems or in an environment to maximise the well-being of humans and their productive use of those systems or environments
© Australian Curriculum, Assessment and Reporting Authority (ACARA)

society a body of individuals living as members of a community

Figure 4.3 Consideration of the environmental impact is a trend that is influencing many designs.

TIMING

Timing is an important factor in the success of a design. Not only must a designer consider if a consumer is ready for the design but they must also consider when they will launch the item to the consumer.

Some questions to consider regarding timing are:

- Is the target market ready for my product?
- Will it be launched at the right time?

Figure 4.4 Launching the product at the right time can help ensure the market is ready for it.

Applying a holistic approach by considering the factors affecting design and production

When designing there are many factors that will affect the outcome of the final product and its production. Therefore, it is important that designers consider these factors before they begin designing their product. Completing a full analysis of these factors will ensure that the correct materials, tools and techniques are being used and the designed item will be completed on time and on budget.

Impact of historical and contemporary design considerations

Taking into account the historical, contemporary and future considerations when designing is important. This may involve demonstrating how your design has been influenced by current and past materials, tools or techniques as well as considering what possibilities may be achieved with future technologies and innovations.

Some questions to consider are:
- Has the design been influenced by past techniques, materials or design periods?
- Will advancements in materials, tools or techniques refine the design?

ACTIVITY 4.1

You have been commissioned to design a new school locker.

1 Sketch your design and label each feature with the techniques, materials and key design features.
2 Identify and describe how the factors affecting design have been considered holistically. Draw on specific examples to illustrate your points.
3 Outline any historical, **contemporary** or future considerations that have affected your design.

contemporary belonging to or occurring in the present

Figure 4.5 School lockers

DESIGNING

ACTIVITY 4.2

Analyse and report on the factors that affect the decisions taken in the development of design ideas and solutions for one design project you have undertaken. When reporting back, ensure you provide specific examples showing how you have addressed these issues in the design and production process.

COMMUNICATING

4.2 Ethical responsibilities surrounding Aboriginal and Torres Strait Islander cultural and intellectual property

Aboriginal and Torres Strait Islander peoples have produced art for many centuries using specific tools, techniques and materials that have been passed down from generation to generation. Traditional art has gained in mainstream popularity over the years and with the increase in popularity comes an increase in prices.

It is our ethical responsibility to ensure that the traditional artists see the profits of their art. At times, artists have been exploited with their art being sold for huge sums with little or none of the profit going to the artist. The APY Art Centre Collective is a group of Aboriginal owned organisations working together to promote and market their artwork. The Collective was formed to ensure APY artists and their businesses receive a greater share of the Indigenous art market and to shore up the sustainability of APY Lands art centres.

As well as recognising who should benefit financially from art, it is also important that we understand the cultural sensitivities of all groups. Traditionally, Aboriginal and Torres Strait Islander people avoid naming deceased people as a mark of respect and also as a mark of grief for the family. This practice has also been extended to include photographs, audio or film footage of the deceased, which is why Australian TV shows and films will sometimes include a title card that will warn viewers if the show includes images, voices or names of deceased persons. It is important to respect this cultural protocol. This same respect should be applied to techniques that have cultural significance, for example the use of symbols, icons and imagery that have significance to Aboriginal and Torres Strait Islander peoples. Such techniques should not be appropriated by designers who do not have a link to, or full understanding of, Aboriginal and Torres Strait Islander culture.

Figure 4.6 The APY Art Centre Collective tries to ensure the correct people profit from their own artwork. For more information on the Collective, see https://cambridge.edu.au/redirect/8488.

Protection of cultural knowledge and heritage

Aboriginal and Torres Strait Islander peoples are custodians of the world's oldest continuous living culture. This culture has been passed down through the generations in stories and songs.

The NSW Office of Environment and Heritage describes Aboriginal cultural knowledge and heritage as follows:

Aboriginal cultural heritage consists of places and items that are of significance to Aboriginal people because of their traditions, observances, lore, customs, beliefs and history. It provides evidence of the lives and existence of Aboriginal people before European settlement through to the present. Aboriginal cultural heritage is dynamic and may comprise physical (tangible) or non-physical (intangible) elements. It includes things made and used in traditional societies, such as stone tools, art sites and ceremonial or burial grounds. It also includes more contemporary and/or historical elements such as old mission buildings, massacre sites and cemeteries. Tangible heritage is situated in a broader cultural landscape and needs to be considered in that context and in a holistic manner.

Aboriginal cultural heritage also relates to the connection and sense of belonging that people have with the landscape and each other. It recognises that Aboriginal people understand cultural heritage and cultural practices as being part of both the past and the present and that cultural heritage is kept alive and strong by being part of everyday life.

Cultural heritage is not confined to sites; it also includes peoples' memories, storylines, ceremonies, language and 'ways of doing things' that continue to enrich local knowledge about the cultural landscape. It involves teaching and educating younger generations. It is also about learning and looking after cultural traditions and places, and passing on knowledge. It is enduring but also changing. It is ancient but also new.

Aboriginal cultural knowledge provides crucial links between the past and present and therefore represents an essential part of the identities of Aboriginal people and all Australians.

Figure 4.7 Cultural heritage may comprise physical or non-physical elements.
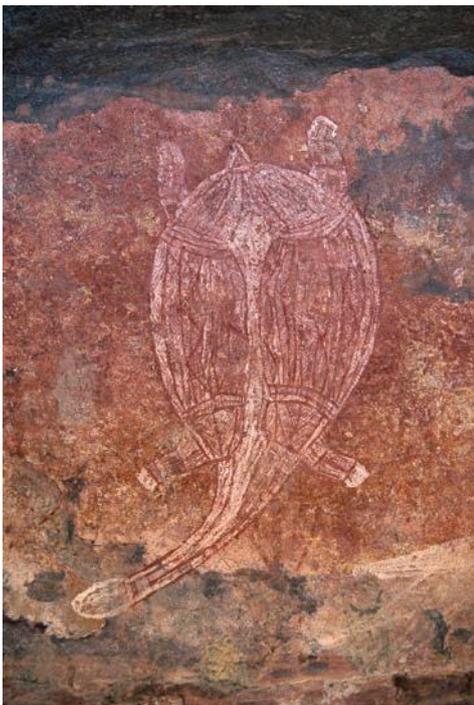
If care is not taken, this rich history may be lost due to the fast-paced demands of the modern world. It is important to protect it for current and future generations. In some states, this has been recognised and enshrined in legislation. For example, the Queensland *Aboriginal Cultural Heritage Act 2003* created a legal responsibility for all people in the state to take 'all reasonable and practicable measures to ensure [their] activity does not harm Aboriginal cultural heritage'. Failure to do this can result in significant fines.

In NSW, the *National Parks and Wildlife Act 1974* contains some protections for Aboriginal objects and places, but the NSW Government is currently developing a more robust legal framework to respect and conserve Aboriginal cultural heritage. Between September 2017 and April 2018, the government conducted public consultation on a proposed new system, including a consultation draft *Aboriginal Cultural Heritage Bill*. While the feedback was generally supportive, a number of issues were raised. As a result, the Office of Environment and Heritage and Aboriginal Affairs is undertaking further targeted consultations in order to refine the draft Bill. If the draft Bill is passed by Parliament, it will become the *Aboriginal Cultural Heritage Act*. It will include the establishment of the Aboriginal Cultural Heritage Authority which will consult with relevant groups and publish detailed policies and guidelines.

The Interactive Textbook contains a video in which Anthony Lean, Chief Executive of the Office of Environment and Heritage, and Jason Ardler, General Manager of Aboriginal Affairs, explain the need for change and the benefits of the proposed new system.

GO

Protocols for consultation

In addition to legislation, many organisations have developed their own **protocols** to be followed when dealing with Aboriginal and Torres Strait Islander groups. A key element is the importance of consultation: ensuring a respectful relationship in which members of Aboriginal and Torres Strait Islander communities have a voice in matters that affect them. It involves seeking out and listening to the views and knowledge of Aboriginal and Torres Strait Islander people, and considering this when making decisions.

protocols a set of rules and acceptable behaviours for a particular situation; may be based on ethical principles

A document released by the Queensland Department of Aboriginal and Torres Strait Islander Partnerships makes the point that both consultation *and* negotiation must take place. There have been occasions in the past where consultation has been merely token, having no real impact. Negotiation is 'a more equal relationship where parties work through any conflict, finding areas of agreement and agreeing to disagree if areas of conflict cannot be resolved'.

The following are the key points from the protocol document developed by Oxfam Australia.

Aboriginal and Torres Strait Islander Cultural Protocols – Oxfam Australia
Principles

These protocols give practical expression to a fundamental human rights principle that: 'Indigenous peoples have a right to own and control their Indigenous cultural and intellectual property', that is, they have a right to protect their Indigenous heritage.

The following values and principles provide a framework for implementing Aboriginal and Torres Strait Islander cultural protocols:

1. Respect

The rights of Aboriginal and Torres Strait Islander people to own and control their cultural heritage, and their rights and interests in how they are portrayed (in images, text or the like), must at all times be respected and protected …

2. Aboriginal and Torres Strait Islander control

Aboriginal and Torres Strait Islander peoples should be consulted and involved in all decisions affecting their cultural heritage and in particular, on the ways in which their history, community, stories and interviews, lives, families and cultural and intellectual property are represented and used …

3. Interpretation and integrity

Aboriginal and Torres Strait Islander people should be recognised as the primary guardians and interpreters of their cultures. Representation of Aboriginal and Torres Strait Islander cultures should reflect their cultural values and respect their customary laws …

4. Secrecy and confidentiality

Some Aboriginal and Torres Strait Islander material is unsuitable for public scrutiny.

Secret and Sacred Material

Indigenous people have the right to keep secret their sacred and ritual knowledge in accordance with their customary laws. Secret and sacred material refers to information that is restricted under customary law and so is unsuitable for publication …

5. Attribution

Aboriginal and Torres Strait Islander people should be given proper credit or appropriate acknowledgement for their achievements, contributions and roles in the development of media stories and/or use of cultural material …

6. Sharing of benefits

Aboriginal and Torres Strait Islander people have the right to share in the benefits from use of their culture, especially where it is being commercially applied …

7. Legal recognition and protection

Oxfam Australia supports the development and implementation of Australian laws and policies that respect and protect Indigenous rights to cultural and intellectual property, by engaging in and supporting their partners' advocacy and lobbying efforts.

Source: https://cambridge.edu.au/redirect/8516

CASE STUDY 4.1

#thismymob

#thismymob is a smartphone app being developed to give Aboriginal and Torres Strait Islander peoples a safe and culturally appropriate platform to connect with each other.

[#thismymob] will give young Indigenous users the opportunity to reach out to Elders from around the country to ask for guidance and support. It will encourage young Indigenous Australians to take up degrees and careers in STEMM (science, technology, engineering, maths and medicine). It is where Indigenous artists will be able to promote their work to both Indigenous and non-Indigenous buyers.

Recognising the importance of engaging with potential users of this app – and the need to avoid imposing cultural values other than those belonging to the app users – the designers conducted workshops with four different communities. From this they learned what people wanted from an app, how it would be used, how to make it user-friendly and culturally appropriate, and how to support cultural safety and identity.

One thing they learned was that functionality needed to be different for different groups, and so they needed to design and code for different identities. They describe this as 'coding for culture'.

Source: https://cambridge.edu.au/redirect/8489

1   The approach was described as participatory design. Explain why this approach was particularly important for this project.
2   At the time of writing, a prototype of the app was being tested with five different groups: Eora, Jumbunna, Bard, Tiwi Island and Gunditjamara. Use the internet to find out the current status of the app.

ACTIVITY 4.3

You have been asked to design a T-shirt that celebrates the traditional owners of the land on which your school stands, or another location of significance to you. Conduct research into the traditional owners of the land before completing the activity below.

1   Identify a unique element of the culture you could recognise in your design.
2   Provide a rough sketch of your design.
3   Write a paragraph explaining how your design respects cultural sensitivities.

DESIGNING

4.3 **Industrial practices and workplace legislation**

Designers must consider the requirements of the law. For example, the *Competition and Consumer Act 2010* aims to ensure that the consumer is protected in the aspects of the product quality and service, including product safety. The Patents Act 1990 and copyright laws protect the designer and the product designs from imitation and copying.

Some legal questions to consider are:

- How does legislation affect your designing and producing?

- Why is it important to abide by laws, particularly for the designer and the end user?
- Which legislation do you need to abide by? Why?
- Discuss the implications for employers and employees if laws are not abided by.

We will now consider three key areas of legislation: anti-discrimination, equal employment opportunity and work health and safety.

Figure 4.8 The *Competition and Consumer Act 2010* protects the consumer in the areas of product quality and service.

Anti-discrimination legislation

Discrimination is where a person or a category of people are treated unfairly, due only to a factor such as race or sex.

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discrimination the unfair treatment of a person or group

In New South Wales, the *Anti-Discrimination Act 1977* protects workers by law from being unfairly treated because of:

- their gender
- their race
- their age
- having a physical, mental or other disability
- their sexual preference or identity
- being a carer, such as for someone with a disability
- their marital status.

At the federal level, there are a range of Commonwealth laws that protect people in a number of circumstances from being discriminated against. Some aspects of these acts overlap with what is protected by the NSW *Anti-Discrimination Act 1977*, and both layers of legislation protect those in New South Wales from being unfairly treated. Commonwealth legislation includes:

- *Age Discrimination Act 2004*
- *Australian Human Rights Commission Act 1986*
- *Disability Discrimination Act 1992*
- *Racial Discrimination Act 1975*
- *Sex Discrimination Act 1984.*

GO Discrimination can come in two forms: direct and indirect. The Interactive Textbook contains an exercise to help you understand the difference.

Having these laws in place means that any employer must treat all job applicants fairly, and determine successful candidates on the basis of individual merit and not personal characteristics. When working, employers and supervisors must do their best to ensure that harassment is not occurring within their team or workplace.

Anti-discrimination laws do not just affect the workplace: they also need to be considered in designs. You should not incorporate anything into your designs that contravenes this legislation. Even if you intend a design to be humorous, or ironic, it may still be perceived as discriminatory.

In addition, the *Disability Discrimination Act* contains provisions for accessibility – the importance of ensuring products and environments can be used by people with disabilities. An obvious example is buildings including wheelchair ramps or lifts as an alternative to stairs. Other examples include signs that incorporate braille, and the beeping noises made by pedestrian traffic lights to aid the visually impaired. When considering the target audience for your design, remember that not everyone will have the same abilities. Questions you might ask include 'Will a colour blind person be able to distinguish elements of the design?' and even 'Can this be used by someone who is left-handed?'

Figure 4.9 Anti-discrimination laws prevent workers from being treated unfairly.

Equal employment opportunity

Equal employment opportunity (EEO) principles are in place not only to ensure that all workplaces are free from all forms of unlawful discrimination and harassment, but also to provide ways by which those in minority groups can overcome past or present disadvantage. These principles are designed to achieve a diverse and skilled workforce, improve employment for disadvantaged groups and build a workplace culture of fairness.

EEO groups are those who have been disadvantaged in the past, or continue to face difficulty trying to gain employment. Members are more likely to be unemployed or work in lower paid jobs. These groups include women, Aboriginal and Torres Strait Islander people, people with a disability and many ethnic and religious minority groups.

EEO principles are strategies that employers put in place to ensure that they are meeting the requirements for fair employment and are not at risk of breaching anti-discrimination laws. This may include recruitment programs, including merit selection and targeted positions for new employment, and providing access to training and careers to those within EEO groups in existing positions. By implementing rules, policies and encouraging positive behaviours, employers can create a workplace that is fair for all people. At the heart of all EEO principles is the aim to create an environment where all workers are valued and respected equally, and have the opportunity to reach their potential in the career path of their choice.

In New South Wales, equal employment opportunity, like anti-discrimination, is covered by state and national laws. In order to encourage EEO in the workplace, the Australian government provides incentives like funding for employers to support EEO groups such as people with disabilities, Australian Aboriginal and Torres Strait Islander people, the long-term unemployed and older people.

Figure 4.10 Equal employment opportunity principles aim to build a workplace culture of fairness.
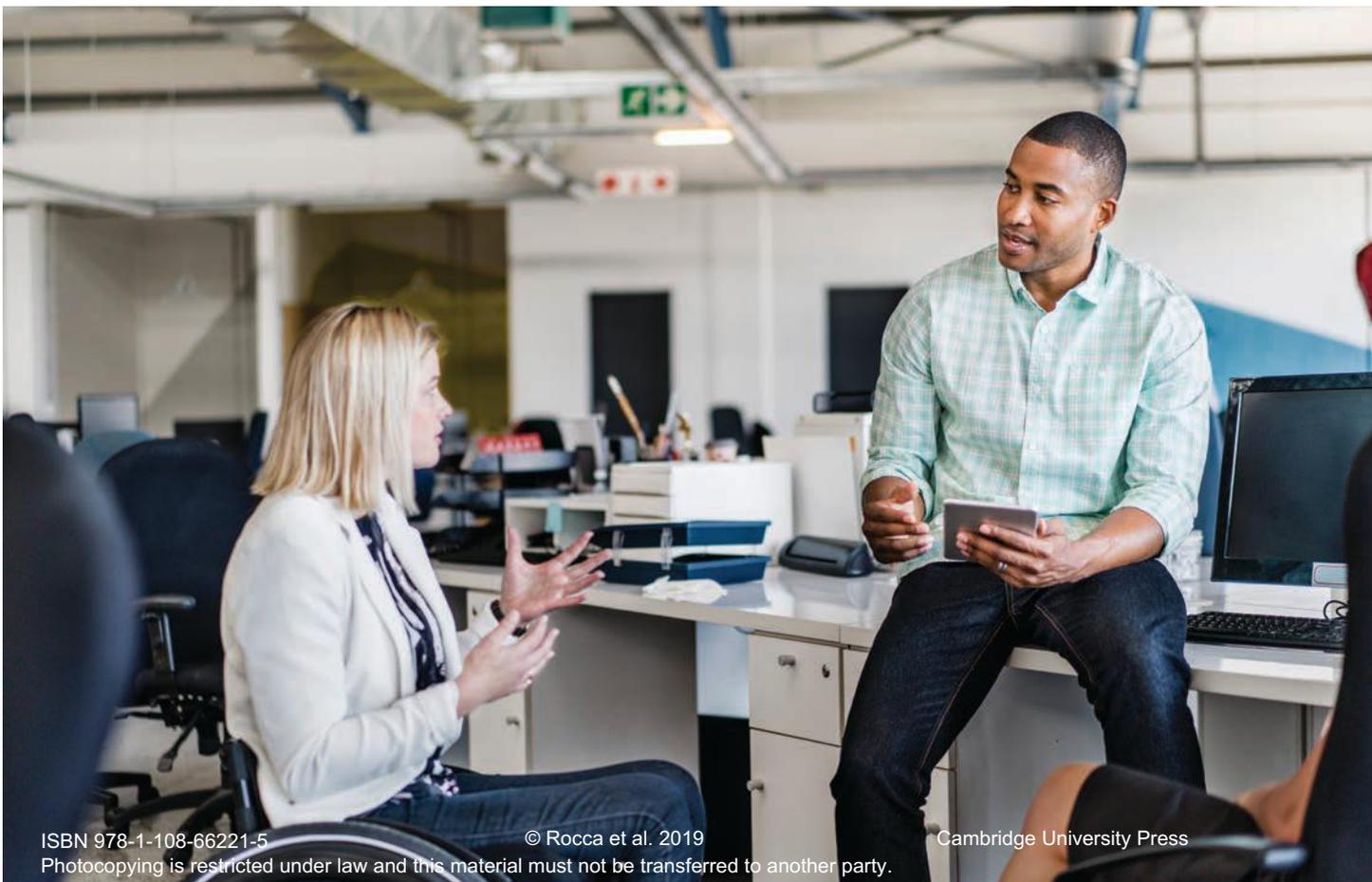
ACTIVITY 4.4

Formed in 1986, the Australian Human Rights Commission (AHRC) is an institution funded by the Australian government. It operates independently from the government and is tasked with investigating matters of discrimination in Australia, including in employment. As a proactive measure, the AHRC provides a range of advice about best EEO practices for business.

Visit the Australian Human Rights Commission website and the ten steps that the AHRC recommends businesses take to create a fair and productive workplace.

After considering the advice given, design a poster that can be used to promote a strategy for fair employment to employees. As a class group, brainstorm ideas for posters from the advice given. Your poster may promote your selected strategy by recommending a positive EEO workplace practice or by highlighting a discriminative practice to avoid.

DESIGNING

Work health and safety

In New South Wales, the health and safety of employers, employees and visitors to places of work are protected by law. The *Work Health and Safety Act 2011* requires persons conducting a business or undertaking (PCBUs) to consult with those involved with their workplace and collaborate to ensure that everyone is protected from risk.

The *Work Health and Safety Act 2011* is New South Wales **legislation** that took effect on 1 January 2012. It is based on the national model *Work Health and Safety (WHS) Act* developed by Safe Work Australia, following input from all states and territories. Prior to this, each state and territory had its own laws protecting the safety of those in and around work. While many of these laws have been standardised across Australia, the national model also allows states and territories to include their own individualised features where required. In March 2018 the *WHS Act* was amended in response to the NSW Work Health and Safety Act 2011 Statutory Review Report. The report made 11 recommendations, of which six have now been implemented.

legislation a law passed by an elected government

Under Part 2 of the Act, a PCBU must make provisions for its employees' health, safety and wellbeing by:

- keeping the workplace safe, including providing safe entrances and exits
- providing for the safe use and storage of tools, machines and materials
- making sure the tasks and environment do not cause a risk to the health of the employees
- providing any necessary training so that their employees can perform their tasks safely
- meeting the needs of their employees' welfare by providing any required facilities, such as toilets and meal rooms.

While it is enforceable by law that these provisions are made by employers, workers also have a duty under Part 2 of the Act to take reasonable care of the health and safety of themselves and others. When at work, an employee must:

- take care of their own health and safety
- take care not to endanger the health and safety of those around them

- do what is needed by their employer to help meet the requirements of the Act
- follow the rules and procedures put in place to maintain a safe working environment.

Safety in relation to designing and producing refers to:
- the safe use of tools, materials and techniques during all stages of the design process
- the designer's legislative responsibility for the safety of the design projects they develop
- health and safety in handling, use and storage of materials
- heath and safety in the use of techniques
- legislative requirements.

Some questions to consider are:
- How will safety affect your design and the production of your design?
- In terms of safety, what must you consider and why?
- What will be the effects of materials, tools and techniques during experimentation and production?
- Are there any safety issues that might affect the end user? Describe how these could be limited, reduced or removed.

Figure 4.11 Employees are also responsible for each other's safety and should ensure this by acts such as confirming colleagues wear the correct gear at work.

Cambridge University Press

4.4 Environmental sustainability practices

Designers need to be aware of the impact their design will have during production, while in use and after its use. For example, the following factors should ideally be considered prior to production:

- Will the making of the product cause pollution?
- Where will this pollution go?
  - Does the product require packaging? If so, what type of packaging is required?
  - How can packaging be kept to a minimum?

- Does the method of decoration pose any health risks? For example, is toxic glue or paint needed?
- When the product is used, does it create any problem fumes or sounds?
- What are the resource choices and availability (e.g. tools, materials, time, finance)?

There are many different environmental sustainability practices that can be considered. Possibilities include alternative energy sources, recycled or reclaimed materials and **zero waste living**.

zero waste living to not make, or produce as little waste as possible

Figure 4.12 A product which requires a large amount of packaging is not good for the environment.

Alternative energy sources

Some sources of energy, such as coal, oil, and gas, are finite: one day they will run out. In addition, the use of these resources can have bad effects on the rest of the environment, such as polluting the air.

However, there are other natural resources, known as renewables, which can produce energy without being used up, and which have a much lower overall impact.

In Australia we use the following energy sources.

SOLAR

Solar energy is any energy that is created by the light or heat of the sun. Australia is a very sunny country! In fact, we have the highest average amount of solar radiation of any continent in the world. Not surprisingly then, there is a lot of potential for solar power. Right now, more than two million Australian households have some type of solar system on their roof and **solar thermal plants** are being researched, planned or built around the country.

WIND

A wind turbine is needed to capture the energy of the wind and convert it to electricity. The force of the wind causes the outer blades of the turbine to turn. This motion is transferred through a gearbox into a generator. The generator produces electricity which is fed through a transformer to a substation. Wind energy is currently the fastest growing renewable energy source in Australia and is responsible for about 30% of the country's renewable energy. It is also the cheapest source of large-scale renewable energy.

HYDRO

Hydropower uses the energy of flowing water to produce electricity via a hydroelectric power station. Hydroelectric power stations are usually powered by water that has been captured in a dam or reservoir. The water from the dam is released into a pipeline and over a turbine. The force of the water causes the turbine to spin, operating a generator. The generator produces electricity which is transferred through a substation into the grid. Excess water is released back into the waterways.

solar thermal plants power stations that use the thermal power of the sun to heat reservoirs of fluid and power turbines

Figure 4.13 Hydropower generators at a dam. The generators contain turbines, which spin as the water blasts through.

Recycled or reclaimed materials

There are many areas where finished products are discarded, when they could be repurposed for use in other ways.

For example, the average Australian buys nearly 27 kilograms of new clothing and textiles each year, with older items frequently becoming landfill. And yet, there are an increasing number of different ways to recycle this material. In 2019 a new organisation, the Australian Circular Textile Association, announced a pilot clothing take back scheme to try and make the fashion industry more sustainable. Under this national scheme, clothing dropped off at participating charities and stores will go through a recycle, reprocess and redistribution process to extract recyclable materials. Currently, charities receive many tonnes of unusable donations, which they have no choice but to dispose of.

Another industry under pressure to become sustainable is construction. One suggestion to attain sustainability is the increased use of reclaimed materials: items that have been used in an old building project, and are then used in another project. A key point about reclaimed materials is that they are not reprocessed in any way, although they might be adapted or altered, or used in a different way (repurposed). For example, if a house is demolished, then a roof beam might be reclaimed and used to make a mantelpiece. Other materials that can be reclaimed include tiles, bricks, tiles, fixtures and fittings, stairs and window frames. Reclaiming is slightly different from recycling, which involves materials being completely reprocessed.

Zero waste living

Zero waste living aims to minimise the impact of modern life by reducing the amount of waste we produce. Society is encouraged to look at everyday items that can be replaced with multiple use instead of single use items, such as carrying a Keep Cup rather than using disposable coffee cups.

ACTIVITY 4.5

1   You are designing a lawnmower. Identify two ways you could minimise its impact on the environment – one relating to the design/production process, and one relating to the end user.
2   Research other forms of alternate energy sources. Create an infographic highlighting the main functions, features and uses.
3   Read the following article: https://cambridge.edu.au/redirect/8525. Complete an audit of your waste for a week. Where can you reduce your environmental foot print?

COMMUNICATING

4.5 **Appropriate technologies and available resource choices**

Resources are fundamental to a successful design. Prior to starting on a project, designers need to ensure the availability of all resources required. Tools, materials, time and finance are just some of the resources designers use. Without consideration of these, designs may not be completed on time or incorrect materials may be used, which could potentially be very costly.

Skills, materials, tools and techniques

SKILLS

Human skills are important in designing. It is important that designers consider the skills that they require in order for their final designs to come to life. If the designer or design team do not have all the skills required to complete a product, they will need to find another designer or team who does have the required skills and bring them onboard.

MATERIALS

Designers consider availability and properties (weight, strength, hardness, look, feel) of materials as well as the facilities available for development. The working properties of the materials and the ability of the manufacturer must be considered. The durability of the product will be influenced by the properties, process and quality of the materials.

Some questions to consider are:
- How will the physical properties of the materials affect your design?
- What is the impact of cost in relation to materials? How does this affect the designing and development of your design?
- How will the cost of materials affect the development of your design and the production of your design?

Durability refers to whether the design will last for its intended life in the situation or environment for

Figure 4.14 Durability of the product depends on the materials used to make it.

which it has been designed. If the product is not durable, it may fail due to prolonged stress on the parts, poor workmanship, inferior raw materials or poor original design.

Some questions to consider are:
- What must my product do to achieve its intended purpose?
- What is the life of my product?

TOOLS

Tools can be hand or powered instruments, and can be any items that assist in the production of a design. Designers need to consider which tools they will use, as the choice of tools will impact on the final techniques used in their design, as well as on the finance, time and action plan. Careful planning is required when considering the tools to use.

Some questions to consider regarding tools are:
- What is the purpose of the design?
- Who will benefit from using this product?
- What are the tools or techniques that I will be using throughout the process?

TECHNIQUES

Designers must also consider the techniques that they will use in the development of a design. Access to different technologies and tools can have an impact on the techniques available.

Some questions to consider are:
- Have the correct functional techniques been used in the design?
- Are the decorative techniques appropriate for the design?

Figure 4.15 Designers need to consider which tools they will use.
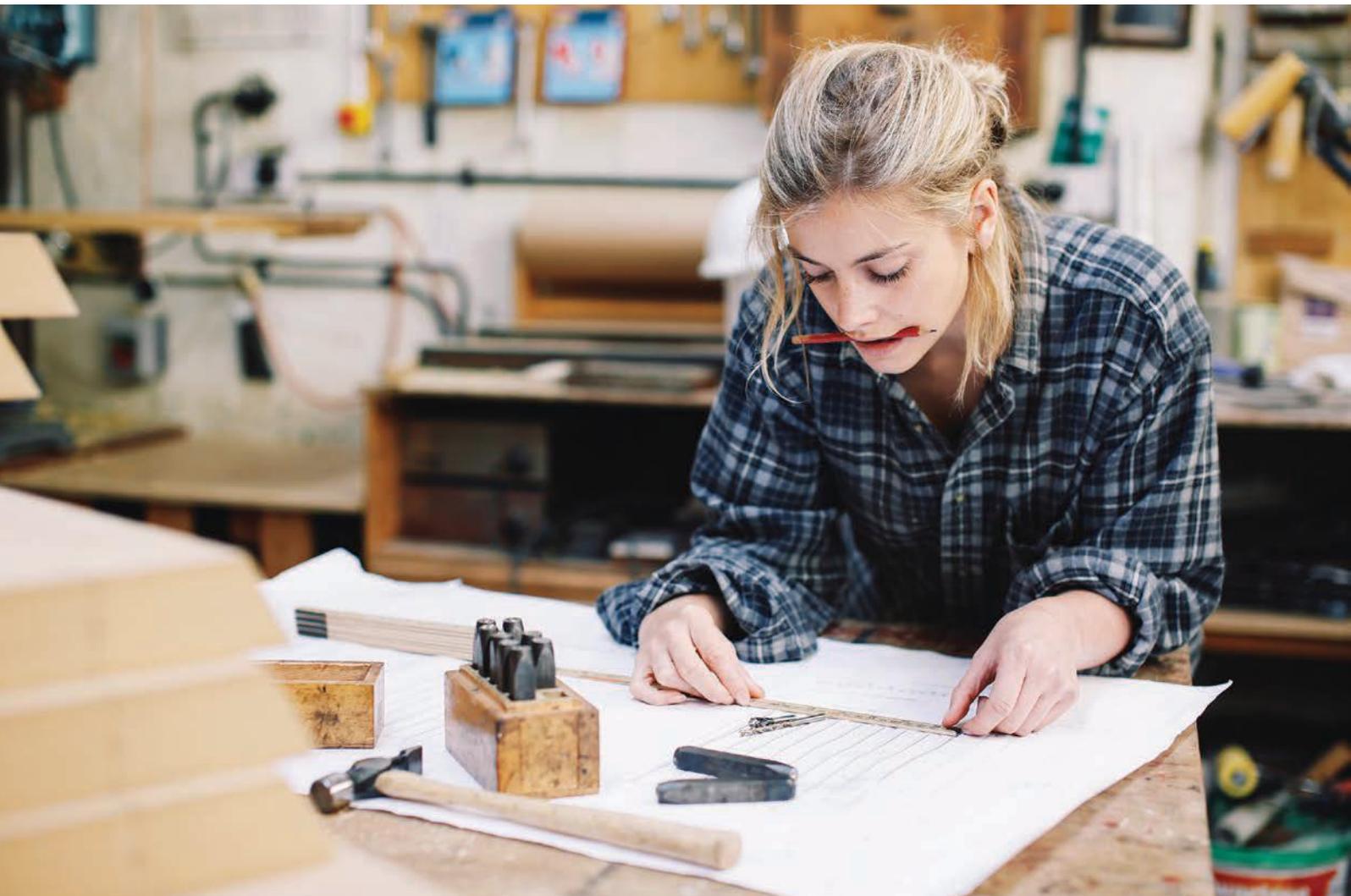
Data analysis and presentation

An integral step in the design process is research and experimentation. The analysis of this research and experimentation and helps the designer make informed decisions and choices. Data analysis involves discovering useful information, informing conclusions, and supporting decision-making. This ensures a final product system or environment is developed using the best tools, techniques and materials. The presentation of the information, whether to the client or the rest of the design team, needs to be clear, concise and well presented.

Some questions to consider:
- What research needs to be completed to help make an informed decision?
- How will I present this data e.g. table, pie graph, in experiment layout?

This is covered in detail in Chapter 6 – Research and exploration.

Time and finance

TIME

Time is one of the most important resources, and it will influence the quality of the final design. Careful planning and managing of this resource is required. Designers manage this by creating a time and action plan.

Some questions to consider regarding time are:
- How will time impact on the tools, materials and techniques you use?
- How will your design need to be modified because of the time constraints?

FINANCE

Development and production costs must be considered. The designer must justify the investment made by stakeholders. If the product is too expensive to make, it is likely to be too expensive for the consumer. Labour costs are a consideration. If a product takes too long to develop, the labour cost will be high.

Some questions to consider regarding finance are:
- How will the cost affect your design/product?

Figure 4.16 Careful time management is required to ensure a design is delivered on time.

- Will the cost of materials or tools affect the design/production?
- Will the product be affordable to all consumers?
- What are the ethical implications of pricing, sales and distribution? How will these affect your design?

4.6 Human, technical and environmental factors affecting design and production in design projects

Human capital

Human capital refers to the knowledge, skills and techniques people can draw on when they undertake work, and also to their personal attributes, including creativity. Economists recognise that investing in human capital – employing motivated staff and supporting their personal and professional development – can result in a positive return on investment. This carries across all fields, and is clearly applicable to designers.

KNOWLEDGE

Knowledge is the theoretical understanding of an area. For example, if you are designing a piece of jewellery you will need to consider how your knowledge of adornment and the processes involved in the development of adornment pieces will influence your final design and product.

You may also need knowledge of your client. For example, if you are asked to design a trophy for a major judo tournament, understanding of some of the basic judo rules and moves may influence and enhance your design.

SKILLS

A skill is the learned capacity of talent required in order to carry out predetermined results, often with minimum output of time and/or energy. Skills can often be divided into types:
- domain-general skills
- domain-specific skills.

Examples of domain-general skills include time management, teamwork, collaboration and motivation. Domain-specific skills include those skills that are specific to a certain environment or subject area. For example, in jewellery the skills needed for successful development of a project include project management, development and realisation of ideas, cutting, soldering, buffing and polishing.

Some questions to consider before beginning any project are:
- What are the domain-general skills and domain-specific skills you will use throughout the development of your project?
- How will the domain-general skills and domain-specific skills affect the development of your design, the processes used, production and the finished product?

Figure 4.17 Domain-general skills, such as teamwork and brainstorming, can be applied to many different types of projects.

TECHNIQUES

Techniques can be either functional or aesthetic. An example of a functional technique is a butt join, as it provides strength and assists with the structure of the product. An aesthetic technique may include staining, as a stain enhances the appearance of a join but does not play a role in the the structural integrity. Whatever the technique, forward planning is required in the design and production plan. A clear indication of the role of each technique is vital. Some questions to consider are:

- For what reason is the product being made?
- Who will use it?
- What techniques will I use to produce it?
- Which techniques will provide an aesthetic aspect?
- Which techniques will assist in the function of the design?

Figure 4.18 One aesthetic technique that could be used in woodworking is staining.

Sustainability

As you saw in the previous section, environmental sustainability is an important factor that affects design and production. Designers should make efforts to minimise the effect the production process has on the environment, such as by using sustainable materials. It is also important to consider what will happen to the product after its use: for example, whether it can be recycled or disposed of in an environmentally friendly manner.

Values and ethics

VALUES

Personal values evolve from situations that we experience throughout our life and can change over time. Values can be shaped by culture, religion, politics, personal experiences, family and friends. Values can be related to the norms of society, which broadly look at rules for behaviour for specific situations. Values identify what should be judged as good or bad, right or wrong, desirable or undesirable.

Some questions to consider are:

- How will your values affect the materials, processes, research methods and techniques that you use in the development of your design and production?
- What are your beliefs about what should happen to your product when it is no longer in use –

recycle, reuse, end up in landfill? How will this affect your choice of materials?

ETHICS

Ethics is a major area of philosophy that looks at our behaviours and the moral choices we make in life. It is also known as analysing right and wrong behaviours, acts and processes. Recently there has been much discussion about ethical design, processes, materials, techniques and final products, systems and environments.

Consider the effect that ethics has on the selection of processes, materials and techniques for your project.

ACTIVITY 4.6

1   Explain the difference between knowledge and skills.
2   Reflect on a design project you have undertaken, and list the knowledge, skills and techniques you needed to conduct the project.
3   Describe a situation in which selection of materials would be strongly influenced by values and ethics.

COMMUNICATING

ACTIVITY 4.7

Describe factors affecting the design and production of design ideas and solutions in the following areas. Provide examples to support your responses:

1   Fashion design
2   Interior design
3   Graphic design
4   Game design
5   Industrial design.

COMMUNICATING

4.7 End-user aspirations and the needs of individuals, society and the environment
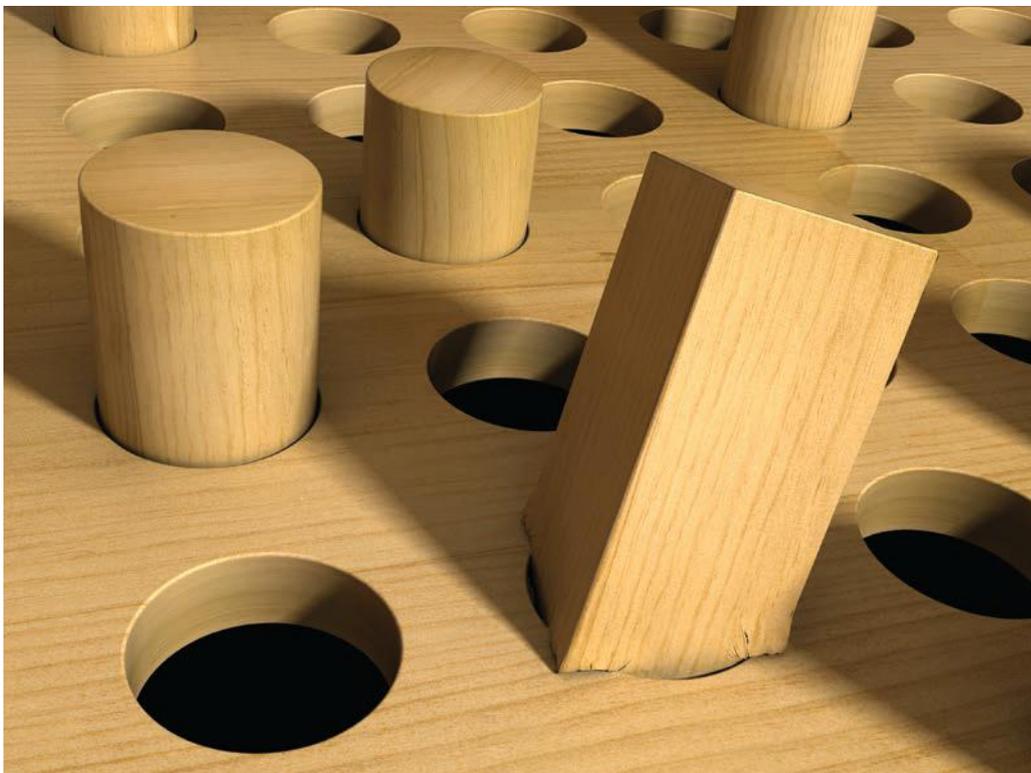
The needs of a design project and end user aspirations

Designers must always keep the end user in mind in the development and production of their designs. Some questions to consider are:

- Does the design meet the needs of the target market?
- Does the design suit the environmental context?

Figure 4.19 Make sure your design suits the environmental context.

Individuals and society

When designing it is important that the end user is always at the heart of decisions that are being made. A designer must always consider what impact their design has on the individual and society. An individual is one person in a community, whilst society is a group of people within the community.

Individual needs must be met to ensure success of a product, system or environment. This can be done by surveying a target market, market research or identifying a gap in the market.

Societal needs cater for group of people i.e. a school, suburb or town.

Ergonomic requirements

The relationship between the end user and the design is important. Designers need to consider how end users will interact with the design and need to address this factor in order to ensure that the design is functional.

Some questions to consider are:

- How will ergonomics affect your design? Why must you consider this?
- Do you need to consider a range of different body shapes and sizes?
- Does it need to fit snug against the body?
- Should you make it adjustable to suit a number of sizes?
- Does your design consider a range of ages and genders? How will these traits affect your design?
- Describe the relationship between you as the designer and the tools, techniques and materials that you use throughout the production process. What ergonomic considerations do you need to take into account?

Figure 4.20 The designer must think about the ergonomic requirements of the end user especially if a range of people will be using a product, for example a park bench.

ACTIVITY **4.8**

1 Research the redevelopment of George Street, Sydney, for the new light rail. Analyse how the needs of a design project and end-user aspirations have been considered

2 Describe a situation in which there may be a conflict between individual and societal needs for a design. How might it be resolved?

3 List three ways in which an office chair must meet ergonomic requirements.

COMMUNICATING

Accessibility requirements

One in five Australians has some form of disability. That is over four million people, so it is highly likely that at least some of the people you are designing for will have some form of accessibility issue which you need to consider. Disability does not just mean being in a wheelchair – in fact, wheelchair users only represent 4.4% of Australians living with a disability. When designing a product, you should be aware of the special needs of people with a wide range of issues. For example:

- One in six Australians are affected by hearing loss, including 30 000 people with total hearing loss. Does your product rely on sounds? For example, some refrigerators make a beeping noise when the door is left slightly open. Is it possible to include a visual indicator as well in the design?

- The number of people with visual impairments is increasing. Vision Australia estimates that there are approximately 357 000 Australians with low vision, or who are blind, and that this will increase to over 564 000 by 2030. Can your design be used by someone with limited vision? Can you do anything to make it more accessible? Think about how pedestrian buttons at traffic lights use sound as well as the red and green figures.

- Colour blindness affects about 8% of males and 0.4% of females in Australia. While you may accept that the subtleties of your colour choices are not available to everyone, be wary of using colour alone to communicate important information. A single light that changes from green to red may not be enough to warn of danger – again, sound may help, or you could simply use two separate lights (like traffic lights) and reinforce this by labelling one of them in text.

- Many people have difficulties with fine motor control, meaning they can have great difficulty using small electronic devices.

People may also have a temporary need of accessible design, either due to a short term injury (e.g. a broken leg) or just current circumstances. If you are carrying a lot of parcels, it is easier to hit a large button with your elbow than to use your finger to press a small button or touchscreen.

Ensuring your design is accessible to all does not need to limit your creativity or restrict the kind of product you make. Making a design accessible can improve it for everyone, and drive innovation. OXO is a brand of kitchen utensils with soft, non-slip, easy-to-grip black handles, known as Good Grips. The founder, Sam Farber, saw that his wife's arthritis made it difficult for her to use ordinary kitchen tools, and in 1990 he launched his first group of Good Grips kitchen utensils. The tools were popular with everyone, and in 2004, OXO housewares was sold for $US273.2 million.

In fact, some things that now seem part of everyday life were originally driven by accessibility requirements. Sloped curbs at pedestrian crossings were originally for wheelchair access, but are also beneficial to people with shopping trolleys, prams and luggage. The origin of computer keyboards can be traced back to early typewriters developed to enable the blind to write.

Figure 4.21 An OXO Good Grips meat tenderiser: the soft handle makes it accessible to people with arthritis or other motor disabilities, but also increases comfort for all who use it.

ACTIVITY 4.9

1   Consider a product you use regularly – perhaps an electronic device, a tool or a larger installation such as a lift. Think of a way it could be adapted to make it more accessible to someone with a visual, auditory or fine motor disability. Describe or sketch your changes.
2   What impact would these changes have on someone who did not suffer from that disability, or on someone who had a different disability?

DESIGNING

Product life cycle

Life cycle analysis looks at each step in the production process from the initial idea through to the death of a product.

At each stage, a designer considers the energies used and the environmental impact these choices have on the environment. It is important that designers then use this information and where possible make changes to minimise a product's environmental impact.

Because a product's life cycle may extend over years, designers need to incorporate long-term visions or outcomes, and whether these will benefit individuals or society. This is known as preferred futures, and is discussed in more detail in Chapter 5.

Case study 4.2 looks at the life cycle of making a BMW car.

CASE STUDY 4.2

The making of a BMW car

Figure 4.22 BMW logo

Watch the 'BMW Car Design Process' video in the Interactive Textbook and read the case study.

The product development process for a new model extends over a period of some five years and is divided into three phases.

It starts with the company commissioning a design for a new automobile. Adrian van Hooydonk, Senior Vice President BMW Group Design, and his interdisciplinary team jointly draw up a briefing for everyone involved in the design process.

This conceptual framework gives the designers, developers and engineers the greatest possible creative scope for designing the new car.

Phase 1: Fundamentals

At the start of the initial project phase, the critical attributes are laid down. Based on these, the designers then produce the first proportional models for the new vehicle.

Determining the proportions is a highly important aspect of the design process. As with any product, perfect proportions are seen as the key to aesthetics and harmony.

The designers start out by drawing the rudimentary silhouette and the characteristic lines of the vehicle.

After the initial sketches they produce what is called tape drawings on a package plan, which are a kind of grid map of the vehicle on a 1:1 scale, including all its technical and structural constituents.

Using flexible tape, the designers attach the main proportional lines onto the package to accentuate them.

In the finished tape drawing, the silhouette and contours already convey the character of the completed vehicle. In the ensuing dialogue between the designer and CAD (computer-aided design) modeller, a virtual 3D proportional model of the new car is created.

The aim of this first phase is to gain a mutual understanding of all the factors influencing a proposed design and their impact on it.

Already, at this early stage, key components such as the wheelbase, luggage compartment volume, range of engines, interior width and safety stipulations are fixed as part of the design brief.

At this point, a closely integrated design/technology convergence is essential since all the available technical innovations must be implemented in a way which the ultimate user will experience as functionally perfect, expedient and visually compelling.

Phase 2: Competition

A key aspect of the form-finding process for BMW Group Design – and one which is unique within the motor industry – is the internal, highly creative contest for the design of the exterior and interior of a vehicle, in which the designers compete against one another.

The entire Exterior and Interior Design team, under the baton of the relevant head of design, develops its diverse ideas through sketches and virtual representations, which are then rendered as 3D physical clay models.

In adherence to the agreed proportions, the distinctive design language of each particular concept then emerges.

The brief is to create innovative design drafts and highly aesthetic proportions and surfaces.

The work on clay models is very time and cost-intensive. Only a few car manufacturers place so much value on 1:1 models made of clay – a special type used by designers – and refine them in such faithful detail.

Covering the model in a special foil that resembles Titanium Silver Metallic paintwork allows the lines, surfaces and proportions of each model to be realistically assessed in varying light conditions.

Clay models allow for the continuous development of the design since any desired modification can be rapidly implemented and realistically visualised on the 1:1 model.

During this phase, the number of clay models is gradually whittled down based on decisions by the Board of Management.

As part of the process, the designers' image of the perfect appearance of the exterior and interior of the new model takes on a definitive shape.

The ultimate decision as to which design will be implemented is made around three years before the scheduled production launch in a final showdown between two contenders.

For one (potentially very young) designer, winning this showdown means his or her design has won the contest and will be turned into reality.

Phase 3: Detail work

Once the final design proposal has been selected by the Board of Management, it is time for precision work on the details that are crucially important to the series development process.

For this phase, BMW Group Design has lined up a special Detail Design team whose task is to fine-tune all the exterior and interior elements to a state of design perfection.

Extremely close coordination between the designers, engineers and manufacturing specialists also forms part of this phase, aimed at the precise definition of each individual detail down to hundredths of a millimetre.

In this way the BMW Group ensures that every product lives up to its premium claim – from surface quality right down to the micro-level.

Only then is the sculpture which was perfected by human hand transformed into a product capable of being reproduced by machine.

In a CAD process, laser scanning turns the model into a 3D feasibility model; that is, a technical reference model for all further developments.

In parallel with this, various **virtual technologies** are specifically employed to optimise efficiency in the development process and ensure precision in execution.

virtual technologies
technologies used in the creation of a virtual (rather than actual) version of something

Figure 4.23 After undergoing an intricate product development process, a new BMW car was launched in 2018.

During this phase, the designers intensely turn their attention to those aspects which the eventual owner will experience when using the vehicle and which will guarantee its enduring fascination, even after many years.

Adrian van Hooydonk, Senior Vice President BMW Group Design, explains:

> In the design process I aim to coax the maximum creativity from my team. That is why I keep the briefings as open as possible. Every single designer is invited to deliver their own take on the brand or the relevant project, in words and images. My job is then to select the best of the numerous opinions and proposals. For me that's one of the most exciting moments in the entire design process.

1 Describe the design process that the BMW designers undertake.
2 Discuss which factors affecting design the BMW designers consider when developing a new design.
3 Using the internet to conduct research, analyse how the BMW designers address social and environmental issues in their new designs.

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4.8 **Creativity and problem-solving techniques used by designers in their work**

There are a number of different ways in which designers demonstrate their creativity and their ideas. Most designers will initially start their idea development by either brainstorming or creating a mind map to help track and expand their ideas on paper.

Cognitive organisers are a simple way for designers to record their creativity and ideas. Examples of cognitive organisers may include:

- Brainstorm lists: listing possible ideas, solutions, tools, techniques and materials
- Mind maps: writing down a central idea and thinking up new and related ideas that radiate out from the centre
- Concept boards: presenting key themes and illustrations on a board.

Figure 4.24 A concept board keeps key themes and ideas in one place.

Needs and opportunity analysis

When identifying an opportunity for new and better solutions, it is important that you are aware that your project does not have to be something brand new. In many design projects, the designer may have used their knowledge of existing materials, techniques and processes to modify their design.

Your design brief will be the first step in your design process, yet when you are attempting to solve a problem that you have encountered you will need to identify the needs of the user first. Therefore, identifying a need will really be your first step.

Designers may complete a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis of their needs. A SWOT analysis looks at strengths and weaknesses internally, and then looks at opportunities and threats externally.

Think about these factors in terms of one of your design products. What are some internal and external factors that may impact on the development of your design? Think of factors such as time, finance, skills, resources available and materials.

Table 4.1 SWOT analysis table for designing and making medals for a local martial arts competition.

INTERNAL	
STRENGTHS • Have previously designed and made medals for netball and tennis competitions • Already have all necessary tools	WEAKNESSES • No direct experience of martial arts so might design something that is technically inaccurate
EXTERNAL	
OPPORTUNITIES • My work is likely to be photographed and shared on social media by winners • Could lead to commissions by other sports groups	THREATS • Event is quite soon – will there be time to complete the work? • There is a limited budget for medals • Not sure about reliability of materials supplier – had issues with them when making tennis medals. May need to look for alternative.

Constraints analysis

Part of the analysis conducted at the start of the design process involves looking at what may impact or hamper the design process. This is known as

constraints analysis. What could potentially impact the design process? Constraints may be factors such as budget, time or skill levels.

Collaboration

Working through the design process can at times involve working with others who can bring different skills and knowledge to the table. This is known as collaboration and it ultimately allows for

a better final design. Designers work with experts who are authorities in particular areas, taking advantage of the skills and knowledge they have to offer.

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Research and exploration

Researching and exploring the best possible design ideas, tools, techniques and materials ensures that the final design is of the highest quality. A designer should not cut corners in this area. Knowing what is out on the market, and how to select and execute the best tools, materials and techniques, makes for a successful design.

Figure 4.25 Researching the market and the materials and tools available is essential for a successful design.

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CASE STUDY 4.3

yelldesign

yelldesign is a Melbourne-based company that makes bite-sized chunks of branded videos to share via social extensions to Instagram, Facebook, YouTube and Twitter. Its specialty is stop motion animation and yelldesign work regularly with major global brands and agencies.

The following is an extract from an interview with yelldesign founders Sahr and Matt Willis.

yelldesign is 'Australia's first fully dedicated, short-form content studio'. How would you elaborate on your studio's output, and what influences your style?

MW: We are known for creating clean, colourful and quirky work. Most of our content features coloured paper, food or technology – these are the things we all love in the studio. We also have a strong musical background, both in live performance and theatre, so there's always an element of putting on a show. We've recently started a live series on Facebook, a weekly show that has interactive elements and lots of behind-the-scenes, featuring our studio and its processes.

I think a couple of key things have influenced our style along the way. A few years ago, I managed to convince Magda Ksiezak, a local papercraft and illustrator extraordinaire to join us as senior designer! At the same time, we installed a commercial laser cutter in the studio. This new supercharged capability, coupled with a strong design sense and well-rehearsed animation team, has really carved out a distinctive niche for us to work in.

SW: We're all pretty keen to have a good time at work, but without compromising on quality. One of the things that we pride ourselves on is working FAST. We can turn around videos in a couple of days, which is pretty amazing for stop-motion. We also like to incorporate humour in to our work – short-form content works best when it's sharable and 'relatable', which generally means fun! We spend a lot of our time trawling the internet for references (and cat videos).

Tell us a little bit about your studio's creative process; how do you generate your ideas and then go about creating a project to a final cut?

MW: We are generally flowing as a group, everyone busy with their own tasks. So the creative process can fluctuate quite a lot. We always try and get input from the whole group for each new project, but sometimes this is not possible due to time constraints.

Our own internal projects, like 'Papermeal', go through a slightly different process. We often discuss these over lunch, where we can really flesh out concepts in a relaxed way, but we all know that at the finish of the meal we need to have everything agreed! Another technique we use is six-word pitching – this is great! Our work is usually used in social media for five to 15 sec ads, so if you can't pitch the concept in six words, then it's likely too complicated! An example of this would be the pitch for 'Papermeal':

1)Cooking 2)Show 3)Made 4)Entirely 5)From 6)Paper!

SW: The way the team works has evolved over the years, but we generally start with a loose brief (like, we want to make a series of videos about food made from paper) and then expand ideas by chatting about our ideas in the group. We might take a bit from one concept, and marry it with another. We have a bit of a motto of: "You can do anything you want, as long as it's not sh..". Which might sound a bit harsh, but actually works really well. We're not limiting anything; we just have to really think it's great.

Source: https://cambridge.edu.au/redirect/8490

Use information from the yelldesign website (especially the 'What we do' page) and the interview above to help you answer the following questions.

1   Outline the steps undertaken in the development of a yelldesign product.
2   Identify and describe the factors the designer needs to consider when they are using the internet as a medium.
3   Describe how the designers collaborate and communicate to ensure the final product meets the needs of the clients.

CASE STUDY 4.4

Bourdeau Furniture

> I design functional furniture with character and history from real, recycled timber.

Source: Mitch Bourdeau

When Mitch Bourdeau moved to the NSW South Coast, he spent time renovating his residence and in the process he created a number of unique items of furniture. As a result of this, and seeking a working environment that included lots of outdoor time, in 2014 Mitch founded Bourdeau Furniture. Social media was a powerful tool in helping the business grow, as people were able to see and share photos of his work.

Every item is unique, based on the individual needs of the customer. It is therefore important for Mitch to work one-on-one with his customers, making sure he understands exactly what they want, and the best way to provide it. In the early days of the business, Mitch's style was quite chunky and heavy, but this has evolved over time to become more refined and slimline, meeting the changing needs of his customers.

All furniture is made from locally sourced, recycled timber. This makes finding timber more challenging than simply going to a lumber yard, but Mitch has contacts with a local demolition business, and they let him know when they see materials he might like. Old floors made from NSW Blackbutt are an excellent source of hardwood, and for softwood Mitch likes Oregon (Douglas Fir) that has been used for rafters.

Recycled timber is more challenging to work with than timber that is already dressed and finished with 90° edges. Mitch's timber may have been sitting in an attic for close to 100 years, and often has cracks and nails in it. But he feels that the extra work is more than repaid by the character this wood adds to his pieces: he hand-picks all of his timber, and is particularly interested in finding wood with a natural, aged patina. For every item of furniture, Mitch likes to provide a description of the timber: where it came from, and when the building was made.

Mitch constantly challenges himself to do new things, coming up with different designs that work organically with the timber.

Figure 4.26 A unique design for a space-saving bathroom

1 You have been commissioned to create a new stool design for Bourdeau Furniture. Draw and annotate your solutions, identifying the factors affecting the design.
2 Mitch Bourdeau's philosophy is to source sustainable materials. Discuss why.

Figure 4.27 Side tables made of polished concrete sitting on reclaimed Australian wormy chestnut

Figure 4.28 Reclaimed timber cube, with a concrete top

CHAPTER SUMMARY

- Designers must ensure that the factors affecting design and production are considered prior to the commencement of designing and producing.
- Designers must always keep in mind the end user in the development and production of their designs.
- Social, cultural, global, political, economic and environmental influences directly and indirectly affect trends and in turn impact on design and production. When developing your design, consideration of trends is vital.
- Legislation relating to anti-discrimination, equal employment opportunity and work health and safety can have an impact on design and production.
- Working through the design process can at times involve working with others. This is known as collaboration.

- Design and production costs must be considered. The designer must justify the investment made.
- Researching and exploring the best possible design ideas, tools, techniques and materials ensures that the final design is of the highest quality.
- All designers work through a design process.
- Careful planning and managing of time is required. Designers achieve this by creating a time and action plan.
- Ergonomics is the relationship between the human and the end design, and is very important.
- Resources are fundamental to a successful design. Prior to starting on a project, designers need to ensure the availability of resources.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1. Contemporary
2. Discrimination
3. Environment
4. Equal Employment Opportunity
5. Society
6. Work health and safety (WHS)

REVIEW TASKS

1. Describe how form and function impact the design of a skateboard.
2. Discuss why aesthetics may not always be an important factor to consider.
3. Describe functional and aesthetic requirements when developing a new garment for the elderly.
4. Outline the importance of ergonomics when developing a new chair.

5 Complete a SWOT analysis of a design brief that you are completing this year.

6 'Skills should not be considered a resource.' Discuss this statement.

7 Describe how designers use creative solutions to document their design process.

8 Discuss how technology has impacted the global environment.

9 Describe the functional and aesthetic techniques that you have used in a recent project.

**10** Discuss how historical factors have impacted on the design of the fridge.

EXTENSION TASKS

1 'Collaboration is not necessary in design.' Discuss this statement.

2 Research either the Barangaroo precinct or Westconnex road development. Analyse how the following factors have impacted on the development of your chosen project:

- function
- form
- aesthetics
- end-user aspirations and context
- time – historical, contemporary and future considerations
- quality
- trends.

PRACTICAL TASK

You have been commissioned to develop a product or system that helps new Year 7 students in your school feel welcomed and part of the school community.

You need to research and identify the needs of a new Year 7 student and develop the product or system accordingly.

Be creative with your solution!

5 Ethical and responsible design, appropriate technology and preferred futures
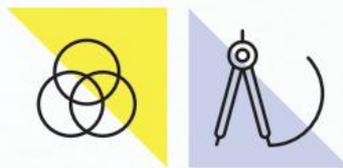
KEY TERMINOLOGY

- **Appropriate technology**
- **Design issues**
- **Design solutions**
- **Emerging technologies**
- **Environment**
- **Innovation**
- **Principles**
- **Responsible design**
- **Society**
- **Preferred futures**

This chapter explores how designers respond ethically and responsibly to design issues, and revisits the concept of appropriate technology from earlier chapters. It also investigates the concept of preferred futures, and looks at innovation in design.

This chapter addresses **Outcome DT5-5** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the content areas **Ethical and responsible design**, **Preferred futures** and **Innovation**. It also deals with some of the dot points in the content areas **Factors affecting a holistic approach to design and production** (appropriate technologies and available resources) and **Influence of design on the individual, society and environments** (project outcomes and preferred futures).

5.1 **Ethical and responsible design and appropriate technology**

Ethics involves learning what is right or wrong, in order to do the morally right thing. Good design should be aesthetically pleasing but also should be ethical as this will not only enable the user to enjoy the product on a surface level but will also ensure that the product will not cause any harm. Realistically it is hard to find design that incorporates both elements. There are some common themes that need to be considered when studying design and ethics, such as:

- personal ethics – what type of designer do you want to be?
- discrimination – gender, race, sexual orientation
- anti-consumerism – persuasive techniques
- ethical theories – applied and pure
- user safety – user responsibility and misuse
- social/environmental sustainability – obsolescence and life-cycles
- consumerism – security and privacy
- manufacture – sweatshops, de-skilling workforce and hazardous materials
- intellectual property and liability.

Designers have responsibilities they need to uphold when designing products, systems or environments. Three main responsibilities are ethics, honesty and environmental responsibility. Ethics play an important part in the design profession, and some examples of where design and ethics converge are as follows:

- Software, hardware, and others' intellectual property: Designers should respect the intellectual property of their clients. Licences in software and the codes of practice and conduct for organisations should be strictly adhered to.
- Ethical practices: Designers should not take on work or clients they believe have questionable ethics. Certain behaviours and standards should be upheld.
- Bias, accuracy and privacy of data: Data can be collected in a number of different ways. These include contacting customers/users directly by way of face-to-face, telephone or online surveys; tracking sales and performance of items (e.g. how often products are returned for repairs); and monitoring behaviour (e.g. by offering a rewards card that is scanned with every purchase, information is gained on customer buying patterns). Bias can be present where survey questions have been poorly designed. Errors can be made when performing data entry. Privacy of data must be ensured, as people expect the information they have volunteered to be used and handled with care. Unethical behaviour and inappropriate use of data might result in the selling of private data to another party. A more extreme example is hacking, which is an illegal and unauthorised form of access to data.

Figure 5.1 Ethical design includes understanding how products are manufactured, and rejecting the use of unethical production methods such as sweatshops.

Needs of society

In order to counteract inequities that exist in the world, designing must move away from supporting the needs of business and towards supporting the needs of **society**, particularly in developing economies in countries that account for more than 80% of the world's population. The basic essential elements of life – clean drinking water, energy, sanitation, health care, education and the tools for self-determination – should be available to all communities across the globe. Skills in designing must be balanced with social awareness, environmental sensitivity and cultural sensitivity. The next generation of engineers, designers and innovators must be responsible practitioners who think about how their work can contribute to the quality of life in global communities. Designers who responsibly, ethically and appropriately design with tools, wisdom and expertise can succeed and be effective designers.

New directions can be based on **principles** of sustainable and socially **responsible design**, with a focus on designing for a need rather than market agendas, to achieve the necessary change.

Many global societies lack the necessary resources for well-being, health care and education, and are denied the tools for freedom. Some communities are in need of solutions to problems of sustainable energy production, sanitation, water supply, disease prevention, shelter, clean and efficient cooking and communication, and need permanent alternatives to ongoing humanitarian aid. While we as designers have not caused these problems, we can lead changes to address these issues. This contributes to the main reason why we need ethical, responsible design and **appropriate technology** when developing design ideas and solutions.

society a body of individuals living as members of a community

principle an accepted or professed rule of action or conduct

responsible design a practice in which social, environmental, moral or ethical considerations inform the design

appropriate technology encompassing technological choice and application that is small scale

Figure 5.2 Communities that lack basic sanitation requirements look to designers to help address the problem.
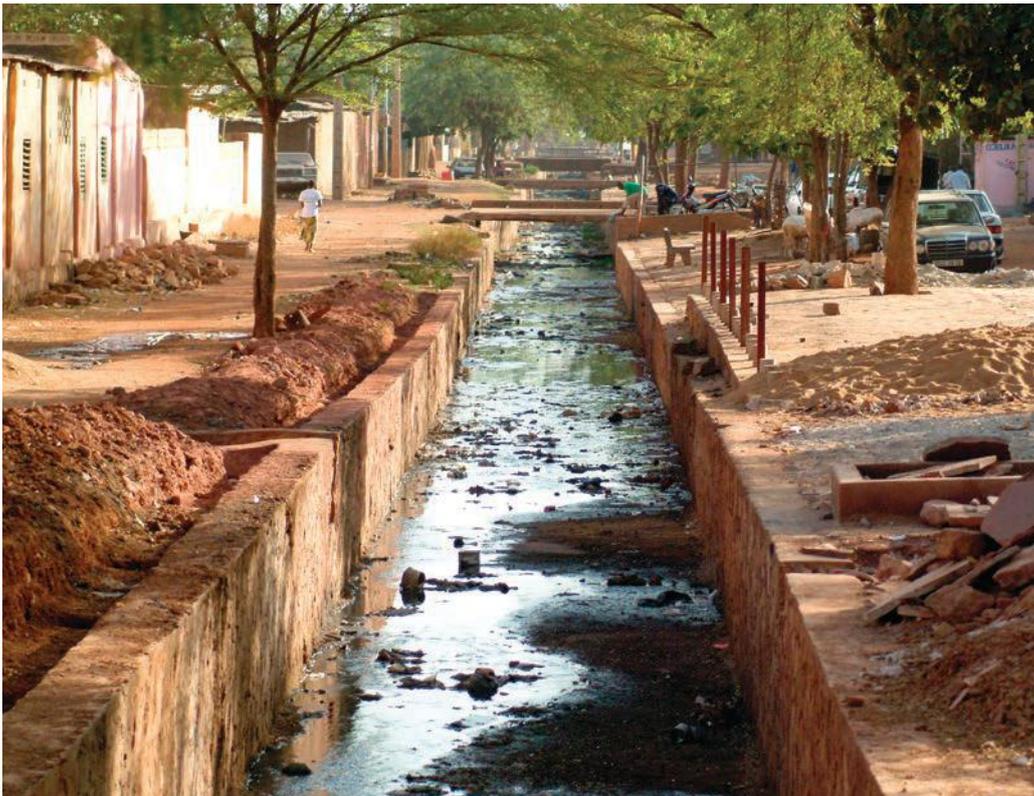
Appropriate technology

These substantial and complex problems need holistic solutions that are not product-focused, but instead are people-focused, locally-focused and co-designed. It is estimated that approximately 80% of all product-related environmental impacts are set during the design stage, as a result of decisions about materials, manufacturing, transport, packaging or resource consumption.

As a consequence of these issues, product design teams and design students must not only be aware of the possible environmental, social, cultural and economic impacts of their designs, but also have the skills and knowledge to develop alternative sustainable product solutions.

This in turn may raise some ethical issues relating the fields of robotics and artificial intelligence (AI). These technologies could create machines as smart as humans, the most intelligent species on the planet, and while this is a demonstration of human excellence, the introduction of computers that think could be devastating for our species. As well as this, smart materials are now being integrated into manufacturing. These materials could adapt, change properties, interact or respond to their environments. Materials could adapt and repair by themselves without maintenance, or they could be programmed to break down on their own. This will raise new questions of standardisation, ethics, land fill, copyright and legal requirements.

Appropriate technology involves ensuring that technologies fit within the context for which they were designed. This may include biophysical contexts, such as health, climate and the environment, as well as psychosocial contexts, such as politics, economics and religion. Using appropriate technologies can have a significant impact on society by increasing efficiency and the standard of living. For example, composting toilets in the Tasmanian rainforest provide the benefits of protecting ground water, saving water, electricity and money, and recycling nutrients.

Determining the appropriateness of technology can be done through evaluation, understanding the design criteria and having a grasp on the issues of design. Design issues will vary depending on the project. However, there are some issues that need to be considered for each project. These include:

- **Safety**
  Understand the safety requirements of the work you are completing, not just for the users of the end product but also your own safety when using heavy machinery or dangerous tools. Familiarise yourself with the *Work Health and Safety Act 2011* to understand the rights and responsibilities of employers and employees in the workplace.

- **Ethics**
  As discussed at the beginning of the chapter, ethics generally refers to a personal code of conduct based on beliefs, values and society. As a designer, you need to consider any ethical issues related to your project. Ask yourself if your product is benefiting society. Is it damaging any parts of society? Be aware of the impact your design will have on the target market and any other external stakeholders. Your personal ethics will also influence the choices you make as you work on your design. For example, you may be drawn to a certain project because it relates to an issue you are passionate about.

Figure 5.3 Designers can reduce the impact on the environment by sourcing sustainable materials.

- **The environment**
  Wastage and pollution are major issues in the modern world. Mass production can have long-term consequences for the environment due to the overuse of resources and excessive waste.

Designers can help to minimise the impact of production by sourcing sustainable materials, working with environmentally-conscious companies and selecting processes that will not harm the environment.

ACTIVITY 5.1

1 Describe one design project you might be drawn towards due to your personal ethics, and one that you might reject. You can consider the common themes listed at the start of this section.
2 Explain how technology has impacted on designer processes and practices.
3 Analyse the life cycle of a smartphone in terms of sustainability and the environmental impact of resources being used.

COMMUNICATING

CASE STUDY 5.1

3D printing helps with life-changing medical procedures

The idea of 3D printing body parts may sound like science-fiction, but it's already a reality. 3D printed ears, bones and muscles have already been implanted into animals, and now human patients are receiving the benefits.

In 2017, the ABC's *7:30 Report* did a story on Victorian woman Susie Robinson, whose broken jaw was repaired with a 3D printed section. Search online to read the story in full.

But Susie's story is just one example of this new area of medicine, as the following report from *New Atlas* shows.
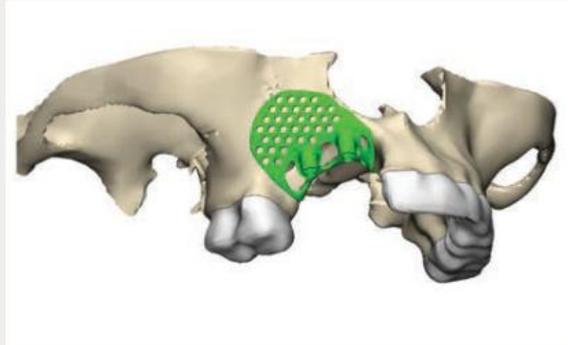
Figure 5.4 A scan of Susie Robinson's jaw with the 3D-printed implant

3D printing still holds a lot of unfulfilled potential. Talk abounds of disrupting manufacturing, changing the face of construction and even building metal components in space. While it is hard not to get a little bit excited by these potentially world-changing advances, there is one domain where 3D printing is already having a real-life impact. Its capacity to produce customised implants and medical devices tailored specifically to a patient's anatomy has seen it open up all kinds of possibilities in the field of medicine. The following information discusses three significant, life-changing procedures made possible by 3D printing technology.

A titanium heel implant

Len Chandler, a 71-year-old man from Melbourne, Australia, was faced with amputation below the knee after doctors diagnosed him with cancer in the heel bone. In exhausting all options, the surgeons had also been working with experts from the Commonwealth Scientific and Industrial Research Organisation (CSIRO), exploring the possibility of producing a 3D-printed implant to save the patient's lower leg.

Using schematics of the heel bone, a titanium implant was printed and inserted into Chandler's foot. Three months later, he was said to be recovering well and able to place some weight on his heel again.

A 3D-printed hip implant

The doctors of a 15-year-old Swedish girl suffering from a congenital disease resulting in skeletal deformations in the left hip were uncertain about whether she would walk again. But they then approached an implant manufacturing company called Mobelife to see what options might be available.

Mobelife used a tomography scan to create a detailed picture of the patient's unique bone anatomy, ultimately printing an implant that would be secured with screws to the bone surrounding the defect. The operation was performed and 18 months later she was walking entirely unaided.

Planning for complex heart surgery

When surgeons were approached by the parents of a 14-month-old boy born with four heart defects, they knew they had a task on their hands. But in planning for this surgery, they would be afforded the help of an invaluable new-age medical tool.

Using CT scans of the baby's heart, researchers were able to print a 3D model of the organ, measuring 1.5 times its actual size. This process took around 20 hours and cost US$600, but gave the doctors unprecedented opportunity to plan prior to a heart surgery, seeing them repair the heart's defects in a single operation. Following his release from hospital, the boy was said to be in good health.

These are no doubt just the tip of the iceberg in terms of the benefits 3D printing will bring to the field of medicine in the coming years.
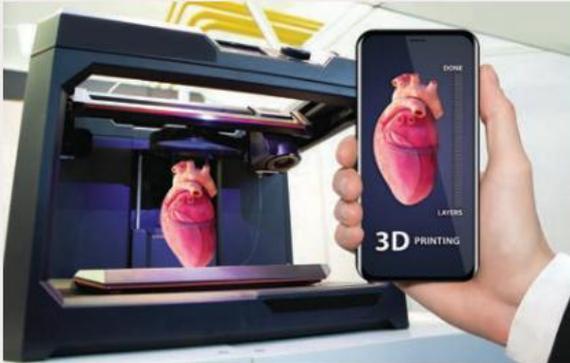
1   Identify some ethical issues relating to the emerging technology of 3D printing.
2   Explain how the designers may respond ethically and responsibly to this innovation.
3   Analyse how cultural and social factors determine the success of this innovation.
4   Write a 400-word essay about whether this emerging technology is an appropriate technology.

Figure 5.5 Advancements in medicine include 3D models of human organs.

Using ethical and responsible design

The influence of ethical design is expanding beyond the realms of typography, logos and titles and into healthcare, public policy, education, financial services and other areas of design and innovation. Designers working in these emerging design fields are responsible for projects that have a significant and fundamental impact on the quality of people's lives with clear ethical implications.

In healthcare, for example, designers are responsible for creating everything from the industrial designer's medical device that keeps a heart beating to the physical layout of an operating room or waiting room. Designers are given no guidance for ethical decision-making even as they continue to expand their influence into newer and riskier fields with long-standing moral implications. Material choices, media choices, ideas and presentation all account for ethical choices while designing and producing.

Responsible design

AN EXAMPLE OF RESPONSIBLE DESIGN

Cotton On is a popular casual clothing company that makes affordable clothes for children and adults. The company has built its successful brand around the values of sustainability and building communities. Cotton On stands out in the crowded market of fast fashion by focusing on ethical sourcing, design and manufacturing.

Responsible design: from the Cotton On Group website

We aspire to always do the right thing and have a positive impact on the world – for our customers, our suppliers, our partners, our workforce and all those we touch along the way. We value honesty, integrity and transparency and take a zero-tolerance approach to unethical behaviour. The Cotton On Group has the utmost respect for the work of all individual designers and sets clear expectations on how our product should be designed and created.

We closely govern our design processes with a strong focus on training and educating our talented designers on respecting boundaries of inspiration. We have a zero-tolerance approach to the flagrant copying of designs and have robust procedures in place to manage complaints and address issues that may arise. We routinely educate our team members on the importance of using language and slogans that are considerate of each of our global markets, and conduct checks to determine product and campaign suitability.

Source: https://cambridge.edu.au/redirect/8493

The Cotton On Group acts responsibly in the following ways:

- ethical sourcing
- no copying of designs
- ethical commitment
- sustainability in their factories
- ethical designs
- considering the environment.

ETHICS IN ROBOTICS

One area where responsible design is becoming increasingly important is robotics. New generation robotics will increasingly have more autonomy and the capacity to react without us having to pre-program their responses. We will need to have greater trust in and reliance on robots, and this will bring their similarities to humans even closer. Neuromorphic chip technology has enabled a major step in computing power and has been amongst the most revolutionary developments in AI. Mimicking the workings of the human brain, a neuro-inspired computer would work in a way similar to how our neurons and synapses communicate. A neuro-inspired computer could potentially learn or develop memory. An example of how such a development could aid design is a drone equipped with a neuromorphic chip, which would be better at surveillance by remembering or recognising new elements in its environment.

Figure 5.6 New generation robotics could increasingly have more autonomy and think for themselves.

ACTIVITY 5.2

1. Identify five points that make a responsible designer. Refer to a specific focus area in your answer. You may need to conduct some research.
2. Describe, with examples, two issues of ethical and responsible design that should be considered in the following designs (you can refer to the list from the Cotton On Group, above):
   a. A child's soft toy that can record audio and connect to the internet
   b. An installation at a cultural festival, designed to showcase the work of local Aboriginal and Torres Strait Islander artists
   c. Layout and furnishing of the waiting room at a doctor's surgery.
3. Discuss the ethical issues that could arise from robots acting like humans.

COMMUNICATING

5.2 **Intellectual property, trademarks and copyright**

intellectual property legal ownership of the intangible creative, intellectual, scientific and industrial activity in a product; also includes cultural expression of individuals and communities

When you design and create a product, you own the physical product. But you also own the creative ideas behind your design. This is known as **intellectual property** – it means that legally, as well as ethically, nobody else can 'steal' your ideas. Similarly, you cannot copy someone else's work and pass it off as your own. Of course, sometimes it is difficult to work out whether a new idea is a copy of an old one, or simply inspired by it: in the most extreme cases, people may be sued over this, and the courts are required to make a final decision.

Protection of Aboriginal and/or Torres Strait Islander cultural knowledge and heritage

Another important aspect of intellectual property is to protect the cultural knowledge, expression and arts that belong to particular individuals or communities, and which may have been passed down through generations.

This means that groups such as Aboriginal and Torres Strait Islander peoples have ownership of their cultural and intellectual property, and have the right to authorise any use of it by other parties, including refusing to allow use, or even maintaining secrecy of cultural practices. Where their heritage is used by other parties, it must be correctly attributed.

Figure 5.7 The Injalak Arts Centre is an association of artists and weavers from the Gunbalanya community, in the Northern Territory. Its objectives include preserving culture and providing economic benefits for the artists.

CASE STUDY 5.2

Aboriginal and Torres Strait Islander Cultural Protocols – Oxfam Australia

In Chapter 4 you looked at Oxfam Australia's Aboriginal and Torres Strait Islander Cultural Protocols. In this case study, you will consider these more closely.

You can download the Protocols document at https://cambridge.edu.au/redirect/8516

1   What does Oxfam's Protocols document consist of and why does it exist?
2   The seven principles in the Protocols document, which give practical expression to fundamental human rights principles, were summarised in Chapter 4. Read them in full from the document. What are the seven principles and how do they support Aboriginal and Torres Strait Islander peoples and their cultural knowledge and heritage?
3   Using the reference materials listed below as a starting point for your research, list 10 points about cultural protocols, building partnerships and preserving culture.
    • Australia Council protocols for various Indigenous art forms, written for the Aboriginal and Torres Strait Islander Board of the Australia Council's Culture Series can be found at the Australia Council website

• *Building Better Partnerships, Working with Aboriginal Communities and Organisations: A Communication Guide for the Department of Human Services*, Koori Unit, DHS, 2006
• *Message Stick: Cultural Protocols for Indigenous Reporting in the Media*, Australian Broadcasting Commission
• *Protocols for Media Access*, Northern Land Council, Darwin
• *Protocols for Photography, Film, Recording and Media*, Central Land Council
• *Respect, Acknowledge, Listen: Practical Protocols for Working with the Indigenous Community of Western Sydney*, Community Cultural Development NSW, 2003
• *The Greater Perspective: Protocol and Guidelines for the Production of Film and Television on Aboriginal and Torres Strait Islander Communities*, Lester Bostock, SBS Corporation, Sydney, 2nd ed, 1997
• *Writing Cultures: Protocols for Producing Indigenous Australian Literature*, Terri Janke, Commonwealth of Australia, 2002

Protection of creative, intellectual, scientific and industrial activity

There are several actions that designers can take to protect designs:
• Patents can be applied for, to give legal right of protection for a design, including how they work and are used.
• Registered designs protect the appearance of a design.
• Artistic works such as film, sound and computer games can be protected through copyrighting.
• Trademarks are used to protect branding of designs.

A level of legal protection can be given by simply being able to prove when the design work has taken place and by whom. A design portfolio is evidence of this. It may be satisfactory when working on a smaller scale, especially as there is no additional cost to the designer. However, depending on the level of investment of time, effort and finances, many designers enjoy the peace of mind that formalised protection of their work gives.

5.3 **Preferred futures**

Today's society is very different from the one your parents or even your older brother or sister grew up in. The introduction of technologies such as smartphones, fitness trackers, tablets and gaming consoles has helped to shape the way we live our lives in the twenty-first century. Today it is hard to imagine life without these technologies, whereas in the past it may have been hard to imagine life with it. Design and technology play an important role in shaping the future. Designers are required to imagine a future that does not exist yet. This is a concept known as preferred futures and some people have even made predicting the direction of the future their career.

In design and technology, preferred futures relates to the development of long-term visions or outcomes that will benefit nations, companies, communities and individuals by helping them to achieve sustainable prosperity in a globalised world. A preferred future is carefully thought out, researched and evaluated in order to shape communities locally and globally. However, not all preferred futures are achievable; some may need resources that have not yet been invented.

Figure 5.8 If you have a smartphone, you may not need to carry cash or a credit card.

Possibilities and constraints

One of the difficulties with thinking about preferred futures is that we don't always know what technology is around the corner. The next big thing could surprise everybody. Our vision and thinking is constrained by what we know, making it difficult to envisage what could be possible and thus what impact it could have. For example, the early mobile phones were considered entirely as verbal communication devices, and when messaging was first introduced, take-up was relatively slow. It is unlikely that anyone realised messaging would become, for many people, the preferred communication method.

ACTIVITY 5.3

In a 300-word essay, explain our current thinking about resources and everyday technology use, and the impact this has on the possibilities for preferred futures.

COMMUNICATING

Visions for preferred futures

LIFESTYLE CHOICES: RECYCLING AND IMPLEMENTING THE 3 RS INTO YOUR HOME AND LIVING A SUSTAINABLE LIFE

Achieving a preferred vision may involve making lifestyle changes – sometimes quite difficult ones. Sustainability is a key element of many future visions, but it may seem incompatible with our current lifestyles, which often involve purchasing many new products, and throwing away old ones. This 'throwaway' society may have arisen, in part, from the fact that if an item breaks it is often cheaper and easier to buy a new one than to repair the old one. We even buy things just because they are new, even though the existing product may still be fully functional – think about how many people have old, still working, smartphones, which have been replaced with the latest model.

However, this is not good for the future. Visions of a sustainable future often refer to the three Rs:

- Reduce excessive consumption
- Reuse what you can
- Recycle old items rather than sending them to landfill.

More recently, some organisations have added extra Rs to this list – two examples are Repair (broken items), and Refuse (plastic and disposable packaging).

It may seem difficult to introduce these principles into your current lifestyle. But remember, most of these approaches seemed completely normal in the past, before the growth in production of cheap, disposable items.

FINANCIAL CONSIDERATIONS

Achieving a preferred vision can sometimes be expensive. A good example of this is owning a home, which is often considered one of the great Australian dreams. However, house prices in Australia, while they may fluctuate, have steadily increased since your parents' and your grandparents' day, making home ownership much more difficult for young people in the twenty-first century.

The First Home Owners Grant is a way for Australians to achieve this vision. This government scheme helps by offsetting the effect of the GST on home ownership. It is a national scheme funded by the states and territories of Australia.

- Why does this dream of homeownership exist?
- How does the grant help with this vision?

ACTIVITY 5.4

1 Research the two organisations below to further investigate lifestyle choices or living a sustainable life.
   a International Futures Forum
   b World Future Council
2 List five new visions from these two organisations.

COMMUNICATING

SOME SPECIFIC EXAMPLES

Vision 1

The world of medicine is constantly changing and technology is an integral part of this industry. Medical breakthroughs have allowed life expectancies to increase drastically and diseases that were previously a death sentence can now be effectively managed. One new medical technology that is at the forefront of the industry is regenerative medicine. This technology will fight diseases such as diabetes, help with organ failure and fight the effects of ageing. It also has the potential to produce fully functional organs that can be transplanted.

Figure 5.9 Regenerative medicine is the vision of the future for the field of medicine.

Vision 2

You may not realise it, but sensors are a large part of people's day-to-day activities. On average, people carry approximately 11 different sensors. The more sensors are used by us, the more potential they possess. At the moment, sensors are found mostly in our phones and tablets, but these same sensors could one day be seen in your bathroom mirror, displaying your body temperature and heart rate. Perhaps in the future these sensors could determine the state of your health; they may be able to warn you when the flu is coming on, so you know to stay home from school and rest. You could use this technology to have a doctor's certificate sent straight to your school. The next decade will be revolutionary for monitoring and managing our health and well-being. With the use of technology and mobile devices, we are recording more information about ourselves than ever before.

This is already starting to happen with devices such as Apple Watch, Fitbit Charge, Nike FuelBand and Samsung Gear. And even more sophisticated health-monitoring systems are on the way.

Vision 3

You may be aware of wearable technology. Interactive glasses and fitness trackers have been available on the market for quite some time. Currently, some companies are trying to take wearable technology to the next level with bionic, data-rich and in-body technologies that may change what it means to be human. A company called Athos offers smart fitness clothing that tracks your muscle activity, heart rate and respiration and provides a detailed record you can view in an app. The purpose behind the clothing is to help people become their ideal versions of themselves, putting their health and their physical abilities as their main priority. Popular brand Levi Strauss is also exploring this transhumanist approach to clothing with garments that interact with your devices. Touch-sensitive surfaces will make it possible for garments to monitor weight and muscle gain, and even allow you to make phone calls without touching your phone.

Athos Shirt
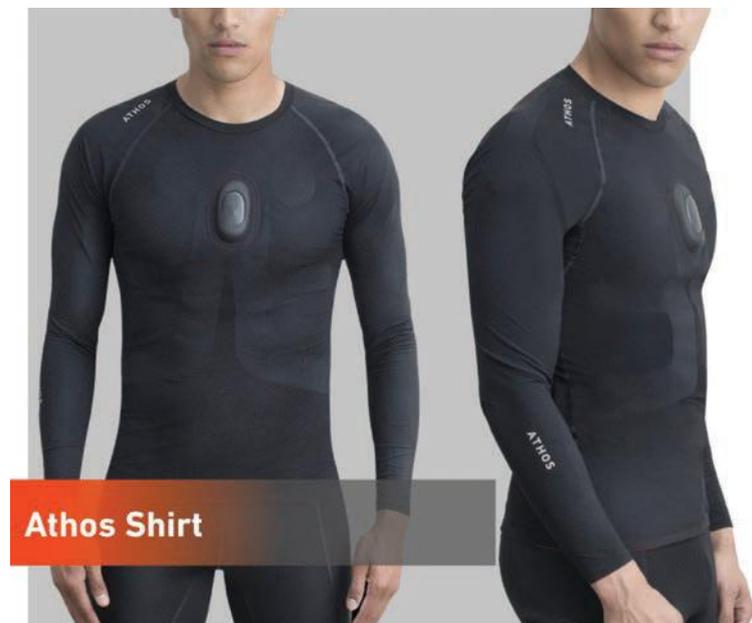
Figure 5.10 An example of the revolutionary fitness clothes from Athos

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ACTIVITY 5.5

1   Refer to Vision 1. What could this new medical technology mean for society?
2   Discuss five advantages and five disadvantages of Levi Strauss's new technological garments.
3   Identify specific examples of preferred futures in the armed forces and defense industries.

COMMUNICATING

Design solutions

Problem-solving is a fundamental part of design and technology. New problems arise each day in design and, through innovative and creative thinking, design solutions are being created not only by designers but also by people in fields that are not related to design. With technology that is so accessible to certain parts of the world, more people are being given the opportunity to create and deliver design solutions to problems. It is anticipated that this open approach to problem-solving will increase in the future. People who may not necessarily have a background in design may be exposed to problems that are new and in need of a solution.

Great designers have a sharper eye for detail and for the wow factor than most, but a lot of their choices are less instinctive than most people realise. There is research involved, a background knowledge

of design history, project experience – all of which helps designers make better decisions and create an end product that is more effective. But you don't necessarily need to have a formal design education background to grasp and apply universal design concepts that touch on the elements and principles of design while also figuring out context and relevancy to the audience and the times.

However, when designers justify their decisions they base their assessment on predictions, the future and possible emerging technologies. As a designer, you need to justify your design decisions in order to show your clients or consumers that you have thought about materials, tools and technique choice. When designers justify their design decisions and consider preferred futures they are more successful.

ACTIVITY 5.6

Explain a vision of your own, and justify your design solution with a consideration of preferred futures.

DESIGNING

Changes to achieve preferred futures

Achieving preferred futures requires more than just technology. Social and economic changes may be needed to support particular visions – for example, increased corporate responsibility

towards sustainability, and support for research and development in areas that will benefit everyone without necessarily generating an obvious profit, such as disease eradication.

ACTIVITY 5.7

Identify what changes will occur in society to achieve a preferred future (choose Vision 1, 2 or 3, or a separate vision of your own).

COMMUNICATING

Predicting future directions for design solutions

When trying to picture the future of design solutions, we need to consider three design principles: integration (of systems and information), interaction (of people, systems and services) and independence (of people and performance). The advancement of technology plays a large role in these principles. Technology is becoming increasingly integrated into our lives, and more and more people are beginning to understand its potential. Technology is also allowing for increased collaboration. Typical barriers that may in the past have restricted who and what we interact with are now being overcome by collaborative software and social media applications.

Independence has also been made easier through technology. Now, instead of going to a course to learn something, we have access to learn online, in our own home and at our own pace. If something breaks, we can now teach ourselves to fix it rather than having to go to a specialist to get it fixed. This improves our performance and allows us to develop skills we may not previously have had an opportunity to learn. New media is leading to a transforming shift in business, technology and socio-cultural practices that is further driving the rapid expansion and uptake of design in the community.

Figure 5.11 Future designs must consider integration, interaction and independence.

ACTIVITY 5.8

1   Explain in your own words what is meant by the three design principles that will assist in the prediction of design solutions – integration, interaction, independence – and describe how they will affect our lives.
2   Imagine that you are an industrial designer. Name a design solution and explain the future direction you propose. Predict your own future direction for the design solution.

COMMUNICATING

CASE STUDY 5.3

SYDNEY PARK WATER RE-USE PROJECT

Much has been achieved over the past two decades to transform the Sydney Park site from its former post-industrial history and [site of] waste disposal, into 44 hectares of parkland and a vital asset for the growing communities of Sydney's southern suburbs.

This project forms the City's largest environmental projects to date, built in partnership with the Australian Government through the National Urban Water and Desalination Plan. It is an integral component of Sustainable Sydney 2030; targeting 10% of water demand to be met through local water capture and re-use in the park. The City also seized the once in a lifetime opportunity to use what was essentially an infrastructure project to breathe new life into the park – as a vibrant recreation and environmental asset for Sydney.

The City engaged a design team led by landscape architects Turf Design Studio and Environmental Partnership who orchestrated an intense and multi-disciplinary collaboration intersecting design, art, science and ecology – in a 'roundtable' of creatives shared between water experts Alluvium, artists Turpin + Crawford

Studio, ecologists Dragonfly Environmental, engineers Partridge and the City's own Landscape Architects. Design Landscapes constructed the project.

The result is an interwoven series of community infrastructures and 'made' systems – water re-use, recreation, biodiversity and habitat all integrated within the physical fabric of Sydney Park.

Sydney Park now offers an enhanced recreational experience to the Sydney community, going beyond the picturesque; creating instead a revitalised, multi-faceted waterscape that celebrates the connection between people and place.

Source: https://cambridge.edu.au/redirect/8494

1   Explain the effect that this design solution will have on the lives of people in the Sydney area.
2   Analyse this design solution and the predicted future for this solution. Include material use, sustainability and emerging technologies in your answer.
3   Critically analyse social, economic and ethical issues to do with this design solution for the Sydney community.

Figure 5.12 Sydney Park Water Re-Use Project

Cambridge University Press
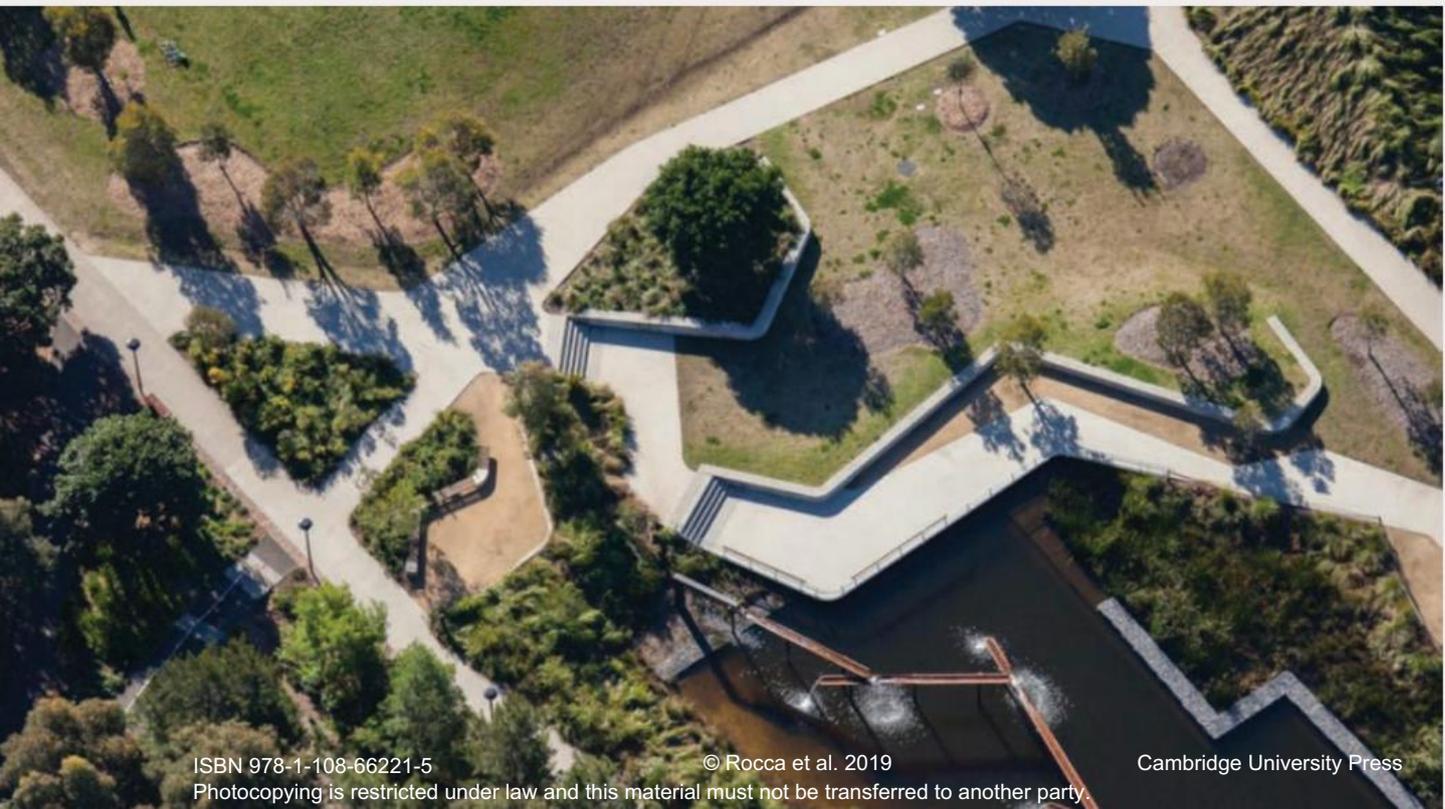
5.4 **Innovation**

Innovation can be defined as a new idea or invention that has been converted to a product or service that solves a specific problem or customer need.

Innovation is the process of utilising research, creativity and risk-taking to develop new products or services that are considered valuable. It involves turning new ideas into solutions to customer needs. Innovation is inherently risky; new products and technologies require new markets, and many ideas that may be considered new and radical in themselves fail commercially because they do not reach a potential market. A framework for defining innovation and determining the value of an idea therefore needs to include a focus on market needs as well as things like creativity and progressiveness. Designers strive for innovation. They work towards using their creativity to solve problems in new ways and coming up with ideas that are as valuable as they are radical.

innovation something new or different

Figure 5.13 Innovative ideas, such as a robot that does housework, first require a consumer market.

Types and examples of innovation

Innovation is often very subjective (based on people's opinions). Despite its subjective nature, there has been some useful research into thinking about what innovation is and how it works.

The 4Ps model developed by John Bessant and Joe Tidd provides a powerful tool for looking at successful innovation and lists four ways such change can take place. The 4Ps are:

1 **P**roduct innovation: changes in products and services
2 **P**rocess innovation: changes in the creation or delivery of products and services
3 **P**osition innovation: changes in communication which affect how people perceive products and services
4 **P**aradigm innovation: changes in the underlying philosophies that shape the organisation.

PRODUCT INNOVATION

Product innovation is probably the most familiar form of innovation. It involves introducing a new product or service, or improving an existing one, to better serve customer needs. One such innovation is the Bic ballpoint pen. Prior to the invention of the ballpoint, pens had a metal nib which either needed to be dipped in ink, or used an internal fountain of ink. A ballpoint uses a thicker type of ink and dispenses it over a metal ball in the tip, which avoids clogging, smudging and leaking. This was patented by László Bíró in 1938, and in 1950 the patent was bought by Marcel Bich. Key innovations in his first pen – the Cristal – were to use stainless steel for the tip, and a tube that was hexagonal rather than round, and made of clear plastic. This barrel design meant it was less likely to roll off the desk, and the amount of ink remaining was clearly visible. Later Bic innovations included introducing a retractable pen in 1956, replacing the stainless steel tip with tungsten carbide tip in 1961, and launching a four-coloured pen in 1970. The Bic Cristal is still the best selling pen in the world.

PROCESS INNOVATION

Process innovation is a form of innovation that involves achieving the same end goal in a different, more efficient way through the use of new technology, equipment or software. Process innovation is usually driven by the need to cut costs and deliver goods and services more quickly and to larger numbers of people. A famous example of process innovation is Henry Ford's use of the assembly line in the first decades of the twentieth century. As demand for cars grew in the first decades of the twentieth century, Ford implemented the process of lining up workers and machines next to conveyor belts. Each worker concentrated on making one part only and sent their finished part down the conveyor belt to a team who put the parts together to create a car. This meant that multiple parts and multiple cars were being built at one time, whereas prior to this a single car was built at a time.

Figure 5.14 The ballpoint pen has undergone many design changes since it was first invented.

Figure 5.15 Assembly lines were adapted by Henry Ford to manufacture cars.

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Cambridge University Press

POSITION INNOVATION

In contrast to product and process innovation, position innovation involves a change in how an existing product or process is perceived. One example is Levi Strauss jeans. Jeans were initially conceived as workwear for male factory workers and labourers, but over time have undergone a variety of shifts in perception to the point where their original conception may be one of the last things we think of when we think of jeans; we are now much more likely to think of them as a fashion item than something a tradesperson would wear to work.

PARADIGM INNOVATION

The final form of innovation refers to a change in the underlying pattern of thought, or mental model, of a business or organisation (or any group of people). An example of paradigm innovation is low-cost airlines. Formerly, airlines catered only to those who could afford the high price of passenger tickets and would generally provide a lavish service. A low-cost airline company cuts out or requires separate payment for all the extra services – such as meals, seat selection, entertainment – and gives the consumer just the flight at a reasonable price. By giving the customer what they need, the airline can eliminate what is undesirable and build a whole new market.

Figure 5.16 Low-cost airlines removed onboard services from being built into the ticket price to provide the customer with no-frills, cheap flights.

The practical task at the end of this chapter will give you an opportunity to explore ways of creating innovative solutions.

CASE STUDY 5.4

Lucky Iron Fish

Iron is one of the essential nutrients the body needs to function, and yet iron deficiency affects nearly 2 billion people in the world each year (World Health Organization, 2008).

This nutritional deficiency is completely preventable, but in some parts of the world iron-rich food is not readily available or commonly eaten. For example, in Cambodia, diets predominantly consist of rice and fish, with almost no iron. As a result, up to half the population suffer from severe anaemia. While using iron pots for cooking or taking dietary supplements may help, these solutions are expensive and uncommon.

Epidemiologist Christopher Charles, who was conducting research in a Cambodian village, gave women in the village iron discs to put in their pots while cooking: this would supplement the iron levels in the water, and thus increase people's iron intake. However, almost nobody used the discs. He redesigned the discs to look like lotus flowers, but there was still little interest in using them. From village elders, Charles learned about a type of fish that was believed to bring good luck, and so again distributed discs, now in the shape of this fish. This version was received much more positively by the villagers, who began using it regularly while cooking.

After a three-month trial, the villagers' iron levels were found to have increased significantly, although subsequent tests have had mixed results.

Charles work shows the value of innovative thinking, and also highlights the importance of design in making a solution effective. As he said, 'You can have the best treatment in the world, but if people won't use it, it won't matter.'

1   Research further the benefits of having more iron in our meals and how the Lucky Iron Fish could help with this. Use an A4 sheet to record your findings using graphics and text.
2   Describe the characteristics that make the Lucky Iron Fish an innovation.
3   Explain, with the aid of examples, the impact that this innovation could have on the lifestyles of people in developing countries.
4   Analyse the social, cultural and economic effects that this innovation has, or could have, on developing nations.
5   What might be some of the limitations to the more widespread use of this innovation in developing countries?

Figure 5.17 In Cambodia, Lucky Iron Fish are placed in the cooking pot to help fight anaemia.

Judging innovative products

When judging if a product is innovative, it is worthwhile considering a variety of factors. Some of these may include:

- Does the product address a concern that is now resolved?

- Does the product perhaps open up new markets, or is it just a really good idea?
- Does the product improve the quality of life for the intended users?

CASE STUDY 5.5

Edible water bottle – Ooho

This ball-shaped edible water bottle could put an end to plastic packaging. The water is surrounded by a biodegradable and natural membrane: when the water ball is swallowed, the membrane is digested, releasing the water within. The membrane is made from a seaweed extract and it is tasteless, although flavours can be added to it.

It is cheaper than producing a plastic water bottle. The balls are created by dipping a block of ice into a solution of calcium chloride and brown algae. This causes the membrane to form around it. A layer can be peeled off to keep the exterior clean for consumption. The hope is it will replace the millions of plastic bottles thrown away every year.

1   In small groups, or as a class, make a judgement about this product by considering the questions listed above.

Figure 5.18 The edible water bottle could replace plastic bottles, which add to landfill and ocean pollution.

5.5 Past, current and emerging technologies and innovations

Technology has impacted people's lives dramatically with every major new development since the mid-twentieth century.

Past technologies

One of the earliest pieces of technology was the calculator. In 1642, Blaise Pascal invented a mechanical calculator that worked using gears and which could only add and subtract. Pascal's invention would eventually lead to the development, in 1971, of the microprocessor, which is now used in all calculators and computers.

In 1837, Charles Babbage, together with Ada Lovelace, proposed the Analytical Engine, a mechanical general-purpose computer. It used punch cards and had a calculator and a storage unit that could hold 1000 figures of 50 digits each. However, it was never built. The first electronic digital computer, the Colossus, was built over 100 years later, in 1943. Three years after that, the ENIAC (Electronic Numerical Integrator and Calculator) was built. Both of these early computers were very different from computers today: the Colossus was programed with plugs and switches, and the ENIAC was so large it took up an entire room. It was 30 metres long, 3 metres high and weighed over 27 000 kilograms.

Many of the characteristics we take for granted with today's computers – such as fast processors, larger storage, portability and take-anywhere
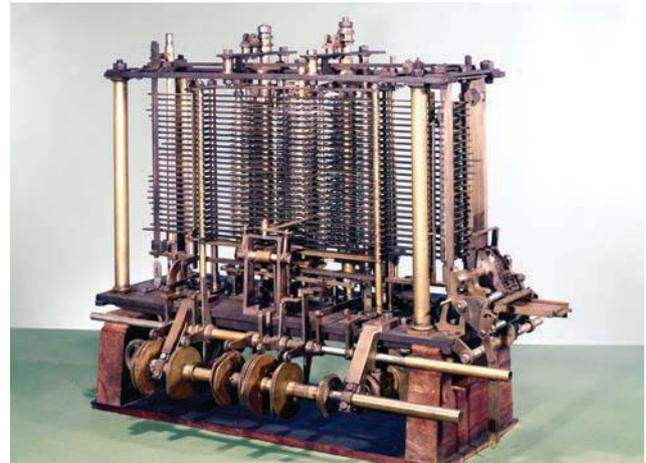
Figure 5.19 The trial model of the Analytical Engine, the proposed first mechanical computer.

accessibility – began to be introduced in the 1990s. The World Wide Web (WWW) was conceived in the 1980s and was introduced to the world in 1991.

The internet offered new and exciting ways of doing things. For example, communication could now be done via email. File transfer became easier and increasingly common. Businesses and workplaces developed infrastructures that allowed them to provide goods and services online, and e-commerce started to emerge.

Current and emerging technologies

emerging technologies new technologies that are currently developing or will be developed and that will substantially alter the business or social environment

Technological convergence is the current trend in **emerging technologies**. Technological convergence is when several different technologies or functions are merged into one device or piece of equipment, making them cheaper and smaller. Smartphones, tablets and smart televisions are all examples of this. Before the days of smartphones, people needed separate devices (digital or non-digital) to make phone calls, store addresses, record appointments, take

photos, play media, navigate with GPS and use the internet. The ability to stay connected on the go with powerful computers and wireless connectivity has allowed greater freedom for the user, and has changed the way individuals, businesses and society interact and behave. It has also impacted our environment.

The easy availability and improvement of technology has changed the way people and businesses work. New technology has many positive impacts on individuals, society and our environment.

In this section, two innovations and emerging technologies are identified. The range of focus areas consists of communication systems, environment, fashion, accessories, software and industrial and information systems.

GESTURE RECOGNITION

Gesture recognition by computing devices involves analysing the features of a person that identify them, and/or analysing any action or movement they perform. This requires an input device – a sensor that makes a 3D digitised map of the movement – or a camera to input an image or video. Secondly, it requires software to analyse the input and interpret it as a command. Human features used to identify people include finger and palm prints, faces, voices and irises. Movements include eye tracking and lip movements as well as arm and hand gestures, collectively called kinesics. This system as a whole is called a perceptual user interface (PUI), and its purpose is to enhance the usability of software, making computer-human interaction efficient and more natural.

PUIs available for games, fitness and dance applications include the Wii Remote Plus, Xbox Kinect and PlayStation Camera. Sci-fi movies such as Minority Report and Iron Man 2 show a future where computers are controlled by a wave of the hand, which is coming closer to being a reality. Gesture recognition allows computers to be more accessible for the physically impaired, and can also be applied more widely.

Figure 5.20 The software in Wii games takes advantage of PUI to provide an enhanced experience.

Movement sensors for PUI input use accelerometers in hand-held or wearable devices to measure how far the device moves compared with fixed points and directions. Cameras may be 2D, but stereoscopic or multi-angle cameras will create more detailed 3D images.

The social aspects of gesture recognition need consideration in addition to the technical challenges. Gestures should be simple, natural, not easily confused, and acceptable across a wide range of people and cultures in the intended market.

WEARABLE FITNESS DEVICES

The innovative colourful wristbands show how many steps have been taken, calories burned, kilometres walked and what a person has achieved over the course of a day. Running can be tracked via GPS, or the accelerometer tracks when running indoors. Keen golfers can access up to 38 000 course maps, scorecards and the ability to measure distances using GPS. Also a swimming app counts lengths, tracks pace and distance and determines your swimming efficiency score. It comes with a colour LCD screen or band and can last up to three weeks in watch/activity mode (this drops to 10 hours when the GPS is used). It also connects via Bluetooth to receive notifications from a smartphone.

There is a saying that if you can imagine something, then it is possible. Movies often depict future beings with digital tattoos or internal microchips, and this may come to fruition eventually. Researchers are constantly innovating. At Echo Labs in Palo Alto, California, a biometric band that can measure your blood pressure, oxygen and hydration is being developed. The wristband measures the reflection of varying light frequencies to reveal the concentration of molecules in the blood by shining electromagnetic waves through the body.

Figure 5.21 Biometric wristbands have become commonplace in the last five years.

ACTIVITY 5.9

For a design to be successful and innovative, it must provide a solution. Innovative design ideas and solutions should also have data or analysis to support the desired outcomes.

> Design is the action of bringing something new and desired into existence – a proactive stance that resolves or dissolves problematic situations by design. It is a compound of routine, adaptive and design expertise brought to bear on complex dynamic situations.

Harold Nelson

Characteristics of being innovative and enterprising involve five points:
- finding simplicity in complexity
- including beauty as well as functionality
- improving quality for society's experiences
- creating sophisticated solutions
- serving the needs of the consumers.

On an A3 sheet create a collage showing your findings and your meaning of the statement below. Provide examples to aid your discussion.

When design principles are applied to innovation, the success rate for innovation dramatically improves.

DESIGNING
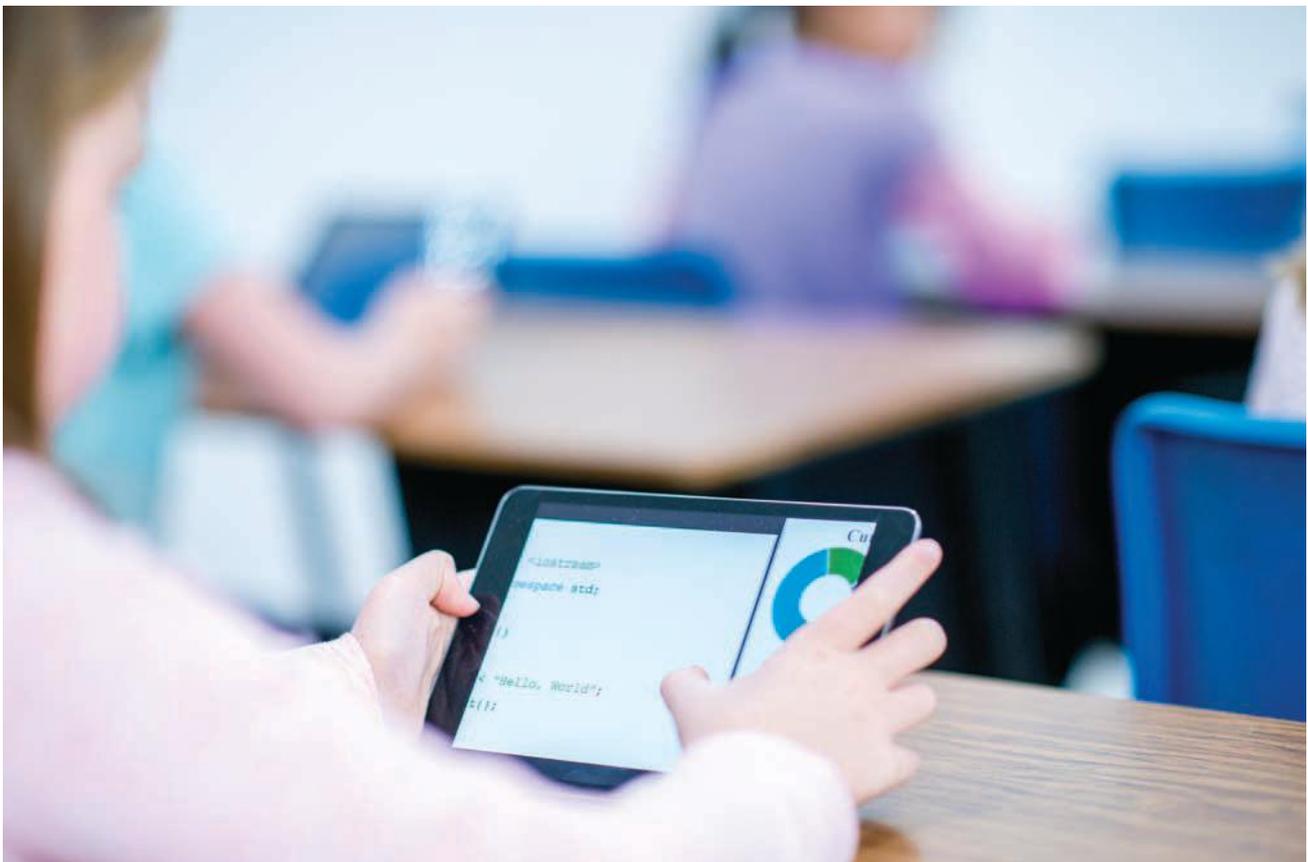
Figure 5.22 The iPad is an example of a successful innovation.

Impact on the individual, society and environments

INDIVIDUAL

Technologies such as mobile phones, email, video calling, conferencing and text messaging have made staying in touch with family and friends around the world easier and much cheaper. People are also able to get news from around the world at the touch of a button, thanks to live and up-to-date internet reports.

Jobs that are important to society have also made use of new technologies to improve the quality of the goods and services they provide. Teachers, for example, use technology to improve learning in the classroom and make homework easier. Doctors use the latest medical technology to accurately diagnose people and give the correct medications and treatments to help them live. Farmers use specialised IT equipment to keep track of their produce to make sure we have enough to eat. In all industries, businesses are switching more and more to digital communications, using less paper to save our forests from logging.

Another group of individuals who can benefit from emerging technologies are people with disabilities. In Chapter 4 you looked at the importance of accessible design, and how this can benefit everyone. But emerging technology can also bring innovations that assist people with disabilities in previously unimagined ways. For example, several groups of scientists are working on different versions of robotic exoskeletons:

- ReWalk, developed in Israel, is a set of braces that can be strapped to the legs, and which use motion sensors and computers to enable people with paralysed legs to walk.
- The AIDE system, developed in Spain, is an exoskeleton which attaches to a wheelchair and can help people perform daily activities, such as eating, drinking or washing, which they previously needed assistance with. This system uses artificial intelligence, so the level of support provided by the exoskeleton can be adapted to the individual's particular needs.

But although new technologies can have very positive impacts on people's day-to-day lives, they can also have negative impacts. While technology can increase productivity and streamline work flows, it can also lead to staff redundancies as faster ways of doing things can sometimes mean less people are required to perform a job.

Technologies can also have a negative impact on the traditional ways of life of Aboriginal and Torres Strait Islander peoples, and other indigenous peoples around the world. Unless care is taken, the adoption of new technology may lead to key elements of cultural heritage being forgotten and lost.

SOCIETY

With the rise of broadband internet, social networking websites, apps, smartphones and other forms of communication technology, we have never had more tools with which to communicate and connect with others all around the world, whether they are family or strangers, from our own or a different culture. However, it could be argued that the use of these technologies has not made us more social. Being connected to the rest of the world via social media and smartphones may possibly leave us feeling more lonely, stressed and isolated from the rest of the world, as these digital connections could come at the cost of our face-to-face relationships. Technology has made some of us question what it means to be social and how to form meaningful relationships with others.

We are undoubtedly at the beginning (or in the middle) of a social revolution. Defining appropriate and ethical social behaviour when it comes to our digital interaction will become increasingly important. Communication technology is developing at an accelerating pace – moving faster, it seems, than we have been able to think carefully about what these developments mean for us.

ENVIRONMENTS

New technology has not only improved trade and commerce; part of industry is now also directed at reversing the negative effects humans have had on the environment. Green technology can be found in many new homes, creating better solutions for energy in the home. Solar panels harness UV rays to create sustainable energy, and kinetic powers such as wind and water currents can produce electricity, which has decreased the demand for coal and other fossil fuels.

In the past, technological innovations were designed with little concern for the long-term consequences they would have on the environment. Greenhouse gas emissions from such creations have caused global warming.

The gas emissions build up in the atmosphere and penetrate the Earth's ozone layer, causing melting glaciers, rising sea levels, air pollution, ocean acidification, disrupted marine and wildlife biodiversity, groundwater contamination and soil depletion.

Green technology aims to improve the state of the Earth and in turn improve the health and well-being of the world's population. Overuse of wood burning and coal in China has caused widespread pollution and resulted in an alarming amount of respiratory disease. China is ranked as the country with the highest record of fatalities by asthma sufferers by the Asia Asthma Development Board. Shockingly, it is expected that of 100 000 Chinese citizens who suffer from respiratory diseases, 36.6 % of these cases will be fatal.

ACTIVITY 5.10

We are living in an amazing time period in which technology is changing how we live. One example of this is drones, which have the potential to transform cities, and revolutionise areas such as travel, goods delivery and building construction.

Elevation, a short documentary exploring how drones will change cities, is available online at https://cambridge.edu.au/redirect/8534.

Figure 5.23 Delivery drones at work in a concept by design studio PriestmanGoode

Write a 500-word essay explaining how the emerging technology of drones could impact individuals, society and the environment.

COMMUNICATING

CHAPTER SUMMARY

- Ethical design involves the study of moral dilemmas in designing.
- Designers have responsibilities to uphold when designing products, systems or environments. Three major responsibilities are ethics, honesty and environmental responsibility.
- Appropriate design involves the idea that consumers have needs and understand those needs better than anyone, and can therefore suggest or invent the technological innovations necessary to meet those needs.
- Innovation can be defined as the process of converting an idea or invention into a good or service that creates value for a customer. To be called an innovation, an idea must satisfy a specific need.
- New technologies that are currently developing or will be developed, and that will substantially alter the business and social environment, are known as emerging technologies.

- Technology has an impact on individuals, society and the environment. In turn, each of these entities has an obligation to act for the benefit of the society at large. Every individual has an obligation to maintain a balance between society and the environment.
- Communities and individuals are making efforts to lessen the negative impacts of technology on the natural environment.
- Designing using appropriate technologies is having a fundamental impact on our society. It has created efficiencies and raised the standard of living for many people.
- Design and technology is concerned with developing visions and strategies to assist nations, companies, communities and individuals to achieve sustainable prosperity, in an interconnected twenty-first century.
- Visions of future design refer to anticipating that which will or may come to be in the context of design and technology.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1 Appropriate technology
2 Design issues
3 Design solutions
4 Emerging technologies
5 Environment
6 Innovation
7 Principles
8 Responsible design
9 Society
10 Preferred futures

REVIEW TASKS

1 Research an interior design company that designs interiors for high-end shop fronts. Discuss potential ethical issues relating to this type of company.

2 Research what it means to be a responsible designer. Identify what qualities make a responsible designer.

3 Explain the four types of innovation. Give examples for each type of innovation.

4 Many major car manufacturers have been conducting extensive research and development into driverless cars, as have technology companies such as Google. Explain the issues a company would need to consider when marketing a driverless car – the benefits, but also the disadvantages, and how consumers would respond to this new technology on the roads.

5 Complete a table like the one below using information you have researched about the Sydney Park Water Re-Use Project in Case Study 5.3.

6 List all the types of technology you have used since you got to school today. How has technology impacted your life?

7 One of the design issues mentioned in this chapter is the use of technology that saves time. Analyse what it means to save time with the use of technology.

8 Refer to Vision 3 on wearable technology in Section 5.3. Discuss the impact on individuals and society this vision would have.

9 Find an innovation that has been developed in response to society (e.g. driverless cars or drones). How were the needs of a community met by this innovation?

10 Refer to Lucky Iron Fish in Case Study 5.5 Research and evaluate the major impacts that this innovation would have on Cambodians.

	INDIVIDUAL	SOCIETY	ENVIRONMENT
Advantages	• • • •	• • • •	• • • •
Disadvantages	• • • •	• • • •	• • • •

EXTENSION TASKS

1 Create a 15-slide PowerPoint presentation that shows how designers can act ethically and responsibly when choosing the materials for their design products.

2 Go to the YouTube channel for 'The Story of Stuff' and watch any one of the videos on water bottles, consumerism, plastic microbeads, capitalism or how things work. Create a summary of what you have learned from the video. Present your summary as an A3 visual representation that you can hand to your teacher.

PRACTICAL TASK

Practical exercises that are completed in the classroom or at home motivate your original ideas to evolve into creative and innovative solutions.

The following exercises come from accelerated learning website *The Mission*.

1 The Wall of Fame and Shame
Find real, everyday examples of innovation to briefly share among the group. Some of the best discussion comes from bad examples that students don't believe will succeed. Students should share why they believe the innovation will succeed or fail. Place on a Post-it note and put it on a main wall in your classroom. Share and discuss.

2 Two piles
Students form teams of 3–5 and choose an index card from each of two piles. One pile of index cards has major brand names, the other has product categories. The groups are told that they now work for the company they chose, and they must innovate a product for the category they chose. The groups have a set amount of time to develop the product's target audience, features, and promotional ideas. One member from each team will then present their ideas to the rest of the groups.

3 Your innovation
Each person approaches innovation differently depending on their talents and strengths. To personalise and internalise innovation, participants should create a poster or presentation about themselves. This should include their favourite inspirational quotes, photos, and a short bio of a person who inspires them. This should also include a description and photo of a skill, hobby, or field they know the most about (outside of family and/or school). A Jung typology test is encouraged to be included and participants should choose which of three types of intelligence (Analytical, Creative, Practical) fits them best. Uniqueness in the presentation of this work is highly encouraged.

4 iWish
Innovations need to solve a problem. Participants are asked to individually think of a problem or challenge they know people face. The individuals are then asked to form teams of 3–5 to discuss each of their ideas and decide on one that can best be solved with a phone app. The group is then asked to illustrate the app interface on a large (A3 poster-sized) sketch of a phone to then share with the rest of the groups.

6 Innovative, enterprising and creative design ideas and solutions
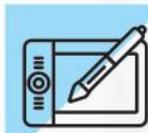
KEY TERMINOLOGY

- **Brainstorming**
- **Collaboration**
- **Data**
- **Enterprising activity**
- **Entrepreneur**
- **Information**
- **Innovation**
- **Research**
- **Stakeholders**
- **Target market**

This chapter explores some of the creative tools that designers use in order to develop the most appropriate solution to their given design brief. This features research, as it plays an important role in informing the creativity in design work. When working as an individual or collaborating with other designers as a member of a design team, innovating through enterprising approaches can help produce the creative solutions that lead to success in design.

This chapter addresses **Outcome DT5-6** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the content areas **Creative and innovative idea-generation, Research and exploration** and **Enterprising activity**.

6.1 **Generating creative and innovative ideas and success criteria**

There are many versions of the design process that designers use to create solutions to identified needs and problems. The specific process that a designer may choose to follow will often be the most practical or efficient for their situation. Regardless of the version that is used, the generation of initial ideas and refining them into a conclusive solution always falls between analysing the given design brief and the production stage of the design process.

To ensure that the best possible solution has been developed for a client, the designer will analyse their given brief to identify what the final design requires. This may include the intended target market and what they like, the form it could take and what materials it could be made from. The designer must then determine the best way to gather this information using the researching tools at their disposal. Some of these tools and techniques are explored further in this chapter.

Figure 6.2 A good designer knows how to make the most of innovative technology.

The process of innovation is based around the inclusion of emerging technologies into existing designs. Good designers and design teams will be knowledgeable about new technologies as they are developed and released into the market. During the process of developing solutions for identified problems, being able to include the latest technologies may give designers the edge over their competition, which can often translate into commercial success. Nowhere has this been more evident during recent times than in the development of mobile technologies, where miniaturisation has led to smaller and more powerful computing technology being used to create each new generation of smartphone and tablet.

Figure 6.1 Analysing a design brief helps reach a solution.

With the brief analysis and research findings at their disposal, the designer is now best prepared to begin producing innovative solutions to meet the needs of their client or target market. As with research, designers will also choose the techniques best suited to them in order to harness their creativity. These techniques will help the designer move through the design process of creating a number of initial ideas, narrowing them down through ongoing evaluation and client or target market input until they arrive at a final idea and will perhaps even create a prototype. Approval could then be sought for this proposed solution and it could be presented to the client or target market, ready for production to begin, or the designer could return to a previously eliminated idea should the result not be satisfactory.

Research and investigation

Informed design is good design. In order to best meet the needs prescribed in a design brief, good designers will go to great lengths to ensure that they have all the background information they need to begin developing the best solutions. This helps ensure that nothing is left to chance, which is important in competitive design markets. Following the analysis of the design brief, the designer will have identified the key areas for research to inform their design work as well as the most appropriate and efficient methods of researching them. This gives the designer an action plan to work through to ensure they have the required understanding to begin creating the best designs.

Figure 6.3 One of the things that needs to be considered when planning a design is the materials that will be used.
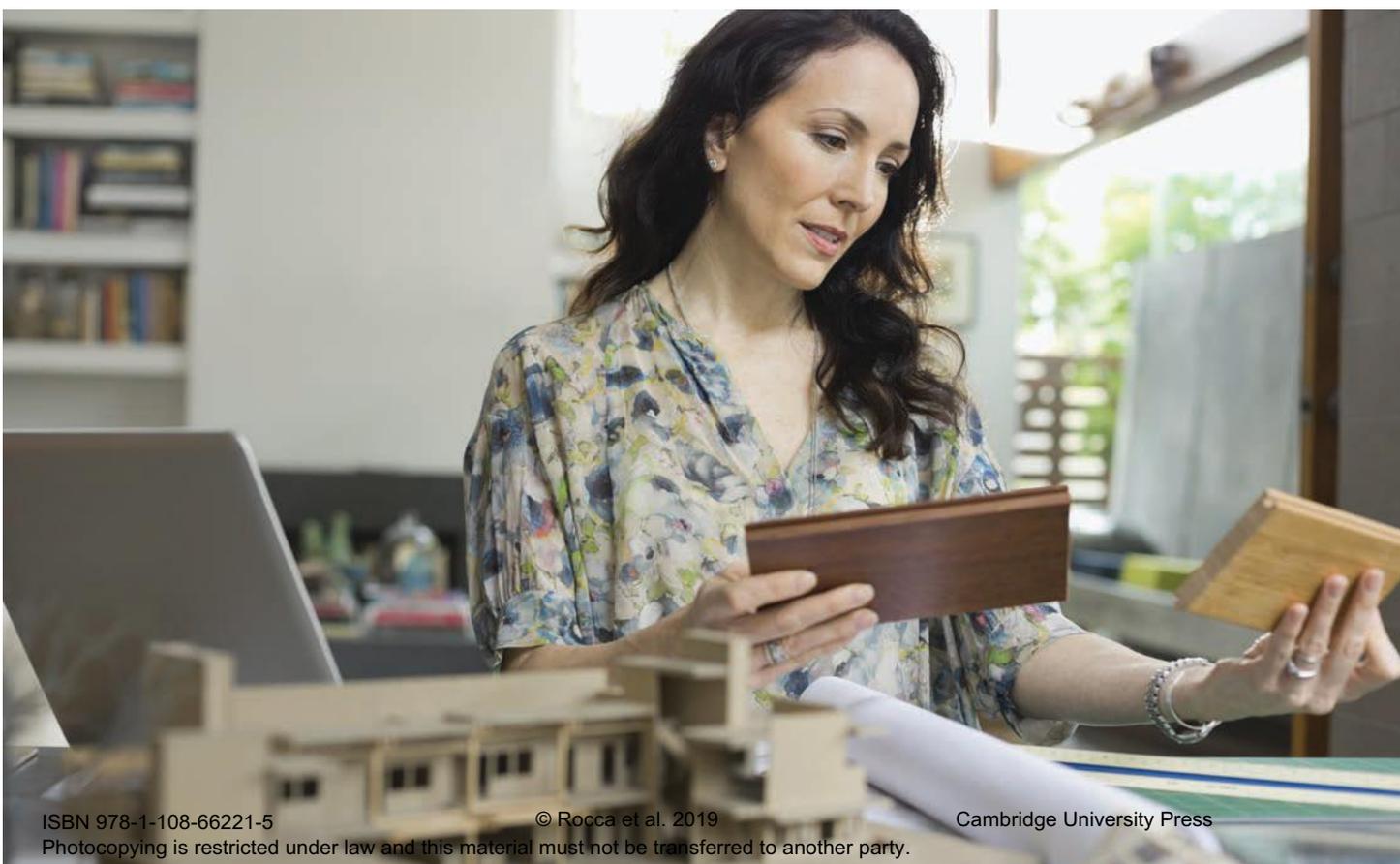
Before the creation of initial ideas can begin, a thorough understanding of these particular areas is required:

- Existing ideas: Inspiration can be found in how designers previously have attempted to produce solutions to similar problems, the materials used and the form the designs have taken. A plus, minus and interesting (PMI) chart is a cognitive organiser that can be used to help the designer identify the things they like and dislike in the existing designs and the interesting things that they would like to include in their own ideas. These inclusions can then be summarised in a mind map, for use when brainstorming and sketching the initial ideas in response to a design brief.

- The target market: For a design to be successful, it must not only address the needs identified in the design brief, but also appeal to the intended target market. Regardless of the size of the target market, if the design is not liked by those

it is designed for, it is not likely to succeed. Understanding what is needed and desired by the target market, such as colour, size and materials, can help ensure that your design is popular and a commercial success.

- Materials, processes and production: Understanding the materials available can be essential when it comes to some designs. Different materials possess different attributes, including how much they weigh, how they can be manipulated and their cost. For example, aluminium is used in the production of car bodies as it is strong and light. However, it is more expensive to purchase and requires specialised welding to join together. As a result, a car with an aluminium body may be lighter and more fuel-efficient but comes at a higher cost for manufacturing and sale.

Section 6.2 of this chapter looks at research in more detail.

Figure 6.4 A PMI chart

EXISTING IDEA	PLUS	MINUS	INTERESTING

Cognitive thinking tools

BRAINSTORMING AND MIND MAPS

The first step in creating a **designed solution** once a design brief has been analysed and investigated is to generate initial ideas. Whether working individually or as part of a team, putting these preliminary ideas down is a process called

brainstorming. Ideas are produced by the designer or design team after looking at their inspiration. Inspiration can come from the analysis of existing similar ideas, colours,

designed solution in Design and Technology, a product, service or environment that has been created for a specific purpose or intention as a result of design thinking, design processes and production processes
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Figure 6.5 Brainstorming sessions are a chance for people to generate and develop ideas.

shapes or styles provided by the client or from the design brief itself.

When brainstorming, there is no such thing as a bad idea. In the long term, some ideas may prove to be impractical or too expensive, but all good designers will consider every idea at this stage. You never know when a fanciful idea may lead you to the best idea!

Brainstorming can happen using traditional design tools, such as a pencil and a sketchbook or butcher's paper, with the designer's ideas taking the shape of written notes, dot points or simple sketches. It is often informal; however, a cognitive organiser such as a mind map can be used to give some organisation to the process. A mind map can group like-ideas into categories based on similar elements such as scale, materials or costs.

When the brainstorming process is exhausted and the design team have considered every idea they can think of, a process of review and analysis must be applied in order to determine which

ideas best address the design brief. This ongoing evaluation will provide the best way forward through the next phase of the idea-generation process. An effective way to document the analysis against the design brief is to use a green pencil to mark the ideas with potential and a red pencil to mark the ideas that at this stage seem impractical.

CONCEPT SKETCHES

Following on from brainstorming ideas for a solution to the given design brief, selected ideas can move forward to the concept sketching stage. Ideas can be explored further through the process of concept sketching. Concept sketches will be used to discuss the potential ideas with others, including experts in the use of materials and techniques and the client themselves. Designers will begin to include features of form and function and their ideas will begin to take shape, becoming more than just a simple sketch or collection of words from a sketchbook.

As a result, concept sketches will need to include enough detail to allow people other than the designer to gain an understanding of the features and purpose of the design. This should include the use of colour and **annotations** of the features, including proposed materials, finishes and functions. Should any of these be left off the concept sketches, there may be some lingering doubt in the mind of anyone other than the designer who is required to interpret the ideas. This is poor communication practice for any designer and could lead to client dissatisfaction.

annotations notes made on a drawing to describe particular points of interest

As with the initial ideas in the previous brainstorming phase, good concept sketches will include ongoing evaluation in the form of review and analysis provided by the designer against the design brief. This will discuss the suitability of each design concept to meet the needs identified from the design brief and rank the concepts in order of suitability, for presentation to the client or target market.

Models and prototypes

Following the evaluation of the concept sketches produced in response to the design brief, the designer, design team and/or client will decide upon the idea that will progress through to further development. Modelling is a very important tool for a designer and design teams to utilise to improve their understanding of the proposed design. Often designs on paper or screen are not enough to give a true idea of the scale, function and form of a design, and a model can help flesh these things out. In some design areas, working prototypes are also useful in demonstrating or testing the functionality that is envisaged for the final product.

Traditionally, some designers have used a range of craft techniques to produce physical models of designs to present to clients. These include automotive designers using clay to sculpt a full-size mock-up of a new car body for wind-tunnel testing, and architects using foam core board to build scale replicas of buildings to show their location on a

Figure 6.6 Models provide a good idea of the final scale, function and form of a design.

block of land prior to construction. The industrial designers at Dyson use cardboard to mock up vacuum cleaner designs as a quick, low-cost way of showing how a new model can be packed away and stored.

In more recent times, designers have been increasingly enlisting the power of computing to assist with the modelling of their designs, with numerous benefits. Computer-aided design (CAD) has given designers a range of new ways to test the suitability of potential designs prior to approval for production. Automotive designers can now 3D-model their car body and wind tunnel-test a design virtually, saving time, space and money compared with clay modelling. Manufacturing robot designers can use CAD to model a robotic arm and animate it to demonstrate how it will work to a client, testing its full range of motions. A bridge designer can use a CAD model to simulate a material's strengths and survivability while accurately estimating its cost before any physical materials have been touched.

As discussed in the previous chapter, an emerging modelling technology that has been embraced by designers is 3D printing. This gives designers the ability to take a computer-generated design from the screen and transform it into a tangible object. It allows for the physical testing of designs for size and function as well as creating a hands-on model with all the advantages of traditional modelling techniques. Unlike traditional methods, modifications can be made quickly to the CAD drawing and reprinted to test again, a process
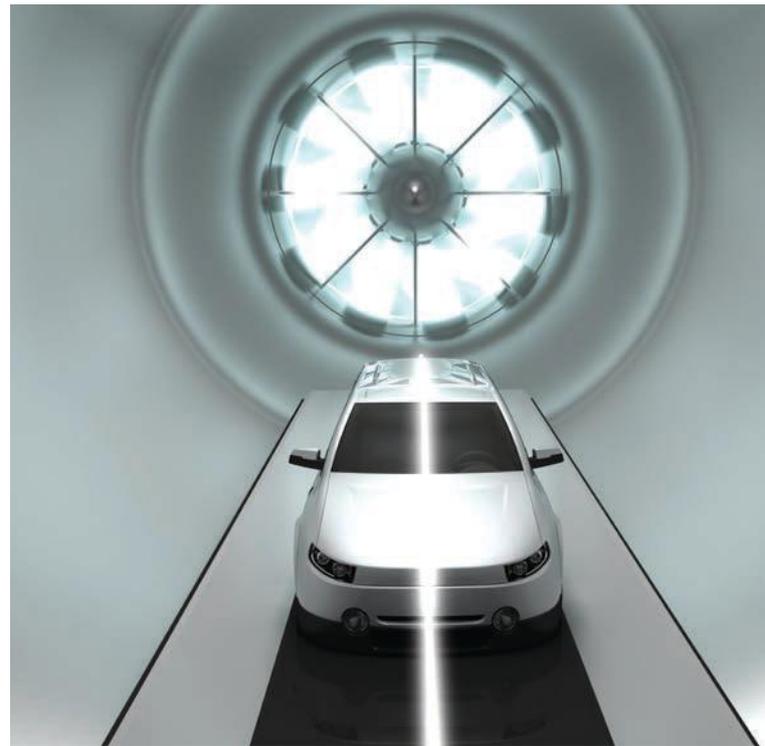
Figure 6.7 A 3D car is used to conduct a wind tunnel test.

that is very time-consuming when using handmade drawings and models.

While a model is typically static, a prototype demonstrates how some or all of the intended functionality works. A prototype may be fully formed, but made out of cheaper materials, or without the aesthetic elements of the final design. Prototypes are also an important part of designing digital products – partial versions of the software or websites that simulate just one element of the product, but which enable users and stakeholders to interact with it.

Observation

Observation is a tool often used by designers when seeking inspiration during the creative process. Designers will employ all senses in order to collect a range of data from the world around them. Primarily through the use of sight, designers will use the world around them to seek inspiration from or to gain a better understanding of the area or medium in which they will be working. Nature can provide much inspiration for designers. Whether it be the Australian bush to create a palette of

biomimicry an inspiration of functions found in nature for use and adaptation in the design of a product, service or environment or to solve human problems. For example, Velcro fastening was inspired by small hooks on the end of burr needles. Termite mounds that maintain a constant temperature through air vents inspired architects to design cooling for buildings.
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colour for homes to blend into their surroundings, or the trend of **biomimicry** where designers look to nature to find sustainable solutions to human-made problems, observation is a valuable tool for sourcing inspiration.

Figure 6.8 Colours from nature, such as the Far North Queensland countryside pictured here, can provide inspiration for nearby homes.

When researching, observation can often be overlooked as a valuable tool due to its passive nature. Watching people in busy areas such as a shopping centre or festival event can give a designer insight and data for a wide range of variables, such as the paths chosen for movement of people through an area, the ages of the target market and their preference in clothing styles and colours. Designers can target specific areas to observe, as identified in their design brief analysis, and produce

detailed results from the data. These data can be tabled and graphed, making it easy to refer to when creating and refining initial ideas. Designers may also choose to identify more general findings from their observations, writing detailed descriptions of what they have experienced during research that they can recount when the design work begins.

As valuable as observation may be to inspiration and research, it can also play an equally important role in further development of initial ideas when

experimenting and testing. Once ideas have been modelled in order to test ideas and concepts, designers may choose to field-test ideas in order to observe their functional performance or aesthetic appeal. When developing a new community garden, architects engaged by a local council may choose to produce a scale model of their proposed designs. Rather than actively survey or interview those who view the model, a researcher may step back and observe the reactions of those viewing it. This allows for raw reactions to the designs to be observed, rather than those made under the pressure of a face-to-face interview or survey.

Figure 6.9 Observing the practicalities required for a project, such as a community garden, helps designers in developing their ideas.

ACTIVITY 6.1

Education is evolving with new technology. However, traditional classrooms often struggle to keep up, and are still set up with tables in rows for taking notes from a board. The twenty-second-century classroom is a concept that features the latest in teaching technologies and tools at the centre of its design. In this activity, you will use design thinking to plan for a future classroom.

Figure 6.10 A twenty-second-century classroom will incorporate many advanced teaching aids.

1   Conduct a PMI analysis of your current classroom to determine its suitability as a twenty-second-century classroom. Record your results in a PMI chart (see Figure 6.4).
2   Define the target market for a twenty-second-century classroom, and construct a survey to determine the needs of this market for a modern learning space.
3   Brainstorm the requirements for a twenty-second-century classroom, identify its features and record your results in a mind map.

DESIGNING

Collaboration

Not all designing is done in isolation by individual designers. Often designers work together in

collaboration working together with others on a project for a common goal

teams in a process called **collaboration**. There are a range of benefits to collaborating when generating

ideas. When working by yourself, it is not uncommon to experience periods of 'designer's block', where you have exhausted your ideas but may not be satisfied with what you have produced. When collaborating, you have other people to assist with brainstorming, each bringing a different design perspective, range of skills and understanding to the process. This may include specialists in areas such as materials, processes and production, and the target market. Understandably, with this wide range of inputs into the creative process, a more comprehensive set of ideas can be produced in response to a design brief.

The introduction of computers and the internet to the work of designers has had an impact on how people collaborate. Traditionally, designers all had to be in the same room to be able to effectively

exchange ideas and develop design solutions. Telephones and email enabled designers separated by distance to be able to collaborate much faster than through post and fax, but time was still wasted waiting for replies from team members. Now technologies such as videoconferencing and collaborative documents or software allow people with an internet connection to meet, share ideas and produce results regardless of their varied locations.

Collaborating with others does by no means guarantee perfect results. A lot of management work has to take place to ensure that team members work together smoothly. Like a committee meeting, one person should be delegated the role of team leader, to keep the group on task. Without a leader, the team may lose sight of the goals and not use time efficiently. The leader's role is also important to manage personalities in a group; as with any group of people, some may not get along and it is important to ensure that the team can get the job done and not become distracted by personal issues between group members.

Figure 6.11 The team leader in a collaborative design process helps keep the focus on the task at hand.

CASE STUDY 6.1

Woolworths, Google Assistant and artificial intelligence

Artificial intelligence (AI), or machine intelligence, is the simulation of human intelligence by computers. This includes the ability of a computer to learn, reason and self-correct and AI is becoming common place in many internet-enabled devices such as mobile phones, tablets and smart televisions.

An example of AI is Google Assistant, which is a voice-activated software agent that responds to direct commands and attempts to predict a user's upcoming needs based on past actions. Constantly listening for the phrases 'Okay Google' and 'Hey Google', Google Assistant can respond in a two-way conversation, providing answers to questions using the Google internet search engine, or executing tasks such as sending an email or controlling a compatible internet-connected device.

Many organisations and businesses are taking advantage of the popularity of virtual assistants. In Australia, this has included Woolworths who have built the Google Assistant AI software into their own Woolworths Assistant app. This allows users to create and add to shopping lists using voice commands. This is very convenient when cooking, saving the time required to wash and dry hands to write something on a shopping list. To begin, users simply say 'Okay Google, speak to Woolies'. Users can add items, remove them and check all the items on the list.

The machine learning ability of Google Assistant means that the Woolworths Assistant app remembers the previous items that have been added to the list and determines the most popular items, brands and sizes and can add these popular items to the shopping list. It can also make suggestions for products based on the weekly specials. Shopping lists are then stored on the user's Woolworths account and can be accessed through the website and mobile app.

artificial intelligence (AI) a sub-field of computer science which aims to develop computers so that they can perform tasks that could previously only be done by people, such as speech recognition, decision-making, and learning

1   Collaborate with a partner to brainstorm a range of other tasks that could be completed by a virtual assistant. Begin by using an internet search to explore the existing tasks a virtual assistant can complete.

2   Select your best virtual assistant idea and consider the features it would have.

3   When complete, pitch your virtual assistant idea to your class.

Figure 6.12 Google produce a range of their own internet-connected speakers called Home, which work in conjunction with Google Assistant.

Figure 6.13 The Woolworths Assistant app stores shopping lists on the user's Woolworths account

Success criteria

Once a design brief has been analysed and the needs of the end user determined, the criteria for success must then be established. The purpose of this criteria is to help determine how well the proposed solution meets the needs of the end user. These criteria may be broad or narrow, for a range of reasons depending on factors such as the nature of the problem, time given to produce a solution and the needs of the end user.

While the criteria for success is developed to suit the nature of the design project, there are some key themes used to help determine overall success of any project:

- Function: ultimately a project must work effectively to be determined a success.
- Aesthetics: how good a project looks can affect how successful it is.
- Cost: if a project costs too much to make, it may be unaffordable for the end user.

- Safety: a project that is not safe to use cannot be declared a success.

Should some or all of the determined criteria not be met by the proposed design solution, the designer will need to return to a previous step of the design process and revisit some previous ideas. This process should continue until the design solution improves to the satisfaction of the end user.

Alternatively, the criteria for success can be ranked from most important to least important. Using this approach means that if criteria that are not that important are not achieved, overall the design can still be determined a success. Without ranking criteria, essentially it is expected that all criteria must be achieved for a design solution to be deemed successful.

Figure 6.14 Success criteria include whether the design can be safely used by the intended market.

6.2 **Research and exploration**

Following the analysis of the design brief, the designers will have a good understanding of what will be required to create a solution for their client. But how can the designer ensure that what they produce is appropriate? Will it be affordable to produce, will the target market like it, and is it better than current designs on the market? Designers can explore these questions and any unforeseen problems or possibilities through research.

You were introduced to research techniques in Chapter 2, and you will learn about them in more detail if you continue to study Design and Technology in Stage 6. In summary, research can be divided into two categories:

- Primary research: This is hands-on research where the designer collates their own data using tools such as surveys, questionnaires, observations and interviews.
- Secondary research: Here the designer gathers their data from theoretical research from other people's research findings from sources such as books, journals and the internet.

When conducting primary research, the data collected can be quantitative or qualitative, both of which are described in the following paragraphs.

- Quantitative research is a scientific form of research. It may use a hypothesis for which the designer is attempting to prove or disprove a theory. Results are often numerical in form and can easily be analysed in tables or graphs. An example would be a survey used by a designer to determine a target market's favourite colour for a hat from five set choices. This form is most practical when researching large target markets.
- Qualitative research gives descriptive results, often based on the opinions and emotions of individuals. While results cannot easily be interpreted like data in a graph, these descriptive results can produce more detailed findings than quantitative research. An example would be an interview of students trying to establish the style of clothing a new school uniform should feature. This method is most useful when designing for a client to determine their individual needs.

The Interactive Textbook has an activity to help you recall the difference between quantitative and qualitative research.

GO

Information and data

ACCESSING INFORMATION AND DATA

Technology has had an impact on all aspects of our lives, and for designers looking to research it is no different. Notably the internet has revolutionised the way we research, due to the ease with which we can find the information we need quickly and effortlessly compared with visiting a library to physically search through books or journals. When accessing data, the internet is very useful for designers to conduct a preliminary search, with more traditional media used when a further in-depth search is required.

Internet research is a very quick and easy way to find information for design tasks, although it may not be as straightforward as it first appears. As researchers, we need to use our judgement when considering information from websites. Unlike a book or journal that undergo a validation process, many websites are published without any fact checking or an editorial process. As a result, we need to determine how valid and reliable the information is that we are reading. Wikipedia is an interesting example of this, as anyone can manipulate the information on a Wikipedia page. It uses a process of **peer review** where other readers report inaccuracies in the information given, but this can take some time. When researching, don't take any website information as fact. Cross-check it against other websites to ensure that the information is valid. Use Australian websites (.au) where possible and look for reliable sources of information, such as government websites (.gov) and those of educational institutions (.edu).

peer review an evaluation of your work by others in the same field

Figure 6.15 Magazines are a valuable resource for showing trends in colours and styles.

While print research may not be as convenient as using the internet with a mobile device, print media do have benefits for researching for design.

Journals, magazines and books all go through a rigorous process of review and validation prior to going to print. Once these media have been printed, it is very difficult and expensive to recall and reprint corrections, unlike information presented on the internet. Because of this, we can consider the information printed in journals, magazines and books to be reliable and can use it with confidence. Journals are the main form of publication for the work of academics and researchers, and a good source of information for cutting-edge research findings. Magazines are very valuable for determining trends in popular colours and styles in design. Books generally contain a greater level of detail on their topics than other forms of publication, and are often better illustrated.

IDENTIFYING AND SUMMARISING INFORMATION AND DATA

Successful designers are guided from brief to solution via the design process, a structure that leads them to the best possible outcome. When researching, it is important to apply a similar organised approach to ensure that no details are left out or forgotten, which can easily happen when dealing with large amounts of information. It is important to set up a system that suits the way we work as individuals, to ensure we can identify and summarise the information as efficiently as possible. This will include the type of data collected (quantitative or qualitative), the source (primary or secondary) and the method used to collect the data. The researcher must also consider the most appropriate method of research, taking into consideration people's rights to privacy.

When conducting quantitative research, researchers will need to identify what data they are hoping to gather. Regardless of whether a survey, interview or observation is being used to conduct the research, a table will likely be the most efficient method of summarising results from a predetermined set of variables; for example, the most popular car colours in NSW. A table can quickly allow raw data to be entered and can even give a tally summarising results without any other input.

Figure 6.16 Information and data can be collated into a spreadsheet to be turned into graphs and diagrams later on.

As with quantitative research, when conducting qualitative research, the researcher must identify the data to be targeted. Qualitative research does not give pre-prepared variables for which one option is chosen; rather, the respondent can give their own interpretation for an answer. Due to the nature of its descriptive and more detailed results, it can take longer to prepare, gather and interpret results; for example, favourite weekend pastimes in NSW. The researcher must take the time to read back through all of the results obtained and, from these, draw their own conclusions. These summaries can then be referenced once creative design work begins.

INTERPRETING AND MANIPULATING DATA

Data on its own will not tell you how to proceed with your design. Having summarised it, you need to interpret it to actually understand what the data is telling you about your research area.

If you have entered your data into a spreadsheet, you can quickly turn it into a graph. This is a visual summary of results, which can be more easily interpreted than rows of numbers, and which you can refer to later when conducting design work.

Data can also be manipulated. You can sort it in different ways, and create subsets of data. Activity 6.2 gives you an opportunity to do this.

ACTIVITY 6.2

When collating data, the use of a spreadsheet table is the most effective method of gathering results.

1   Using a spreadsheet, create a table that can collate the following data:
    - first name
    - shoe size
    - current shoe colour
    - preferred shoe colour.
2   Collect this data by surveying your class. As all good researchers do, ensure you have the respondent's permission to record the data. Once the data is entered in a spreadsheet, experiment with manipulating the data:
    a   Sort the list from largest shoe size to smallest
    b   Create a bar graph of the class shoe sizes
    c   Generate a pie graph of the preferred shoe colours.
3   Identify the type of data generated in this task, and the category of research that has just been conducted.
4   Discuss which of the two types of data this research activity would be best suited to, and how you could better prepare to conduct this task.

DESIGNING

Researching appropriate materials, processes and production methods

To ensure success in their final design, any designer must not only have a sound knowledge and understanding of the materials suggested for use, but also the processes and techniques required for production with these materials. Should a designer not consider these factors during the idea-generation process, it may make their design expensive, excluding it from some segments of their proposed markets.

An example of this could be a child's bicycle. A designer's choice of aluminium may be a desirable material due to its high strength-to-weight ratio. However, its higher production cost and specialised welding needs when compared with steel may lead to a higher cost per bicycle. While some consumers will see the value in a lightweight frame and be prepared to pay more for a child's bicycle, many

in the target market may prefer a less expensive option as their child will quickly grow out of it. Knowing about the higher material and production costs of aluminium as a result of research means the designer can make an appropriate choice of materials when developing their design for the specified target market.

Designers also need to be aware of external factors that may be imposed upon their work. This may include laws and legislation; for example, workplace health and safety legislation. Designers need to ensure that what they specify in a solution to a design brief will not cause any foreseeable harm to the user. Another factor that designers will need to consider is Australian Standards. These are regulations that are developed by the government to ensure that what is being made and sold in

Figure 6.17 Consumer needs and material costs need to be considered when designing products.

Figure 6.18 Designers must be aware of government regulations and Australian Standards such as those that aim to minimise pollution created by vehicle emissions.

Australia meets certain levels of quality. Australian Standards are available for a range of products, from minimising pollution created by vehicle emissions to setting the level of safety for bicycle helmets. Prior to beginning the idea-generation process, designers need to ensure that any final designs they propose will at least meet, if not exceed, the minimal level set out in any relevant Australian Standards.

It is very difficult for a designer to be a specialist in all of the wide range of materials and process and production methods that are now available. While a designer may have an intimate knowledge of one or two materials from previous experience, designers can use research to develop their understanding of new materials and their requirements. Following initial internet and further print research of a proposed material, the designer can make contact with materials experts in order to discuss the details of how they wish to use the material and estimate costs. This research can take place informally through phone conversations and teleconferences, or through more formal means such as minuted meetings or emailed quotations. Including such expert knowledge in their design work can help designers ensure the success of a designed solution.

Impact of design projects

As designers, we need to be aware of the social, financial and environmental impact of our projects. This involves both the design process, and the impact of the finished product.

Questions to be considered can include:

- How much will it cost to develop the project, and (if appropriate) can it be scaled to larger production runs?
- Can sustainable resources be used, and what are the cost implications of this?
- How much waste and pollution will the production process create?
- What environmental impact will the finished product have?
- Will the product benefit society?

ACTIVITY 6.3

3D printing is a popular technology being employed by designers when prototyping their latest work.

1 Using the internet, research the two most popular 3D printing plastics, ABS and PLA. Identify their full names and describe their characteristics.
2 Use the internet to find a supplier of 3D printing materials and determine the cost of each of these plastics per kilogram. This may be listed on their website, or you may need to contact them. If you make contact, ensure you explain you are a student conducting research for an assignment.
3 Imagine a project for which you would use 3D printing, and write a report, explaining, with reasons, which plastic you would use for it.
4 Discuss the social, financial and/or environmental impact of using 3D printing for this project, rather than a traditional technology.

COMMUNICATING

Figure 6.19 Research 3D printing plastics

6.3 Enterprising activity

As design work is often tasked with creating something new or reimagining existing things, it can often take significant effort to get the new design to market, despite how good the design is or even how large the obvious need. This may be a result of the inclusion of new technology, a new style or even a new way of doing something, and with this can come the need for change. Change can be a challenging prospect for many people and as a result, to overcome resistance to change, the designer must not only possess skills as a creative thinker, but must also be an enterprising one. This resistance to change can come from clients, retailers and, ultimately, the consumers themselves. Taking the time to develop trust in a relationship between designer and client is an important tool when overcoming resistance to change that can arise from new ideas.

Enterprising activity is a term that is used in the business world to describe a project being undertaken that comes with some difficulty and requires boldness and energy to overcome.

Designers see this difficulty as just another problem to solve, much like a problem presented in a design brief. Characteristics such as the ability to be innovative, to think creatively, to take risks and to have confidence in their decision making in the development of design solutions are all enterprising skills that a designer can apply to make their work a commercial success.

Scale can have an effect on the ability of designers to conduct their own enterprising activity. The smaller the venture, the easier and less expensive the costs will be to get the design to market. As the scale of a project increases, so do the risks associated with it. Financial risk can be the main concern for many designers, as they are able to come up with great ideas but cannot afford to take the ideas to market. Some will even quit their jobs to focus on the development of their designs. This is where the **entrepreneur** plays a role in enterprising activity.

entrepreneur a person who sets up and manages new commercial enterprises to make a profit

Figure 6.20 Developing trust with the client is an important tool when overcoming resistance to change.

To take control of risks, the designer utilises their well-developed project management strategies. This includes using tools such as a Gantt chart to establish the project actions and anticipated time they will need to deliver a design by a required deadline, and a finance plan with a budget to ensure that their designs are at or under cost.

Just as a designer is an expert in using creativity to problem-solve, an entrepreneur is an expert in using initiative to manage risk in an enterprise.

They may handle the financial risk through backing a designer's work with their own funds, or promote the work to those with other sources of financing, such as government innovation grants or private investors. Entrepreneurs use their business knowledge and skills to take the burden of risk off the designer so that they can focus on the design development work needed to complete the project.

The practical activity at the end of this chapter will give you an opportunity to practise managing the development of an innovative product.

ACTIVITY 6.4

1   Define enterprising activity.
2   Identify project management strategies used by successful designers.
3   Describe the reasons why enterprising activity is important to the work of designers.
4   Explain why a positive relationship between designer and client is important.
5   Contrast the work of an entrepreneur with that of a designer.

COMMUNICATING

Figure 6.21 Entrepreneurs can take care of the business side of a venture, allowing a designer to focus on their projects.

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CASE STUDY 6.2

SongPop and Google Assistant

French entrepreneur Mathieu Nouzareth and his brother Romain began developing Facebook games in 2009, moving onto mobile apps in 2012. They are best known for the hit music trivia game SongPop. It was downloaded 100 million times to 2015 and was rated by Facebook founder, Mark Zuckerburg, as one of his favourite Facebook games.

True to the philosophy of entrepreneurs identifying new opportunities in existing markets, Mathieu saw the impact that voice-controlled virtual assistants were having on the way we use technology and realised how important this would be in the future. He saw that a conversational interface would work well with SongPop and open it up to new markets on emerging devices such as Google Home.

In 2016, Mathieu's company FreshPlanet began work on a version of SongPop for Google Home that utilised the Google Assistant software. When Google Assistant became available on mobile devices, a mobile app version of SongPop was also created. Each version was optimised for the technology that it was available on, with a voice-controlled game requiring a very different interface than that of a touch screen mobile device. FreshPlanet even included unique genres of music for each, based on the way users were playing the game. Trial and error played a big role in perfecting the two versions of the game for both Google Home and mobile devices.

FreshPlanet have gained new players every day since the launch of the Google Home version of SongPop and have been surprised by the number of people requesting to use the voice-controlled action. They continue to evolve SongPop to take advantage of changes and additions made to the Google Assistant service to keep the game engaging for its users.

1   Identify ways in which Mathieu and Romain demonstrated enterprising activity.
2   Research the current status of SongPop. Have Matheiu and Romain moved on to create new products?

Figure 6.22 SongPop users listen to a song and try to identify it. If they are using a smartphone, they select from a list of four answers, but on Google Home they are asked to say the name of the title or artist.

CHAPTER SUMMARY

- Creative design solutions are most effective when the process is informed by appropriate research and investigation of the target market, materials, processes and production methods.
- When working in isolation or in a design team, brainstorming is the first step in creating ideas and the results are best recorded in a mind map.
- Concept sketches are used by designers to give form and aesthetics to initial design ideas.
- Computer-aided design (CAD) and technologies such as 3D printing are used by designers for prototyping and modelling.

- Observations are a non-invasive way to investigate target markets, proposed designs and the way they interact with the world around them.
- Through collaboration, designers work together to widen their range of skills, knowledge and experiences to produce better solutions to design briefs.
- Research can come from primary or secondary sources.
- Data produced from research can be quantitative or qualitative.
- Enterprising activity is required to take a design from concept to market.
- Entrepreneurs are risk-takers with business and marketing skills who conduct enterprising activity on behalf of designers.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1 Brainstorming
2 Collaboration
3 Data
4 Enterprising activity
5 Entrepreneur
6 Information
7 Innovation
8 Research
9 Stakeholders
10 Target market

REVIEW TASKS

1 List the different forms of research that designers may use to inform their work.
2 Describe the results of a brainstorming activity you have recently undertaken when working on a design brief.
3 Discuss the advantages of collaborating when designing.
4 Describe an enterprising activity that a designer may undertake when promoting their work.
5 Entrepreneurs may have a different skill set to designers. Identify the skills unique to entrepreneurs.

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6 Describe the advantages of using CAD when developing ideas into a design solution.

7 Identify different types of data that may be produced during research. Give some reasons why specific data choices are necessary.

8 Compare the differences between primary and secondary sources of information.

9 Identify an innovation and justify why you have classified it as innovative.

10 What is a target market? Describe the importance of addressing the needs and wants of a target market to the success of design work.

EXTENSION TASKS

1 Identify a design from an industry you are interested in. Propose the research methods that the designers may have applied before creating their initial ideas and justify the selection of each.

2 Construct a process of creative techniques that may have been used to develop your selected design. Describe how each technique could be used in your own design work.

PRACTICAL TASK

Produce an innovative product using the following steps.

Working in a design team, you are to identify two simple items that can be combined into one item and create a working prototype of it. An existing example is a mobile phone case that has a space for storing credit and debit cards.

You must follow the design process to design, construct, test and evaluate your item, and document it in a design portfolio.

Key portfolio items should include:
- A mind map that shows your creative design idea generation.
- A sketch of what the initial idea would look like.
- A graphed result of a survey of a possible target market that shows the idea has potential.
- A sketch of the evidence of the testing of a prototype and a written evaluation including strengths, weaknesses and possible improvements.

7 Appropriate communication techniques
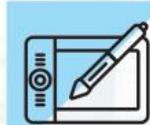
KEY TERMINOLOGY

- Communication
- Computer-aided design (CAD)
- Design portfolio
- Documentation
- Information and communication technologies (ICT)

- Marketing
- Prototype
- Sketches
- Stakeholder
- Target audience

This chapter explores methods that designers can use to communicate their design process and solutions to different audiences, including other designers and clients. It looks at range of communication methods that can convey different information in different ways, such as visual, written oral and digital. This includes the development of a marketing strategy. It also considers the areas in which ICT tools can benefit designers.

This chapter addresses **Outcome DT5-7** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the content area **Communication and presentation techniques**.

7.1 Communicating research findings and design ideas

The ability to convey ideas to clients, manufacturers and target markets is core to the success of any designer. Poor communication can lead to a client selecting a competitor over you for a project, or a manufacturer producing a product not to your specifications. Both of these scenarios can lead to wasted time and lost income for a designer. Good communication is as important as good design, with the appropriate selection and use of communication and presentation techniques playing an essential role in getting your message across to key **stakeholders**. For designers, communication occurs across a range of media, and includes documentation and presentation.

The documentation of work completed during a development process is important for all designers, and this commonly takes place in a **design portfolio**. A design portfolio, or folio, recounts the steps taken as a designer produces a solution to a design brief. This moves from identifying and analysing the need through to the final evaluation,

and is used for personal use or to communicate with other designers. It allows a designer to return to any stage of their design process, review what took place and make any changes or modifications quickly and easily as a result of final or ongoing evaluations. When collaborating with other designers as part of a team, it can enable each person to know what the other designers have been working on, ensuring that stages are not duplicated or left out.

Presentations are required when design ideas need to be communicated to clients, manufacturers and target markets. As these groups may not be familiar with the forms of communication techniques that designers use, it is important to make sure that appropriate methods are used. This may include using different language that is not as technical, clear labelling of diagrams to ensure understanding and more illustrations than text. While a folio is a very useful medium for presenting design ideas to stakeholders, designers may also need to consider more engaging ways to present their design solutions. This may include multimedia options such as projected slide shows, computer animations and 3D simulations. Even physical prototypes can be a valuable resource. Considering the negative impact that miscommunication can have on the success of design work, the importance of effective communication is critical.

Designers have a range of tools at their disposal, each able to deliver specific information to a target audience in their own way. These can be used in portfolios or presentations, and designers must be selective in their choice as well as their application of the following communication and presentation techniques.

stakeholder someone who has an interest in something through time, money and/or energy and will gain from the final design

design portfolio a document used to record the design process used when producing a solution to a design brief

Figure 7.1 A design portfolio showcases the work done to understand a brief.

Visual and graphical

A popular saying is 'a picture paints a thousand words', and this rings true in the world of design. The ability to explain thoughts and ideas quickly and easily to people is the main reason designers see so much value in visual and graphical communication techniques. Regardless of your target audience, large passages of text can be off-putting, no matter what measures have been put in place to make it easier to read.

DRAWINGS AND PROJECTIONS

There are a number of different methods of presenting visual representations of your design. You will probably need to use more than one of these methods throughout the different stages of the project, depending on what aspect it is you want to represent. Some of these methods are outlined below.

- **Sketching** is a simple form of communication. **Concept sketches** are hand-drawn quickly using graphite (lead) pencils during brainstorming sessions to record initial design ideas. Whether in two or three dimensions, sketches are very effective when working with others to ensure mutual understanding

concept sketches the first ideas produced when using a design process to develop a solution to a design brief

of function and aesthetics. These rudimentary sketches can evolve into renderings through the addition of colour and shading. This helps the designer to develop the aesthetics further as the final design idea begins to take shape.

- **Orthogonal projections** are technical-style drawings that are to scale and allow the designer to share important information such as dimensional and material information. When drawn in third-angle projection, orthogonal drawings illustrate a front view of a project, aligned to top, right and/or left side views. Often referred to as plans or workshop drawings, orthogonal projections are used for final design drawings of products, ready to be passed onto manufacturers to produce a prototype or production model of a designed product. Orthogonal projections can be hand-drawn or computer-generated.

Figure 7.2 Concept sketches can be made during brainstorming sessions.
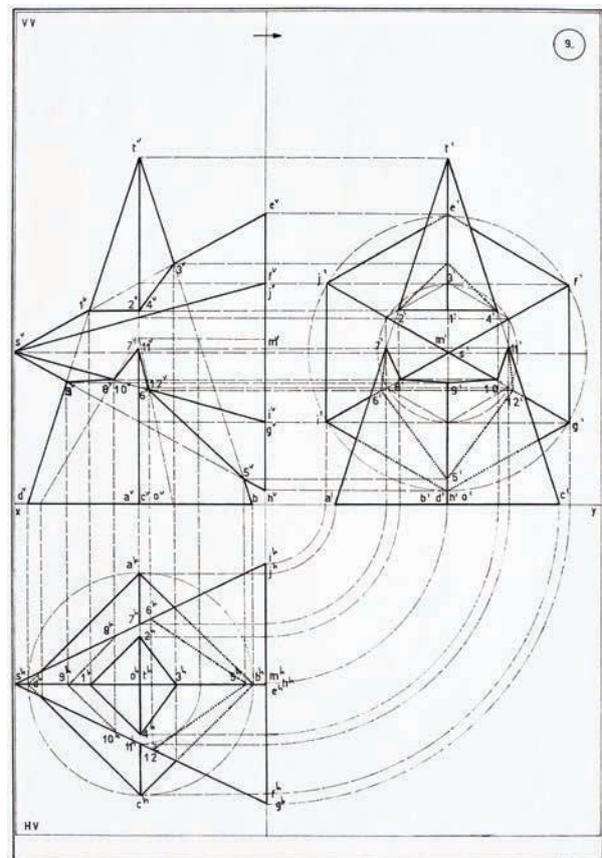
Figure 7.3 Orthogonal projections are technical-style drawings to scale.

- **Isometric projections** are three-dimensional illustrations drawn to scale and are complementary to orthogonal drawings, giving an angular view of the product that includes the front, top and right or left side views. Unlike an orthogonal drawing, an isometric view gives a more complete idea of the design, sacrificing some of the technical information being presented in the process. As a result, orthogonal and isometric drawings are often presented together so that the designer can give the intended audience as much information as possible. Isometric drawings are produced by hand, with most computer-aided design (CAD) drawing packages able to easily produce an isometric view.

- **Perspective projection** is a three-dimensional drawing where each horizontal line is projected back to a vanishing point on a horizon. This form of drawing is useful for giving an impression of a design in use, such as a house sitting on a street, where technical information is not important.

Figure 7.6 Perspective projection of a cube: front view is straight, and lines project back to a vanishing point

Figure 7.4 Isometric projection of a cube: front, top and one side all shown in an angular view

- **Oblique projection** is a simpler form of three-dimensional drawing than isometric. An orthogonal front view is given with a side and top view projected at 45 degrees. It is used to produce quick three-dimensional views where scale is not as important.

LOGOS AND ICONS

It is not always a design that is being communicated through visual and graphical means; other information of importance can also benefit from a wordless approach. This is very valuable for designers when their work needs to be interpreted by users speaking different languages or with varying levels of literacy.

Logos are used to communicate a company or product branding easily. Most successful logos are recognisable without the use of any text at all.

Symbols can be used like a logo to communicate general information. The red no-smoking sign is a great example of an easily recognisable symbol. Keys on a map are another example of an application of graphic symbols.

Figure 7.5 Oblique projection of a cube: front view is straight, and top and side at an angle

Figure 7.7 A logo without text that still manages to convey a concept is an effective method of communication.

VISUAL REPRESENTATION OF DATA

Data normally consists of large amounts of numbers, which it can be very difficult to grasp unless they are presented in a meaningful way. Presenting data using the following means can make it much more digestible and impactful.

Gantt chart a detailed grid that displays the tasks to be undertaken and time allocated, and maps these on a specified timeline

- Presenting data in spreadsheets allows it to be summarised, grouped and sorted in a manner that helps get the key points across.
- Charts and graphs are used to present results from research quickly and easily for those needing to interpret them.
- Charts are not only useful for showing research data. **Gantt charts** are a visual way of presenting action and time plans when managing a project.

Figure 7.8 Gantt charts are used to help manage a project by visually presenting the various actions and time plans.
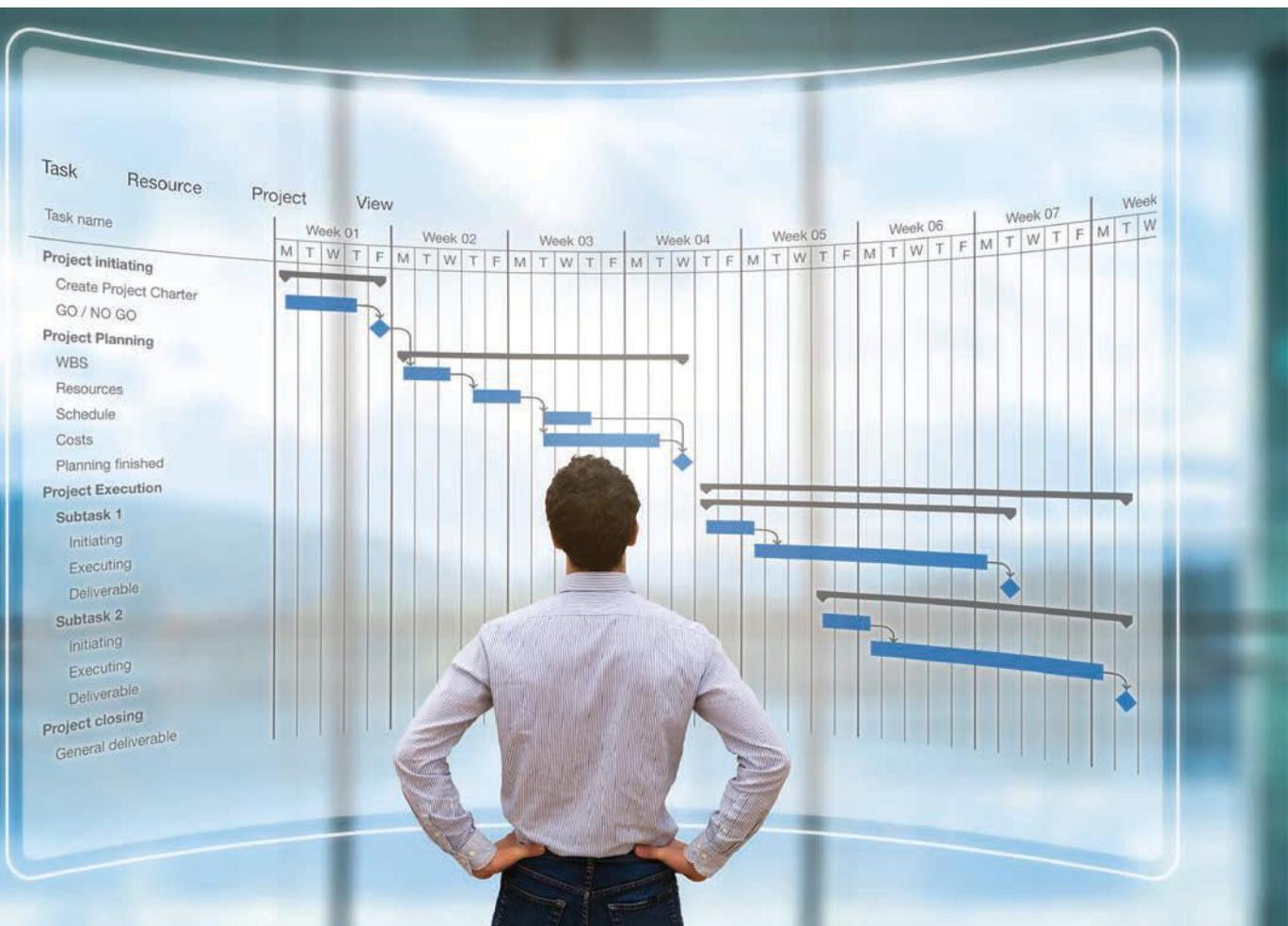
MODELS AND PROTOTYPES

Sometimes a designer will need to illustrate the form of a design, and presenting it on a page or a screen does not do it justice. As you saw in Chapter 6, simple models made from cardboard or clay through to complex 3D-printed prototypes are all valuable, as they are tactile as well as visual. They can be picked up, handled and tested for size, shape and function.

Written

Despite the value of visual communication forms to designers, there is still an important role for written communication.

Design portfolios are an important medium for project management, thus are used by all good designers around the world to document their progress through the design process. Primarily used to communicate design work to other designers, the design portfolio is an important record of the work done while producing a solution to a design brief. Vital information documented in a design portfolio includes:

- the design brief – the goal for the design work and the wishes of the client
- action and time planning – the steps that need to be taken to complete the design work and the time required to do so
- research results – the findings of investigations that will inform the idea-generation and refinement process
- ideas development – while sketching is a visual medium, annotations explaining the features of the ideas and ongoing evaluations of this work will be in written form
- evaluations – periodic review of the progress and a final summary of the level of success achieved in meeting the design brief.

Instructions may need to be given for how a new design is to be used. Illustrations may be able to provide good step-by-step instructions, but further details or advice may need to be included to ensure that nothing goes wrong for the user. Descriptions can be written to give a greater level of detail when a more formal format is required for the target audience. This can be seen in instructions supplied with products manufactured for sale in world markets, with the written information reproduced in different languages, to reinforce any illustrated steps and to ensure that the correct message has been communicated.

Specifications for designs, whether from a client or given to a manufacturer from a designer, are another example of written communication. While they may be supported with a diagram, these are documented in text so that there is a concrete understanding between parties to ensure that what is delivered is what was requested. Materials and cutting lists are given in written form for this reason.

Written communication is important not just for design work, but also for entrepreneurial work. Designers working on a small scale developing their own ideas may not have the capital to bring their work to market. They may apply for funding from government agencies or private funding sources, and the ability to share their ideas and vision succinctly but with all relevant detail included will require effective writing skills.

Oral

Spoken forms of communication are essential when designing. The ability to hold a conversation is a crucial social skill required by designers. Oral communication may be used to:

- discuss the parameters of a design brief with a client
- conduct a survey with a focus group or interview an individual from a target market
- speak with a supplier of a proposed material
- brainstorm ideas collaboratively with a design team.

The ability to select and use the correct oral communication techniques appropriately is an advantage for those wishing to be successful designers. Knowing what questions to ask is just as important as being able to ask them. The right questions will produce the desired answers; not asking the right questions may mean that you do not have the information you need to proceed with a complete design solution.

Where oral communication comes into its own is when making presentations. It is the spoken word of the designer that makes links between the visual, written and digital forms of communication. These are all effective methods of sharing ideas and information with a target audience; however, it is the ability of a designer to give different interpretations of the same information when presenting that ensures that true understanding occurs. Designers can use their skill in oration to engage a target audience and persuade them that their proposed design is the best, using a tone of voice that is reassuring during a time of decision making. These are important skills when the success of a design career or business depends on it. This is why special presentation events are able to help launch new products to market, especially in the technology sector in recent times. Steve Jobs was well known for his talent for public speaking when unveiling new products during Apple presentations.

Figure 7.9 Steve Jobs, the late founder and former CEO of Apple, was well known for his presentation skills when launching the company's new products.
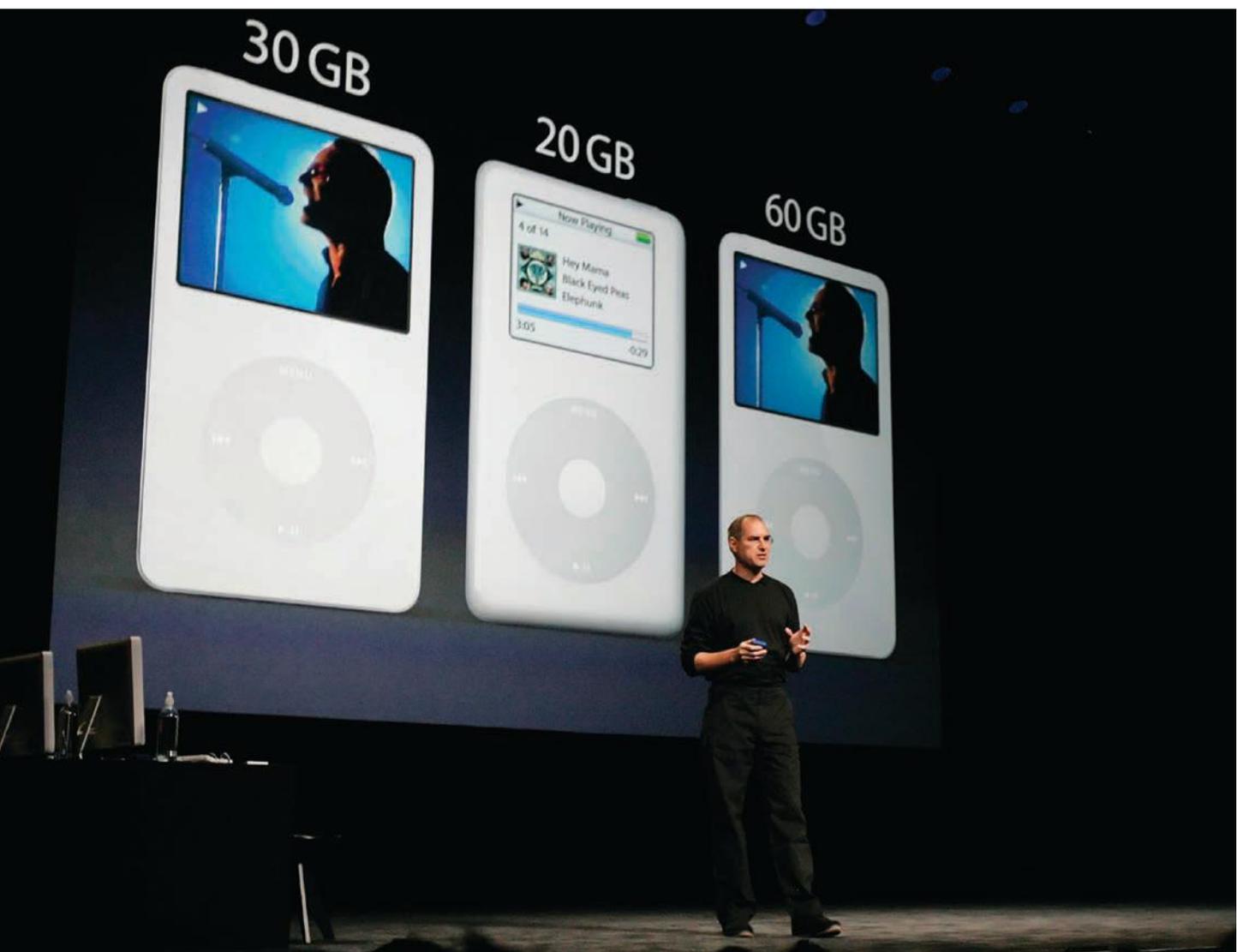
Digital

Recent times have seen great advances in the ways we can communicate using digital technologies. With computers, the internet, mobile devices and **social media**, designers now have a more comprehensive set of tools to communicate and present their work than just the traditional visual, written and oral techniques.

Design portfolio work has become easier for designers thanks to advances in technology. Written work can now be drafted electronically on a computer or mobile device, typed or converted to text using voice-recognition software. Changes can be made easily, spelling and grammatical errors quickly identified and documents stored in the cloud for access anywhere the internet is available. This allows for flexible, efficient and more professional looking written work. Multimedia content can also be included in preference to still photography.

Digital content, such as photos, video and CAD, gives great flexibility to designers. Videos and animations can, in a short amount of time, communicate what may take several pages of written instructions and step-by-step illustrations. Once created, they can quickly and easily be added to portfolios, presentations and websites. They can be updated and changed quickly without having to start from scratch, freeing up time for designers to spend on designing.

social media websites and applications that allow users to create and share content through social networks

Social media has revolutionised the ways we produce and share content. Unlike email, which is a one-to-one form of communication, social media is one-to-many. It is a quick and easy way to promote design work, seek feedback from a target audience and launch a new product or service. Social media allows users to share whatever information they wish to communicate, as though it is being communicated by them, giving a whole new dimension to the way in which target audiences receive information. Facebook, Instagram and Twitter are three of the most popular forms of social media.

ACTIVITY 7.1

1 Outline the following communication techniques and identify a possible target audience for each:
   a design portfolio
   b multimedia presentation
   c concept sketch
   d orthogonal drawing
   e isometric drawing
   f CAD
   g Gantt chart
   h prototype.
2 CAD is a powerful digital communication tool that designers can use to model their ideas and share their design's technical information with others, including manufacturers. Using the internet, research three different forms of CAD software and compare them using a plus, minus and interesting (PMI) chart. Make sure you include at least one software package used for 3D modelling and one used for architectural design.

COMMUNICATING

CASE STUDY 7.1

Communicating the Dyson design process

Figure 7.10 The 1986 Dyson G-force vacuum cleaner

The idea for Dyson, the company best known for its development of industry-leading vacuum cleaners, was sparked in 1978 when James Dyson became frustrated with his own vacuum cleaner and its loss of performance during use. Inspired by his earlier creation of a cyclone tower to separate paint particles from air, he decided to apply this technology to household vacuum cleaners. Five years and 5127 prototypes later, his design developed to become the best vacuum cleaner available on the market. His ability to develop these ideas and communicate them effectively to others has played a vital role in the growth and success of his business.

When Dyson identified the problem that previous designs of bathroom hand dryers left your hands still damp and able to spread bacteria and viruses, his organisation applied its design process and knowledge from vacuum cleaner development to produce a solution, the Airblade. As Dyson moved through this process, it communicated its work using a range of appropriate communication techniques (see Figure 7.10).

At Dyson, initially pencil hand sketching and colour renderings are used to record the ideas created during the brainstorming process. At this stage there is not a fully formed idea for aesthetics or function. Sketching is used as it is a quicker and more descriptive communication technique during this stage. These early ideas in the case of the Airblade were based on research of existing hand dryers and the knowledge of the company's air filtration and air suction technology. Designers working in collaboration can evaluate each other's work against the requirements of the design brief and work towards a possible solution, using annotations to record finer details of each design.

Modelling is a large part of product development at Dyson, as it allows the designers to share the physical details of their ideas in the form of a tangible object. Cardboard models are used as a quick and inexpensive way to communicate the size and shape of ideas with others working on the new project, along with testing these elements of the designs.

With a suitable design settled upon, it is then refined using CAD drawings. These communicate the technical information of the designed solution to the manufacturing division of the Dyson company. The modelling process continues with 3D modelling used to virtually test the function of the design, and the specified materials to be used. A 3D-printed model is then created using a process called selective laser sintering (SLS), a high-quality 3D printing process. These prototypes can then be tested, refined and proven before the CAD drawings are finalised and used to manufacture the final Airblade product.

A proven product design process, based on the appropriate use of communication techniques, has been applied again and again by Dyson and his team of designers. Since the success of the Airblade, they have gone on to refine this product further and to incorporate their hand drying innovations into a wash basin tap, the Airblade Wash+Dry, which saves the need for separate tapware and hand dryers, allowing more space in the bathroom. Further development of the Airblade concept has seen the development of the Airblade V, which dries hands in 12 seconds while being up to 35% quieter.

Figure 7.11 The design process of the Dyson Airblade hand dryer. A high resolution version of this image is available in the Interactive Textbook.

1 Using this example of the use of communication techniques, evaluate the use of sketching and modelling by Dyson in the development of its product design ideas.

2 Sketching and modelling are just two examples of methods that designers can use to communicate their design ideas to others. Propose another technique that the team at Dyson could use. Justify your selection.

7.2 **Marketing strategies**

To ensure the success of their design ideas, a designer must not only be a creative thinker but also think like an entrepreneur. A design is only truly successful if it is being taken up by customers in its intended market, and unless they are aware of its existence it is difficult for this to occur. This is where marketing comes in. Marketing is the process of using research and advertising to promote products and services. This can be undertaken by the designer or by an entrepreneur on the designer's behalf.

A popular tool for determining a marketing strategy is known as the 4Ps of marketing: Product, Place, Price and Promotion. This has now been extended to the 7Ps to include, People, Processes and Physical Evidence. However, we will focus on the 4Ps in this discussion. Also known as the marketing mix, the four variables are blended together to ensure that the desired result is achieved when connecting with the desired target market. The 4Ps are explained in more detail below.

- Product: When marketing a design, the designer must consider its quality, features, packaging and any customer support that will be provided. Does it look like something that a potential consumer would like to own?
- Place: Can the design easily be transported and distributed? Consideration needs to be made regarding where it can be accessed by the potential consumers.
- Price: How much will the design need to sell for to cover costs of manufacturing and advertising? When profit is being calculated, will it be affordable in the marketplace or be out of reach for the target market?
- Promotion: Communicating the benefits of the design to the target market, using the marketing strategies best suited to the audience.

There are a range of promotional strategies that can be used to make a target market

aware of a new design, some of which are outlined below:

- Print advertising is a very traditional form of marketing that became popular with the beginning of black-and-white newspapers, followed by colour magazines. Used to access broad audiences, it uses pictures and text to promote a design. Junk mail comes into this category, as do billboards. Its reach is limited to the circulation area of the printed document.
- Radio advertising is a non-visual medium that relies on sounds and voices to describe a design and its function and aesthetics. It is popular for reaching broad audiences, including target markets that have a radio playing all day, such as tradespeople on building sites. Its reach is limited to the broadcast region, unless the radio station also broadcasts online.
- Television advertising marks a leap forward from radio advertising. Television allows broad audiences not only to see what a design looks like, but also to watch how it works. As with radio, its reach is also limited to the television station's broadcast region.
- Direct marketing targets individuals. Organisations will send personal emails or mail pamphlets directly to people taken from a list identified as being in the sought-after target market. This information can be gathered from a range of sources, including website registrations and competition entries, and is useful when promoting specialised designs.
- Telemarketing is a more intrusive version of direct marketing, using telephone calls to directly contact people identified from the sought-after target market.
- Online advertising is a recent marketing medium that allows for the use of many of the features of other marketing media. Digital versions of print advertising can be used on websites, sound from radio can play and videos from television can pop up, making it a very flexible medium

for marketers. This form of advertising can be placed on websites that members of the desired target market would visit. Websites often use software that remembers the topics you have viewed online and customises your advertising to suit your perceived demographic and interests. Linked to the website design, advertisers earn an income every time an online advertisement is clicked. Advertisers can also pay to have a website appear as a popular search term when a related query is made on a search engine.

- Social media are being used to market designs in ways that are still being explored

by creative advertisers. Videos promoting the work of designers can now become viral – online content is created and planted within a social media platform and shared by members of the target market. Unlike many other forms of advertising, once the content is created, there are no other costs for the advertiser, making it very popular with small organisations. Companies may also in the short term sponsor appropriate digital influencers to adopt and and promote their products, as influencers can affect the buying decisions of their niche audience.

Figure 7.12 Social media sponsorship is becoming more common as a marketing strategy.

ACTIVITY 7.2

Subject selection time can be a busy time for school staff and students alike. Year 10 students are required to choose the elective subjects they wish to study for the following two years, including in the Higher School Certificate, prior to joining the workforce or going on to further study.

In groups of four, present a marketing strategy that could be used by your school to promote the Design and Technology course to potential students in the senior years. Remember to consider your target audience and forms of media that they will engage with. Present your strategy to your peers and your teacher using a presentation software package such as Microsoft PowerPoint or Google Slides.

DESIGNING

CASE STUDY 7.2

Social media helps Western Sydney University rebrand

Western Sydney University is a modern higher education institution, located in Greater Western Sydney, one of the fastest growing regions in Australia and home to over two million people. Over the next 25 years, Greater Western Sydney will account for 60% of Sydney's growth and 25% of Australia's growth.

Figure 7.14 New (top) and old (bottom) logos for Western Sydney University

Figure 7.13 Western Sydney University, Penrith campus

Considering the growth of Western Sydney and its place in the landscape of this quickly growing part of the city, in 2015 the University of Western Sydney rebranded its name to Western Sydney University. At the time, University Vice-Chancellor and President Professor Barney Glover AO described this change as 'putting Western Sydney first, and acknowledging the University's commitment to the region – one of the fastest growing and most dynamic areas in the country'.

The goal of the change to the university's name and logo was to elevate Western Sydney, through placing it at the start of the name and the top of the logo as a symbol of the pride the insititution has in its community and region. A modern image reflects the university's modern facilities and course offerings, targeting high performing students preparing for Sydney's future job market.

During the rebranding campaign, the identified target market was high-performing current school leavers that lived in Greater Western Sydney. The mission was to retain these students in their local university. A through-the-line strategy was determined, featuring social media activity and off-site promotional events. Digital, TV and radio advertising were also used to

establish the new branding amongst this market. Six weeks out from the launch, a range of social media influencers were engaged to use the hashtag #NewWS, with the aim to show Western Sydney through a new lens. High profile people connected with the area, such as sporting stars like Greater Western Sydney AFL players, helped tell the #NewWS story through their social media channels. The campaign reached over four million social media users with 1.6 million impressions made.

One of the most memorable features of the rebranding campaign came with the video that told the story of former Sudanese child soldier and University of Western Sydney law graduate Deng Adut. Shot in the back when he was 12, Deng was rescued by his older brother and smuggled to a refugee camp in Kenya. The UN later granted both boys refugee status and Australia granted them visas. He taught himself to read at 15 and completed his degree while living out of his car. He is now a defence lawyer and refugee advocate in Western Sydney. Across Facebook and YouTube, Deng's story was viewed 1.5 million times, placing the new Western Sydney University name and logo in front of these viewers along with the story of Deng's incredible journey from tragedy to success. You can watch the video in the Interactive Textbook.

The result of the campaign was a 27% increase in enrolments in the year of the rebranding launch. As a result of the campaign on social media, Western Sydney University accounts saw a 20% increase in Twitter followers, 10% more Instagram followers and 1000 more Facebook page likes.

1 Identify the ways in which the new logo is more modern than the old one.
2 Think of an institution or product you are familiar with, and suggest how the logo could be changed

7.3 Using ICT and applications

There is an ever-increasing range of ICT tools available to support your design work, including CAD software, graphics applications such as Photoshop and Illustrator, digital video recording and word processing and spreadsheet tools. Your mobile phone offers you resources that previous generations of designers could only dream of.

As society moves towards use of the internet for all parts of life, web-based tools are now becoming more prominent in the work of designers. We can now create documents in word processors, edit images and video and even develop computer aided designs using web-based versions or new equivalents of our favourite applications when working on design projects. A key feature of these tools is the ability to collaborate in real-time with others on our design work thanks to the connectivity provided by the internet.

With such a range of possibilities, you don't need to use every option available for your project. Consider which applications will be most beneficial in helping you design and communicate your work.

ACTIVITY 7.3

Under the direction of your teacher, produce a digital design portfolio for the publication of your current design project. Products, systems and environments all require different methods of communication to best convey their function and aesthetics, and your teacher will direct you to the most appropriate ones to choose. Aim to include:

- word processing of written information to document your design brief, research findings and your evaluation
- a Gantt chart as a visual way to display your planning of your actions and time usage
- graphical communication of the development of your ideas using pencil sketches of initial ideas and colour rendering of possible solutions, leading to a computer-generated drawing of your final design solution.

Once the format has been determined, create your digital design portfolio as a shared document for collaboration with your teacher. This will allow for prompt feedback during this process, saving you and your teacher time!

Once completed, prepare your documentation for digital publishing. Publishing possibilities include an electronic version in PDF format, with a compressed file size for easy sharing on the web; or a high-quality interactive presentation with video capture of the final design being tested. Check with your teacher for their preferred method of publication.

DESIGNING

7.4 **Using an appropriate technique**

Do you know who your target audience is? Before any communication techniques can be selected to communicate your design, you must have a sound understanding of your target audience. This includes having an understanding of variables such as their age, cultural background and technical understanding. Knowing things such as how much detail and information they want, along with the best way to communicate with them, can only be determined by investigating the target audience. This investigation can include:

- interviews – interacting with individual members of the target market for a detailed response regarding their background
- surveys – seeking a more general response from a large number of target market members
- observation – stepping back and not interacting directly with members; rather, watching and noting who makes up their target market

- researching – reviewing existing records, such as census data and other forms of public information.

Once the target audience is understood, the content then needs to be considered. What information needs to be conveyed to the audience? When collaborating with other designers, selecting the right communication techniques is somewhat easier, as assumptions can be made about their ability to comprehend a similar level of detail to yourself. What is produced and documented during the design process in your design portfolio, including annotated concept sketches and technical drawings, will be satisfactory.

However, presenting to other audiences can be a different prospect. Too much information may overwhelm them and not enough information may leave them not understanding the message you are trying to convey.

Figure 7.15 You must have a sound understanding of your audience.

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Appropriate to various audiences

When selecting the most appropriate communication techniques for your target audience, there will be strategies that can be used to ensure that the information you are presenting is understood. When communicating with those with language barriers or poor literacy skills, it is important to limit the use of technical language and large chunks of text. Breaking down the information into smaller passages of text and including diagrams, illustrations and animations can make the information more accessible. As with instructions supplied with products for global markets, designers may need to consider presenting their ideas to potential audiences in alternative languages.

Information prepared for those with a technical background who work with designers, such as product manufacturers, will need to be detailed and specialised. Examples include a materials list that specifies sizes, types of materials and tolerances for parts required in order to supply the next phase in production, and workshop drawings that show how the parts are to be assembled by those working on the factory floor. When communicating your ideas to audiences such as these, the more technical detail provided can ensure that your design is realised as it should be, without costly errors along the way.

When working on a commissioned design for a client, it is essential to ensure that appropriate communication techniques are selected. If they do not feel that what is being produced is what they had pictured, they may take their business elsewhere. Sharing the evolution of ideas from brief through to final concept is best done using annotated sketches, finishing with a 3D-rendered illustration and possibly a prototype. An action and time plan in the form of a Gantt chart will map out how long the client will have to wait until the design is ready for them.

A finance plan will indicate to the client how much the design development has cost them and predict the final cost of the production of the design. Being able to communicate vital information to this audience can be critical to your success as a designer.

The Interactive Textbook contains an activity about choosing appropriate communication techniques.

Figure 7.16 Concept sketches help communicate ideas with minimal use of technical language.

CHAPTER SUMMARY

- Effective communication with clients, manufacturers and target markets is at the core of successful design work.
- Design portfolios document progress through a design process when producing a solution to a design brief.
- Presentations are made by designers to share their work with target audiences.
- Concept sketches are used to explore and document initial design ideas.
- As designs evolve and technical information needs to be communicated, workshop drawings are produced.
- Written communication is an important part of a design portfolio, documenting features such as research and evaluations in detail.

- Successful designers are skillful in oral communication techniques, speaking with clients, other designers and target markets.
- Selecting the most appropriate form of communication for the desired target audience is key to getting the message across.
- Marketing is required to promote a design to the target audience.
- A good marketing strategy includes a combination of appropriate advertising methods.

REVIEW TASKS

1 List the key elements of a design portfolio.
2 Describe the purpose of a portfolio when developing a solution to a design brief.
3 Discuss the value of sketching when developing and communicating initial design ideas.
4 Explain the advantages of using computer-aided design (CAD) in communicating a design to a manufacturer.
5 Identify the written components of a design portfolio.
6 Discuss an advantage of using oral communication over electronic or written forms of communication when researching.

7 Explain the importance of marketing to the work of designers.
8 Identify five advertising media that may be used to promote the work of a designer.
9 Identify three social media websites and/or applications.
10 Explain the difference between social media and other forms of online communication, such as email and websites.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1 Communication
2 Computer-aided design (CAD)
3 Design portfolio
4 Documentation
5 Information and communication technologies (ICT)

6 Marketing
7 Prototype
8 Sketches
9 Stakeholder
10 Target audience

EXTENSION TASKS

1 'Selecting an inappropriate communication technique when presenting to a target market can lead to miscommunication'. Analyse this statement and its significance for the success of design work.

2 Propose a marketing strategy for a new social media application for use by young adults on mobile devices. Justify the advertising techniques selected to engage with this target market.

PRACTICAL TASK

Communicating ideas, project work and evaluations are an essential part of a designer's work while producing design solutions. The effectiveness of how this is done can determine success as much as the final design solution, especially when designing for a client.

With reference to the design challenges you have completed in class, produce a portfolio of communication work samples that can be used to persuade future clients you are the best designer for their work. A work sample is real evidence of your design work, not just something created for this task.

Your portfolio should contain work samples of:

1 A title page
2 A designer's biography
3 A table of contents
4 Concept sketches
5 Workshop drawings (orthogonal, isometric, oblique, perspective)
6 Written communication
7 Oral communication (such as a transcript of an interview or conversation)
8 Surveys
9 Electronic communication (such as emails, school approved social media like Google Classroom, Microsoft Teams or Edmodo).

8 Management strategies

This chapter explores various aspects of managing design projects. It looks at the implementation and evaluation of the process, addresses finance and budgeting and considers how materials, tools and techniques can be managed.

This chapter addresses **Outcome DT5-8** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the content area **Management**.

Note that the dot point on safe work environment is covered in Chapter 9.

8.1 **Implement and evaluate a process of design**

Project-management strategies when implementing and evaluating a design process ensure a successful final system, environment or product. As skilled designers, you will need to manage:

- time and action plans
- financial costs
- materials, tools and techniques.

Effective project management is vital when developing a design project.

When you are developing your project, it is important that you use a number of different management strategies, such as:

- time plan
- production plan
- resource list

- finance plan
- risk assessment
- areas of investigation.

Consideration of the tools, techniques and materials you will use will ensure that you also complete your project successfully by the due date, as you will have considered all possible options for producing your project while keeping within budget.

It is also essential that you evaluate your management tools so that if you were to repeat this project, or work on a similar project, you would know what aspects worked and what aspects need improvement.

project management a responsibility for planning, organising, controlling resources, monitoring timelines and activities, and completing a project to achieve a goal that meets identified criteria for judging success
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Figure 8.1 Project management strategies are essential for the successful implementation of a project.

Design brief

The first step in managing a project successfully is to identify the needs and opportunities of your design brief. Identifying, exploring and researching these **criteria** will ensure that you are on track from the first day until the completion of your project.

criteria standards by which a design project may be judged or decided

Cambridge University Press
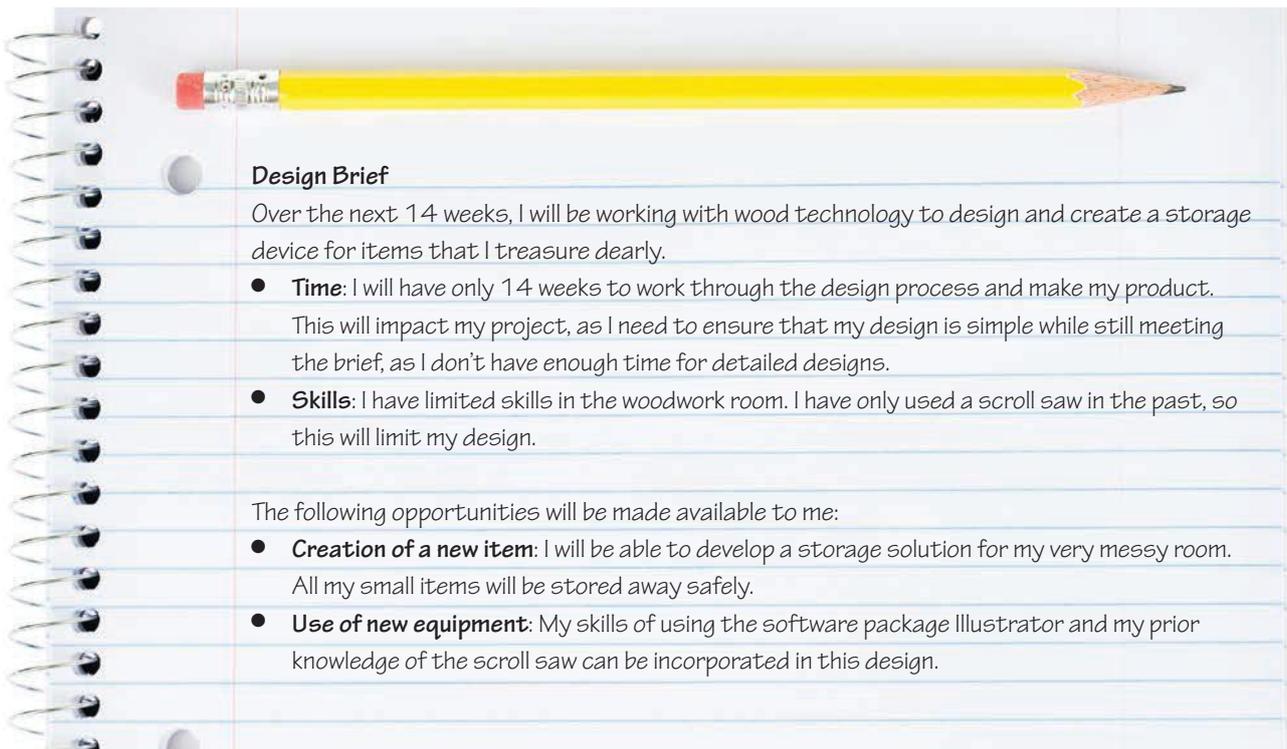
Figure 8.2 An example of a design brief

NEEDS

It is important as a designer that you are aware of the need for your product. Key questions when identifying need are:

- Why are you developing this product?
- Who is your target market?

Identifying the need will help you in developing your product. Once you have identified the need, you must consider the opportunities and/or **limitations** you may encounter. The design brief is an outline of what you intend to achieve.

limitation a restriction or rule that prevents progress

Figure 8.3 An analysis of the design brief should include a look at the opportunities and limitations in developing the product.

OPPORTUNITIES AND LIMITATIONS

An opportunity you identify may be the chance to design something new or to develop new experiences and skills. The limitations are factors the designer must consider that may hinder or slow down the design process. Time, resources available and skills can be examples of limitations if any of these things are restricted. The designer must list and describe the opportunities and limitations they could possibly encounter in relation to the need.

Here are some examples of limitations:

- budget
- school constraints (e.g. equipment, tools, techniques)
- brief constraints
- skill level.

Here are some examples of opportunities:

- the possibility that your product may solve a problem
- opportunity to learn new skills
- opportunity to use new equipment.

Figure 8.4 The design brief should include a time frame.

DESIGN SITUATION

At school your teacher will provide you with a detailed design situation. It is important that you are familiar with the context that you are working with so you should rewrite the brief in your own words so that you are very clear on what you will be designing.

Include some of these points in your own rewrite of the brief:

- the technology you are working with
- the name of the unit

- the product/system or environment you will be producing
- the materials you will need to develop this product
- any special instructions that you must follow
- tools or techniques that need to be implemented in the project
- the time frame.

8.2 **Planning documents for design projects**

Once the design brief has been analysed, this will assist in the development of a time and action plan. These two plans should be developed in consultation with one another. There is no point in identifying the steps of the design process that need completing without assigning the time that each step will take. Ensure that you identify realistic and achievable measures. Ongoing evaluation of your time will ensure that you can see what adjustments you will need to make to remain on schedule.

Time and action plan

Using programs such as Microsoft Excel to create a timeline is a great way of documenting your time. Showing proposed times and then actual times is very important. Time plans must have all proposed times completed prior to the commencement of your design process.

Remember that you should colour in the top row when you *propose* to do the work and then when you have *completed* the task you colour in the next row (see Figure 8.6). You will then need to complete an evaluation to explain the **discrepancy**, when or if there is one.

discrepancy an instance of inconsistency or difference

The actions must be written in detail and be specific to your project. The more details you include, the more accurately you will be able to manage and track your time. The production can be blocked as a set time (e.g. three weeks), but the steps in production can be further refined and outlined in your production plans.

Figure 8.6 shows an example of a time/action plan for the start of a project.
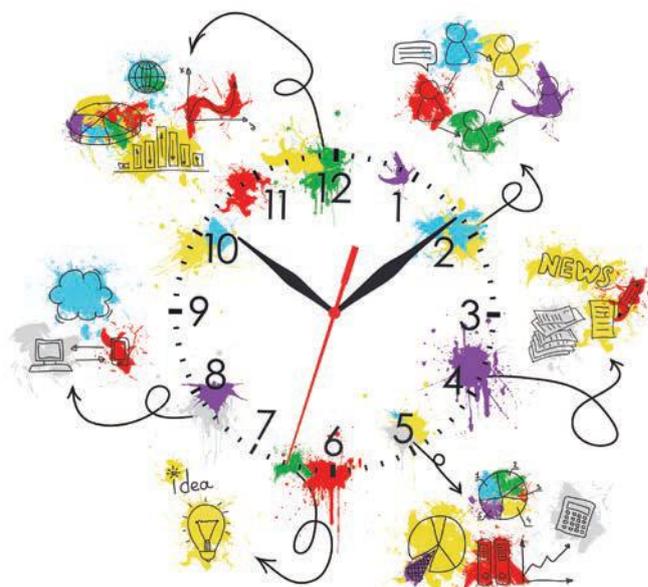
Figure 8.5 Time plans help designers stay on track of the timeline for a project.

TIME/ACTION PLAN									
TERM 4									
Step	Action	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8
1	I will identify and explore my need by writing up a detailed design brief.	■							
		■							
	Discrepancy								
2	I will identify equipment and materials and obtain those I don't have		■	■					
			■	■	■				
	Discrepancy Preferred supplier did not have materials in stock, and had to order								
3	Build prototype			■	■	■			
					■	■	■		
	Discrepancy Could not start until equipment received								
4	Obtain feedback on prototype						■	■	
							■	■	

Figure 8.6 An example of a time/action plan

Production plan

The production plan details the specific steps you take in the making of your product, system or environment. Each step is described in detail. Don't just list the steps; identify the tools and techniques, and the safety considerations that you must think through. Again, you must complete the plan before you begin production. Figure 8.7 is an example of a production plan for a design project involving metalworking.

STEP	PROCESSES	TOOLS/TECHNIQUES	SAFETY ISSUES
1	Create a template of my design on a piece of white paper and then trace this design onto silver.	Paper, pencil, ruler, tracing my design onto the silver	Ensure that I don't drop the silver onto my foot, as it is quite heavy and I may injure myself.
2	Using the hand-held saw, check that the blade is in the correct way and it is firmly tightened. Then, using the up-and-down motion, begin to cut into my silver. Remember to take care and not force the blade.	Silver, hand-held saw, blades, V-peg and clamp. Sawing through the silver is the technique I am going to use.	Ensure that I am wearing my apron and goggles. Ensure that I carry the blade facing downwards when I am moving around the room and ensure that I cut away from my body. My fingers should be clear of the blade at all times. The V-peg must be clamped securely to the table to ensure that my piece does not dislodge and hit me in the face.

Figure 8.7 An example of a production plan

ACTIVITY 8.1

As a class, debate the following statement: 'Time and action plans are only necessary for students'.

COMMUNICATING

8.3 Calculate financial costs of design projects

There are a number of costs in designing. These can slowly creep up if you do not keep a close eye on them. Careful planning is required through a finance plan.

For a finance plan to be effective, you must begin by outlining your budget and detailing how you have come to this amount. You need to justify how you will be paying for your materials. Proposed and actual costs need to be outlined and you need to ensure that you keep all your receipts. The finance plan must be evaluated and discrepancies need to be justified. Using Microsoft Excel to create your finance plan is a great idea, as the formula function will automatically add up for you the total amounts. See the example below.

My budget

My budget for this project is $135. My parents will contribute $70 towards my project and I will fund the other $65 through my part-time job.

Finance plan

ITEM	PROPOSED COST ($)	ACTUAL COST ($)	JUSTIFICATION OF DIFFERENCE
MATERIALS			
Silver	30	42	I got 12 mm thick silver, as it is more durable and cuts better.
Beads	25	12	
Chain	12	8	
Solder	2.5	2.5	
TOOLS			
Saw	13	11.5	
V-clamp	5.5	5.5	
Gas	47	32	
Total	**135**	**113.5**	

Figure 8.8 An example of a budget outline

CASE STUDY 8.1

Tiny Home

Architect Peter Maddison joined forces with the RACV (Royal Automobile Club of Victoria) to design a compact and energy-efficient home.

Many Australians struggle to pay their electricity bills. The prototypical Tiny Home addresses this not only by reducing the size of the living area – and thus the amount of power needed – but also by maximising the home's efficiency. The house has solar panels, and is intended to be positioned so that the panels are on the northern façade to gain as much sun as possible. Part of the northern wall can convert to become an outside deck, allowing sunlight to enter the home in a controlled way. Maddison also took care to install quality windows and effective insulation.

The Interactive Textbook contains a video in which Maddison explains this passive design.

Although it would be completely possible to live in the Tiny Home, the main purpose in designing and building it was as a concept home, to encourage people to think about energy efficiency, and what they can do in their own homes.

1 Discuss why the designer of the Tiny Home would have developed a finance plan.
2 Outline how living in the Tiny Home would reduce power bills.
3 Describe, in detail, how the Tiny Home addresses the factors of function, aesthetics, ergonomics and environment.

Figure 8.9 The Tiny Home is designed to be highly energy efficient.

8.4 **Managing materials, tools and techniques**

The resource list identifies and justifies the ideas and resources that will be used throughout the design process. You must provide a detailed outline of all resources, tools and techniques, and justification for how you will use these and why they are necessary. Photos can act as a visual aid in this section.

	REFERENCE	BENEFITS OF THIS RESOURCE	JUSTIFICATION OF USE/ APPLICATION AND VALUE
Human Experts Teachers	Teacher: Blue, Miss. 15 May 2020. [Pers. Comm]. Northwest New South Wales.	Miss Blue was a great help, as she showed me the correct technique for inserting a blade into the hand-held saw.	I will definitely be using this technique in the development of my project, as it will ensure that I can cut accurately and safely.
Non-human Ideas Books Textbooks	Book: Kimura, S. 2004. *Bags with Style* Iola, WI. Krause Publications, Print encyclopedia: Rosenthal, E. 2001. 'Discrimination'. *Grolier Academic Encyclopedia*, Vol. 6, p. 190. Magazine/newspaper: Morley, J.C. (2008). 'From top to elegant toe'. Essential Living, *Sydney Morning Herald*, 28 February 2008, pp. 14–15.	These resources have been helpful in refining my design.	These resources have influenced the final look of my products – I will focus on a more organic design.
Internet	The Happenstore, 2020. The Happenstore homepage. [Online]. Available at: https://cambridge.edu.au/redirect/8498.	This website helped me in identify current and modern screen prints.	This website has influenced me to create my own screen prints.

Figure 8.10 A detailed outline of resources used on a school project

To assist in managing your resources (materials, tools and techniques), you will need to complete some research in this area. In the project-management section of your folio, it is vital that you outline what you intend to research.

Areas of investigation

In this section, you must describe the materials, tools, techniques and design ideas that you will need to investigate for your design project to be successful. You need to provide details of how you will investigate each of these areas. See the example in Figure 8.11, below.

	AREA TO INVESTIGATE	HOW I WILL INVESTIGATE (primary sources, secondary sources, experimentation)
Design ideas This research will assist me in developing ideas for my project and investigating what is currently on the market.	Research existing trends on the market, such as bohemian and gypsy jewellery.	I will conduct observations at current jewellery stores, such as Sportsgirl, Diva, Equip and Mimco. I will observe what colours, styles and price ranges people are buying.

Figure 8.11 An example of recorded areas to investigate for a jewellery project *(continued)*

Figure 8.11 *(Continued)*

	AREA TO INVESTIGATE	HOW I WILL INVESTIGATE (primary sources, secondary sources, experimentation)
Materials The research on materials will ensure that I am using the best materials to suit my design brief and I will ensure that I consider areas such as cost, function, durability and finish.	I will investigate beads as a possible material to be used in my necklace and to see how much it will cost per glass bead.	I will go to The Bead Shop in Newtown and research the cost of beads, both glass and plastic, as well as different sizes and colours.
Tools The research on tools will ensure that I am using tools correctly and safely and that I am using the tools that best suit my adornment.	I will need to research the following cutting tools: hand-held saw for cutting silver, tin snips for cutting silver wire and solder.	I will use the book *Jewellery Fundamentals of Metalsmithing* by Tim McCreight.
Techniques Researching techniques will allow me to explore different methods, decorative or functional, that I could incorporate into my project and ensure that it is completed to a high standard.	I am going to research the following joining techniques for attaching my silver: soldering, fusing, casting, rivets and adhesives.	I will use the book *Jewellery Fundamentals of Metalsmithing* by Tim McCreight.
Experimentation Experimenting will allow me to determine which are the best tools, materials and techniques for my project without ruining my final design.	I will be conducting the following experiments: soldering, cutting, annealing, drilling, buffing and polishing. I will need to experiment with all of these techniques, as I want to have the best finish for my design.	I will experiment with all of these techniques I have researched and I will probably use these techniques in the production of my silver ring. All experiments will be written up: Aim, Method, Result and Conclusion.

Research and exploration

As designers, it is important that we research and experiment with all potential materials, tools and techniques. From this research we will be able to choose the best materials, tools and techniques to produce a successful end product.

In this section, you will need to document all the research that you have completed.

Figure 8.12 Researching design ideas and looking at other products on the market can provide inspiration.
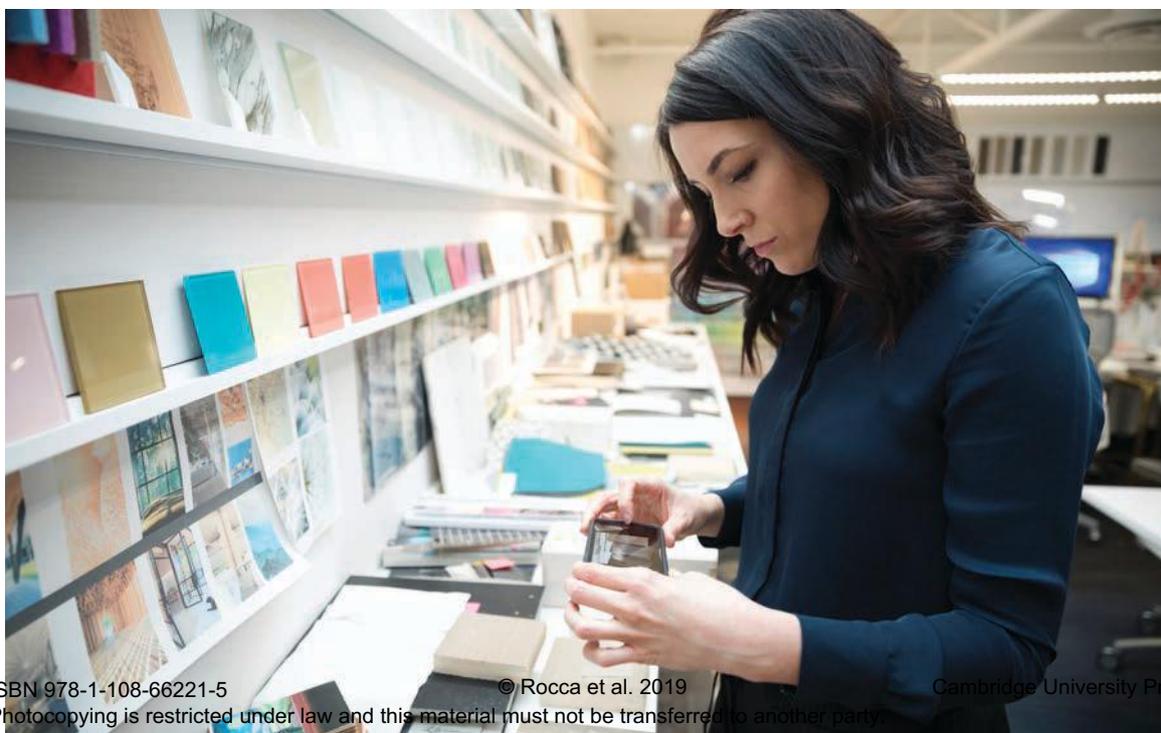
ACTIVITY 8.2

Refer to the areas of investigation (AOIs) for your own project, to see what you said you would research, and use this as a checklist each time you complete an area of research. Complete a table like the one below for AOIs.

	AREA TO INVESTIGATE	HOW I WILL INVESTIGATE (PRIMARY SOURCES, SECONDARY SOURCES OR EXPERIMENTATION)	JUSTIFICATION – WHY I NEED TO RESEARCH THIS AREA
Materials			
Techniques			
Tools			

Areas you may research for your project include:

- design ideas – areas of inspiration, colours, other products on the market
- materials – possible materials that can be used in the development of the product; research a number of materials and their properties, provide ample experimentation and testing, and justify the best possible solution
- tools – possible tools that can be used in the development of the product; research a number of tools, provide ample experimentation, and justify the best possible solution
- techniques – possible techniques that can be used in the development of the product; perform a number of techniques, provide ample experimentation (through sample pieces and prototypes), and justify the best possible solution.

Figure 8.13 Research the use of all possible tools that could be used in the project.

Remember:

- All research must be **concise** and relevant.
- All research must be annotated, summarised and have conclusions drawn.
- Use a wide range of sources – do not just print or copy information off the internet!
- Source and acknowledge all information.
- After each of these sections (design ideas, tools, techniques and materials), complete a brief summary on how it meets the need.

concise brief and clear

DESIGNING

Recording experimentation and testing

personal protective equipment (PPE)
equipment used or worn by a person to minimise risk to the person's health or safety; for example, goggles, ear muffs, face shield, hard hat, apron, gloves
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As you saw in Chapter 2, experimentation and testing will assess the suitability of design ideas by testing and experimenting with tools, techniques and materials. This will assist you in refining your design ideas and ensuring the final product is of the highest quality. The table below shows the recording of an experiment with soldering.

Aim	To experiment with the technique of soldering
Method	1 Put on my personal protective equipment (**PPE**) – apron, hair tied back and leather shoes on. 2 Ensure that my ring is clean, and paint flux on the area of the ring that is to be joined. 3 Using the tin snips, cut a small piece of hard soldering the length of the join and then place it on the join. 4 Using the third arm, place the ring in the grip and light the blowtorch. 5 Using a circular motion, heat up the surface of the ring. Then, using a back-and-forth motion, heat the solder. When it sparks, turn off the blowtorch and place the ring into a bath of cool water. 6 Place the ring in pickle solution and then rinse with water. 7 The ring now needs to be sanded and polished.
Result	I successfully soldered my ring together. It was a simple process. The join in the ring is strong, and once my piece is sanded it will look very professional. I would rate my skill level as 8/10. If I were to do this again, I would move slower on the back-and-forth motion to ensure that the solder doesn't run as far down the ring, as I now have to file this excess solder off, which is kind of a waste.
Conclusion	I will definitely use this process in the final adornment piece, as I am connecting two squares of silver together and, because it is a professional piece that is going to be used for retail, it must be completed to a high standard. It also needs to be durable, and when I tested the durability of the ring it was quite high. Therefore, in terms of aesthetics and durability, soldering is the best option for my final design piece.

Figure 8.14 Recording your experimentation

Figure 8.15 The technique of soldering requires some experimentation to get it right.

Identifying tools, techniques and materials

When using particular tools, techniques and materials, designers must identify the techniques they are using. Take a furniture designer, for example. A range of appropriate fittings and hardware, such as hinges, handles, catches and locks, could be used for your production.

ACTIVITY 8.3

1   Imagine you are a furniture designer. Copy and complete the following tables with descriptions and drawings/images of relevant techniques and hardware. You may like to research the images on the internet and copy and paste them into the table.

	TECHNIQUE	DESCRIPTION	DRAWING/IMAGE
Cutting	Scroll sawing		
	Drilling		
Shaping	Filing using files and wood rasps		
	Drilling		
	Sanding (disc sander and sandpaper)		
	Routering		
Finishing	Puttying		
	Oiling and staining		
	Painting		
	Varnishing		
Joining	Butt join		
	Mitre join using V Ezzey		

	DESCRIPTION	DRAWING
Hinges		
Handles		
Nails and screws (different types)		

Continued

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ACTIVITY **8.3** *(Continued)*

2   Research and describe the characteristics of the following types of timber using the table below.

TYPE OF WOOD – DESCRIPTION	EXAMPLES OF USE
Softwood: • Hoop pine • Radiata pine • Cypress pine	
Hardwood: • Black bean • Spotted gum • Red cedar • Queensland maple	
Particle board	
Veneer	
Plywood	
Medium-density fibre board	

3   Complete the following table with descriptions and drawings/images of some of the tools needed in furniture design. You may like to research the images on the internet and copy and paste them into the table.

	TOOL	DESCRIPTION	DRAWING/IMAGE
Marking and measuring	Ruler		
	Measuring tape		
	Square		
	Gauge		
Cutting	Hand saw		
	Tenon saw		
	Mitre box		
	Scroll saw		
Joining	Finger jointer		
	Biscuit joiner		
	Hammer/screwdriver		
	Portable drill		

DESIGNING

Final product specification sheet

Documentation of which tools, techniques and materials are used is crucial in the project management of a design. A product specification sheet ensures that you have identified all the resources that were used to develop the final design (after all your research).

An important question to ask is: Does my product meet the need? Figure 8.16 is a product specification sheet that you can use as a checklist, to be sure that you have captured all the information you will need.

Product name	
Relationship to need: • What need does your product fulfil? • How did you ensure you met this need?	
Tools used	
Techniques used (both decorative and structural techniques)	Decorative
	Structural
Materials used (include extras, such as knobs, hinges, dowels)	
Photo/sketch	

Figure 8.16 Product specification sheet

ACTIVITY 8.4

Complete a product specification sheet (see Figure 8.16) for your own project. You can cut out samples of your wood, fabric and so on and place it in the 'materials used' section. Describe each item fully, do not just list them.

DESIGNING

Figure 8.17 A furniture designer needs to know the characteristics of different types of wood.

8.5 **The role of project management**

Project management is the activity of organising and controlling a project. If performed correctly, project management will ensure that the designer meets the needs and wants of the individual or society on time and on budget.

A key element of managing a project is maintaining a safe work environment. The safety of the designer, as well as the end user, is paramount. This must be forefront for all people involved in the design process and production. It will be discussed in Chapter 9 in detail.

In Case Study 8.2, you will evaluate the role of project management in a design project.

CASE STUDY 8.2

Emma Chegwyn

Emma Chegwyn is a designer who works with concrete. An industrial designer by trade, Emma is an emerging designer in both the making and styling sectors of the design industry, having studied both in Sydney and Italy. Gaining in-house, hands-on experience in a number of Sydney-based design and manufacturing companies, she has also developed her interest in product photography and styling through a placement with a leading Australian lifestyle magazine. Emma has taken the initial skills and enthusiasm learned through studying Design and Technology in high school, and seeks to implement them in the various design processes she undertakes both in the industry and educationally.

Figure 8.18 An example of Emma Chegwyn's concrete cups

The following project description is from when Emma was employed as a freelance designer supplying and wholesaling concrete cups to an Australian homewares brand.

Brief

There is always a brief and the intended outcome becomes clear to the designer. It need not relate to a specific problem or context, but rather the brief can equally be specific in pertaining to an identified aesthetic and functional outcome. In the instance below, the brief is established to make and finish a batch of concrete cups for design wholesale in a well-known Australian design store. These concrete accessories will then be used for a multitude of purposes, such as desk and jewellery storage, succulent and cactii pots, window displays and candle holders, to name a few. The brief is short and succinct. The desired outcome has been established.

Figure 8.19 Concrete cups can be used to hold succulents and cacti, replacing the disposable plastic pots they are sold in.

Budget

Expenditure relating to the project needs to be managed from commencement. Coming in at, or under, cost is ideal with any design process. Working out the most cost-effective way of repeatedly manufacturing concrete cups was a large component of my design process, for it then determined the wholesale cost of the product, and consequently the percentage that I gained. The lower the cost, the greater the profit margin.

Criteria to evaluate success

Specifically, aesthetics were key to the success of the cups. They were driven by a brief that focused on the visual characteristics of the product more than it valued other elements such as life-cycle considerations. This was primarily due to the understanding that the end product was being targeted at a market that placed higher value on the aesthetic and decorative look of the goods as opposed to any related environmental concerns involved. Should the use of energy and the recyclability of both the inputs and outputs surrounding the concrete cups have been analysed, for example, costs at both ends of the design and sale process would have been affected. For a good that was designed to be sold with as great a margin as possible, this was not necessarily attainable within the time frame and budget costs to which I was restricted. For emerging designers, a common vision for success is that of considering sustainability within design. However, when faced with industry realities and deadlines surrounding time, expenditure, materials and product turnaround, creating the 'perfect' product that successfully meets all CTES becomes difficult to achieve and a fast learning curve to negotiate.

Areas of investigation

Research must be pertinent to the brief at hand. In this case, the AOI related to manufacturing techniques and methods. This was investigated by conducting primary interviews with other makers that were familiar with small-scale concrete manufacturing, in order to determine my own process method, with the materials used a key component of this investigation.

Many existing concrete designs use a pre-made combined mix, whereas I found, through investigation and research, a better finish was achieved through making the mix myself with sand and cement, which further benefited the design in aiding in the structural integrity and thus functionality of the finished goods.

Figure 8.20 Emma found a better finish was achieved if she used her own mix of sand and cement, rather than using a pre-made combined mix.

Below is a list of the final materials used:
- 20 kg Sydney Wash Sand
- 20 kg General Purpose cement
- Crommelin Water Based Paving Sealant
- 80 and 180 grade sandpaper
- large flexi tub – 50 L or larger is ideal as the container to mix the cement in
- 450 mL plastic cups, and 200 mL plastic cups to use as moulds
- pebbles/small rocks to use as weights in the smaller cups
- masking tape
- spray paint in colours of your choice.

Other areas of investigation pertained to the decorative aspect of the cups, concerned with existing products on the market and ways in which I could differentiate the cups I was responsible for.

Research

A key component of the design stage is researching the necessary personal protective equipment (PPE). When working with cement, always wear the correct protective clothing as it is an alkaline substance in its fine powder form.
- long gloves – to guard against skin irritation
- face mask – to prevent dust inhalation
- eye protection – to prevent dust from getting into eyes
- long pants and sleeves – to guard against skin irritation
- safety boots – to prevent injuries to your feet when handling heavy items or using potentially hazardous tools.
- Always wash clothes that may be splashed with cement-based products separately at the end of each day.

In an industry setting, research becomes increasingly based on tangible experimentation. Trial and error is a key form of research in the design process, and was a large contributor to the success of the concrete cups. For every batch that was manufactured, there were imperfections and mistakes to be learned from, first-hand research that otherwise cannot be obtained.

Figure 8.21 Emma wears a face mask to prevent inhalation of the fine, powdered cement.

Production

Prior to production, final production specifications are realised in the form of a product spec sheet, both formally and informally. The spec sheet in this instance detailed the minimum volume of the initial concrete pour, which then determined the quality of the cup groove, a key aesthetic requirement that separated a marketable cup from a non-marketable one. Other specifications included the placement of the inner mould, the order in which pre-production and post-production procedures must be followed, the types of moulds needed for standardised product measurements, and specified materials required that were determined through the research stage to give the best quality results.

Below is my production process for making concrete cups.

- Stir the cement and sand, mix in with the water until a yoghurt-like consistency is reached. The amount of water added will be dependent both on the maker's discretion and the recommendations on the cement packet. The stirring process may take a while; however, it is important to follow through so that there is an even consistency of sand, to cement, to water in the final moulds.
- Once the consistency is reached, pour the cement into the 450 mL cups, 2/3 of the way up, and leave to sit for 5–10 minutes. This resting stage is critical, as it allows the cement to begin to set, making the placement and positioning of the second, smaller mould a lot easier.
- Place the 200 mL cups (with the pebbles inside used as weights in order to keep the cup in place) in the centre of the larger cups. This stage will require further monitoring for the following 10–15 minutes, while the cement begins to harden, in order to ensure that the inner moulds can be adjusted and sit to stay centred (or off-centred, dependent on the maker's choice).

- Leave to sit for a minimum of two days. For the best results, the ideal resting time is anywhere between four and seven days.
- Remove the inner moulds by pouring out the weights and cutting one side of the cup (taking care not to scratch the concrete) to release and pull out the plastic. Do the same with the outer mould, by making a small incision and then peeling off the cup.
- Using the sandpaper, sand down any imperfections on the top of the cups until an even rim is achieved.
- To protect against moisture, water and greasy substances, it is recommended to lightly seal the cups by dipping a cloth into the sealant and brushing over the concrete.
- After 24 hours from the time of sealing, the cups will be ready to decorate. Using masking tape to create a stencil shape of the desired painted area, lightly spray 2–3 coats of paint and leave to dry.

Evaluation

Following manufacturing and production, the first step is to go back and assess whether the finished product meets the brief. Are the cups sellable firstly for wholesale and secondly for customers? Do they meet the aesthetic requirements? Are they functional as intended? The evaluation stage is often where the most knowledge is gained. It is here that improvements in both material choices and production steps can be made.

1. Draw a flow chart of Emma Chegwyn's design process.
2. Describe the tools, techniques and materials she utilises in making her products – use the templates shown earlier in this chapter.
3. Analyse the factors affecting design and production of her concrete items.
4. Discuss the importance of a budget and research for Chegwyn's products.

CHAPTER SUMMARY

- Project-management strategies when implementing and evaluating a design process ensure a successful final system, environment or product.
- Designers need to be aware of the need that drives a project. Key questions to ask include: Why are you developing this product? Who is your target market?
- For a finance plan to be effective, you must begin by outlining your budget and how you have come to this amount. You need to justify how you will be paying for your materials.
- Experimentation and testing will assess the suitability of design ideas by testing and experimenting with tools, techniques and materials. This will assist you in refining your design ideas and ensuring the final product is of the highest quality.
- The resource list will identify and justify which ideas and resources will be used throughout the design process.
- The areas of investigation section outlines the materials, tools, techniques and design ideas that you will need to investigate for your design project to be successful.

- A product specification sheet ensures that you have identified all the resources that were used to develop the final design.
- As designers, it is important that we research and experiment with all potential materials, tools and techniques. From this research we will be able to choose the best materials, tools and techniques to produce a successful end product.
- All research must be concise and relevant. All research must be annotated, summarised and have conclusions drawn.
- The production plan is specifically the steps you take in the making of your product, system or environment. Each step is described in detail.
- A key element of managing a project is maintaining a safe work environment. The safety of the designer and the end user is paramount.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1 Investigation
2 Needs
3 Opportunities

4 Project management
5 Resources
6 Time plan

REVIEW TASKS

1 Describe the importance of employing project-management strategies for all design projects.

2 Outline why it is important to identify your target market in your needs analysis. Explain the implications this may have on the success of your final product.

3 Describe the role of research in the design process and the impact on the quality of the final product.

4 Discuss emerging technologies (e.g. laser cutter, heat press, embroidery machine, Baby Lock, hemming machine) that you have used in one of your design projects this year. How did it impact on your design and production?

5 Explain the impact that identifying tools, techniques and materials have on the success of the final product.

6 Find five products on the market that inspire you. Complete a plus, minus and interesting (PMI) chart for each.

7 Why is it important to consider environmental and sustainability issues when designing a new product?

8 'Evaluation only happens at the end of the design process'. Discuss this statement.

9 Discuss the importance of a time and action plan, and criteria to evaluate success and evaluations in the design process. Include specific examples to clarify your discussion from design projects you have completed this year. (Write a detailed paragraph for each factor listed above.)

10 In a table like the one below, complete a PMI chart about two innovations you have studied this year.

POSITIVE	MINUS	INTERESTING
•	•	•
•	•	•
•	•	•
•	•	•

EXTENSION TASKS

1 Describe how you have used computer technologies in a design project this year. Identify computer programs you may have used.

2 Describe how new computer technologies have helped designers in documenting their design process. Include specific examples based on your projects this year.

3 How have emerging communication technologies changed the way designers interact? Use examples to support your answer.

PRACTICAL TASK

As part of a new development, the local park near your school is trying to encourage teenagers to use the park. Design, create and evaluate a park which will attract the teenage market. Use technologies available to you to showcase your new concept.

Figure 8.22 Designing a park to appeal to teenagers means your area of investigation will be the outdoor interests of this group.

9 Risk management practices

KEY TERMINOLOGY

- **Hazard**
- **Job safety analysis (JSA)**
- **Legislation**
- **Personal protective equipment (PPE)**

- **Risk**
- **Risk assessment**
- **Safe operating procedure (SOP)**
- **Work health and safety (WHS)**

This chapter explores hazards in the practical classroom and how the risks they present can be managed. Safe work practices used in schools are modelled on those used in the workplace, giving students lifelong skills for the workforce. Areas addressed include personal protective equipment, signage and exclusion zones in workshops. The chapter also looks at workplace health and safety legislation.

This chapter addresses **Outcome DT5-9** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the 'safe work environment' section of the content area **Management**.

9.1 **Risk management strategies and practices**

Design and Technology is a practical course and when participating in practical work, **risk** to ourselves and those around us is ever-present. Risk can be defined as a situation that may expose someone to danger, harm or loss. For example, when using a saw, users are at risk of slipping and cutting themselves if their work is not secured properly. It is essential that everyone in a practical classroom or workplace takes the necessary steps to ensure that no one is exposed to harm. The right to work safely is covered by law in Australia, and this is explored later in this chapter.

While working safely in the practical classroom is essential in Design and Technology, it is also important to consider the safety requirements for all stakeholders when producing solutions in response to a design brief. Not only must the processes of production be safe, but the design itself must be safe for use by the intended target market. An example

risk a situation that may expose someone to danger, harm or loss

hazard something that is potentially dangerous

would be making sure that a child's toy does not have any small parts that may break free and become a choking **hazard**. Consideration should also be given to the safety of those who come into contact with the product once it is no longer useful and becomes waste; for example, the use of hazardous materials that may become a risk to others when being disposed of in common garbage systems.

Figure 9.2 Designers must consider the dangers posed to the end user, such as children playing with toys.

Figure 9.1 The risks inherent in using tools must be minimised as much as possible.

Risk assessment

Before any task is undertaken, a risk assessment must be conducted. This may be for the project being made, the workshop being used or the individual tools and machines required.

During this process, an analysis is done of any possible hazards that may cause an accident, and the likelihood of the accident actually occurring is estimated. For example, during a practical lesson someone is more likely to hit their finger with a hammer than receive an electric shock from a power tool. Following the identification of possible causes, the level of the injury and treatment required is also estimated. Hitting a finger with a hammer is most likely to be a minor injury requiring first aid; an electric shock may be a serious injury leading to disability or even death. Good risk management plans will also identify any control measures to reduce the chance of the injury occurring. Accidents such as hitting a finger may seem unavoidable, but good training and appropriate use of the tool will always help to reduce the likelihood. In the example of electric shock and a greater level of possible injury, a higher level of control measures will be required, including inspection before use, regular electrical testing and tagging by professionals, training and appropriate use.

To assist in the assessment of the degree of risk posed by an identified hazard, a risk assessment

Figure 9.3 Good risk management helps reduce the chances of an injury occurring, such as an electric shock.

matrix is used. Set up by organisations to suit the type of work they are engaged in, the matrix is a table that considers the level of potential consequences of an accident and the likelihood of an accident happening due to the hazard. When reading the matrix, compare the consequence with the likelihood for the identified hazard and determine its severity. The matrix will then advise on the level of risk and the appropriate measures to take to manage it.

Figure 9.4 A risk assessment matrix

	VERY LIKELY	LIKELY	UNLIKELY	VERY UNLIKELY
Death or disability	1	1	2	3
Long-term injury	1	2	3	4
Medical attention	2	3	4	5
First aid required	3	4	5	6

Risk level key:

1 and 2 – **High risk:** Immediate action to control the risk is required before work can begin.

3 and 4 – **Moderate risk:** Immediate short-term control is required before work begins, with a plan for a long-term solution.

5 and 6 – **Low risk:** Attention is required in a reasonable timeframe to control the risk.

CONTROLLING RISK WITH THE RISK CONTROL HIERARCHY

We are able to control these risks through the application of a system called the risk control hierarchy. The aim of this is to help those managing risk to minimise or eliminate exposures to hazards. There are six steps in the risk control hierarchy, from the most effective to the least effective, and these are applied depending on the level of risk.

1 Elimination: Physically removing the hazard is the only way to ensure that it is no longer a risk to those who would come in contact with it. In a practical classroom, this may be removing a dangerous machine from the workshop.

2 Substitution: Swapping the hazard for something safer is a good way to reduce risk. For students, this could be using water-based lacquer on timber instead of an oil-based finish, or a cordless tool in preference to a corded power tool.

3 Isolation: When something is not needed, it can be controlled so that it cannot be used. An example of this is a power isolation switch in a practical classroom. The power to machinery can be isolated so that it can only be turned on by one central person, for example if a teacher needs to stop practical work to give safety instructions to the class they might stop power to the machines until the instructions have been issued.

4 Engineering: The fourth most effective control measure involves a technician modifying the equipment that is hazardous. In a practical classroom, this includes dust and fume extraction, such as that used on a laser cutter.

5 Administration: Administrative controls are rules put in place by a school or education department for how tools, machinery and equipment should be used when conducting practical work. This includes safety testing and instruction, signage and teacher supervision.

6 Protection: The use of personal protective equipment (PPE), such as safety glasses, aprons and enclosed leather shoes, is the final control measure used to minimise the risk of injury. This is implemented when other levels of the hierarchy are not practical.

Once hazards have been identified, assessed and controlled, good risk management continues via a monitoring process. The process should be

ACTIVITY 9.1

Due to the practical nature of the Design and Technology course, at times you will need to use a range of different tools and machines as you produce solutions to design briefs.

For a tool or item of machinery being used in your current project, conduct a risk assessment of any potential hazards that may result from its use. Use the risk assessment matrix to determine the level of risk and document the assessment using a table like the one below.

RISK ASSESSMENT FORM				
NUMBER	HAZARD	POSSIBLE INJURY	RISK LEVEL (1–6)	CONTROLS
1				
2				
3				
4				
5				

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documented and reviewed on a regular basis to ensure that the risk of the hazard occurring remains minimised for those working in the classroom. Identifying possible hazards, determining the

level of injury they may cause and implementing control measures before the commencement of work are essential to managing risk within practical classroom spaces.

9.2 Planning for safe work

Planning is an important part of safety in the school workshop. Being well prepared and organised is just as important as being able to read workshop drawings and knowing how to use tools and machines safely. A procedure is often used in Design and Technology classes to plan out what needs to happen. This plan is a description of each practical step needed to complete a project safely, and includes the tools and techniques required to do so.

As a risk assessment is used to identify and manage hazards for individual tools and machines, a job safety analysis (JSA) is an industry tool that formally documents the safety analysis of a project where a greater level of risk exists. As with a risk assessment, the scaffolding that a JSA provides helps us look at the tasks we are required to complete in order to finish a project in the safest possible way.

The process for completing a JSA is as follows:

1 Identify the project to be undertaken.
2 List the steps required to complete the project. This includes any tools or machines required for each step.
3 Identify the hazards that may occur while using the tools or machines for each step. Reviewing risk assessment and safe operating procedures (SOPs) will help with this step and with step 4.
4 List the controls that will be put in place to eliminate or minimise the risk.
5 Identify who is responsible for the controls. It may be the user wearing PPE or it may be the teacher checking that all required guards are in place.
6 Review the JSA as you work through your project to ensure you are adhering to your plan, and update it as required; for example, if additional hazards are identified, add them to your JSA.

Figure 9.5 A fume extractor is an example of an engineering solution to minimising risk.

Figure 9.6 Job safety analysis (JSA) form

NAME:			DATE:
PROJECT:			
STEP:	**HAZARD:**	**CONTROL:**	**PERSON RESPONSIBLE:**

In the workplace, a JSA is used to document the safety planning process. In the event of an accident, an employer will be asked to produce the JSA as proof that a hazard identification and control process was being used, along with other evidence of risk management and supervision. For high-risk work in industry, a safe work method statement (SWMS) may be used.

ACTIVITY 9.2

Conduct a job safety analysis for the project of building a metal bird feeder in your school workshop using the table below. For each step, the person responsible for controlling the hazard will be you, your teacher, and/or other staff at the school.

PROJECT: BUILDING A BIRD FEEDER			
STEP	**HAZARD**	**CONTROL**	**PERSON RESPONSIBLE**

DESIGNING

9.3 **Contributing to a safe working environment**

Being able to work safely in the school workshop, as with any workshop, is the right of every student. As a result, it is also the responsibility of all students to work safely.

By establishing a routine for practical lessons that include the following safe working steps, you will not only be contributing to a safe working environment for yourself and your peers, but you will also be giving yourself the opportunity to produce the best possible solution to your given design brief.

SAFETY TESTS AND DEMONSTRATIONS

Engage in and complete all safety tests delivered by your teacher, be they written or online, making sure that you fully understand the content of the tests. Ask your teacher for help if required.

Actively observe and listen to safety demonstrations delivered by your supervising teacher. As with your safety tests, ask questions if you are unsure about any part of the safe operation of practical equipment or completing a process. Using tools and machinery that you are not familiar with is a source of great risk to yourself and others. You must be confident that you have minimised all risks before beginning to operate all tools and machinery.

SAFE OPERATING PROCEDURES (SOPS)

Follow the directions for use as indicated by the SOP for the tools or machinery you are using. Displayed in close proximity to the described tool or machine, the SOP gives vital information about the possible risks, how to manage them through appropriate use and the PPE required.

SIGNAGE

Observe the safety signage for your workspace. The signage may include the following:
- A sign may indicate that enclosed leather shoes must be worn.
- Black **pictograms** on a yellow background are a warning of a hazard, such as flammable materials.
- A red circle with a slash over a black pictogram on a white background indicates something that is prohibited, such as no entry to a storeroom.
- Blue pictograms on a white background indicate a mandatory requirement.
- Yellow exclusion zones marked on the floor around machinery remind you to give space to the machine and its operator when in use.

pictogram a simple picture used to describe something

GO

Figure 9.7 Safety signs in the workspace are necessary to warn people of possible risks.

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PERSONAL PROTECTIVE EQUIPMENT

Always wear the appropriate PPE for the work you are doing. This can include:

- Eye and face protection, such as safety glasses or goggles. These protect against flying particles during tasks such as drilling and lathe work. If you are welding, you will need more serious protection, such as welding masks and oxy-acetylene goggles.
- Breathing protection, such as disposable masks or respirators, protect against airborne particles from woodwork, or vapours from solvents.
- Hearing protection, such as ear plugs or ear muffs, protect against the noise from loud tools or machinery.
- Hand and foot protection, such as gloves and enclosed leather footwear, protect against sharp tools and equipment that might cause injury (broken glass, splinters, heavy items that can be dropped).

GO

Most PPE is made to an Australian Standard, and should display a logo.

If you notice that any PPE supplied by your school is damaged, be sure to let your teacher know.

FIRST AID

Make sure you know where your nearest first aid station is located, and what your accident reporting process is for your classroom. Most likely there will be a first aid kit in your classroom or nearby, and your teacher will use it to apply basic first aid if and when required. Accidents of a more serious nature may require referral to your school sick bay or first aid officer.

Figure 9.8 Wearing personal protective equipment is a necessary control measure.

TIDY WORKSPACE

Keep your workspace clean and tidy. Return any tools and materials not in use to their place of storage. Cluttered work benches and untidy rooms are potential hazards.

Always allow enough time at the end of a lesson to pack away tools, store project work and clean the practical classroom. Leaving things out at the end of a lesson can lead to damage and also creates a possible hazard for those who use the classroom after you.

CASE STUDY 9.1

Safe working practice at the Canobolas Rural Technology High School

The Canobolas Rural Technology High School is a government school in Orange, New South Wales. It offers a diverse curriculum including a successful Technology education program that features Design and Technology. As with any school, Canobolas has implemented safe working practices for staff and students to follow when working on practical tasks. Practical technology classrooms have been laid out to meet the workplace health and safety requirements in New South Wales government schools, including appropriate spacing between work stations, safe working zones around machinery as indicated by safety lines on the floor and emergency stop systems for electrical equipment. Dust and fume extraction is included for Timber, Metal and Food Technology learning spaces.

At the beginning of the school year, the Technology staff complete a risk assessment of the practical workspaces within the school. Using a form provided by the Department of Education's workplace health and safety team, staff check to ensure that the classroom and equipment are in good working order, machines are guarded, signage is in place and entries and exits are clear. Anything deemed to be not safe is corrected before lessons can begin.

When planning practical projects for any class, the teacher reviews the prior knowledge and ability of their students and then considers the requirements of the syllabus for the course. Once a suitable project has been selected, the teacher will check the Equipment Safety in Schools (ESiS) document. ESiS provides risk assessments for all power tools and machinery for New South Wales government schools and advises teachers on the safety training and control measures required for safe and appropriate use by students. The Chemical Safety in Schools (CSiS) document is a similar resource provided to advise on the use of materials, adhesives and other potentially harmful substances.

Before project work begins, teachers will induct students in safe working procedures for a practical classroom. This will include a demonstration of safe practice, the location of PPE and first aid procedures. Students will complete a test to demonstrate their understanding of what it means to be safe in a classroom. Project work can then commence. During the course of the project, teachers will train students on the safe use of hand tools, power tools and machinery as required. This process is determined by ESiS and often includes a teacher demonstration, teacher observation of safe student use and a written safety test. The teacher will record the date of the training and who was present, and students are not permitted to proceed with the use of equipment until these requirements are met.

Figure 9.9 The Metal Trade Training Centre at the Canobolas Rural Technology High School is an example of a well laid-out practical learning space. It is a well-lit area, with adequate artificial lighting and windows for natural light.

Teachers will manage risk in the practical classroom on a day-to-day basis in order to provide duty of care to their students. This is done primarily through active supervision in the classroom. They ensure that the room is free of hazards before work begins, that students are wearing all required PPE and that any unsafe behaviour is quickly corrected. They also expect that all students are working to ensure not only their own safety, but the safety of those around them.

During the school year, when a hazard is noticed by a student, it is reported to their teacher. The teacher will act on the hazard where possible; for example, a trip hazard caused by poorly stored projects will be corrected by storing the projects correctly. If they are unable to eliminate the hazard, the teacher will report it to the Head of Department. The hazard is then either referred to be repaired within the school maintenance process, or it is referred to the school's WH&S committee and reported to the Department of Education, through the use of a department-provided risk assessment form.

All schools follow a process for safe work practice, developed so that it suits their location, facilities and students. Analyse the role of well-structured, safe working procedures in a school such as yours.

Figure 9.10 Welding metal requires unique risk control measures, such as fume extraction and insulated floor mats. These measures complement personal protective equipment, such as a welding helmet, leather gloves and full-length cotton clothing.

9.4 Workplace health and safety legislation

In New South Wales, the health and safety of employers, employees and visitors to places of work are protected by law under the *Work Health and Safety Act 2011*. The relevant legislation is covered in Chapter 4 of this textbook.

As consultation is a key factor in ensuring the success of workplace health and safety, there are a range of ways in which businesses work with all involved to plan a safe workplace. Depending on the size of the business, employers may consult through a health and safety committee made up of stakeholders, employees may vote to nominate a health and safety representative, or they may negotiate to come up with another arrangement. Whichever way a business and its employees decide to go, these committees and representatives play an important role in ensuring that communication

consultation a meeting with the purpose of reaching an agreement

between employers and employees is ongoing. This ensures that hazards are identified and controlled efficiently, and the planned welfare and safety procedures are followed and improved as required.

Figure 9.11 Good workplace health and safety are required both by law and are solid business practice.

In New South Wales, management of the Work Health and Safety Act is undertaken by SafeWork NSW (called WorkCover NSW prior to September 2015). SafeWork NSW inspectors have the power to check that businesses, employers and employees are complying with the legislated requirements of the Act. Penalties for breaches of the Act can include:

- fines of up to $300 000, five years in jail or both for an individual
- fines of up to $600 000, five years in jail or both for a person conducting a business
- fines of up to $3 million for a corporation.

Workplace health and safety is not only law, it is also good business practice. When employees are away from work due to illness or injury, or tools and machinery are isolated from use as they are unsafe, the lost time leads to a loss of income for a business. Over the long term, this could lead to a business becoming unviable leading to the loss of employment. With livelihoods at stake, it makes sense for all involved to ensure that accidents are avoided at all costs.

GO

CASE STUDY 9.2

The Interactive Textbook contains a video case study looking at Sailfish Catamarans, a small business that in 2017 won an 'Excellence in workplace health and safety culture' award.

ACTIVITY 9.3

Search for an online news article reporting upon a case of the *Work Health and Safety Act 2011* being breached. Remember to refine your search to only return results from Australia, and select a case that has occurred in New South Wales. Once you have selected an article, summarise it by answering the following questions:

1 Describe the breach of the Act.
2 Identify the location and the key people involved.
3 Explain the consequences for those involved.
4 Propose a measure that could stop an event like this occurring again in the future.

COMMUNICATING

CHAPTER SUMMARY

- Safety is paramount in the Design and Technology practical workspace, as it is in any workplace.
- Everyone has the right to a safe workplace, and safety is everyone's responsibility.
- Risk management is the process of identification of any potential hazards, before they cause accidents.
- A risk management matrix is a tool used to assess the potential severity of risk caused by a hazard.
- The results of the use of a risk-management matrix are recorded on a risk-assessment form, along with suggested control measures.
- The risk control hierarchy advises on the best way to reduce the impact of any hazard.
- A job safety analysis helps us plan to avoid accidents before we commence practical tasks.
- Workplace health and safety is legislated in New South Wales under the *Work Health and Safety Act 2011*.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1 Hazard
2 Job safety analysis (JSA)
3 Legislation
4 Personal protective equipment (PPE)
5 Risk
6 Risk assessment
7 Safe operating procedure (SOP)
8 Work health and safety (WHS)

REVIEW TASKS

1 Compare a hazard with a risk.
2 Brainstorm a list of 10 possible hazards in your classroom.
3 Identify an injury that may take place in a Design and Technology practical workspace.
4 Describe the risk management matrix.
5 Propose the most useful time for using a risk assessment form.
6 Describe the process for reporting hazards in your classroom.
7 Identify five items of personal protective equipment that you will use in your Design and Technology practical workspace.
8 Describe the penalties for an employee if they are found to have breached the NSW *Work Health and Safety Act 2011*.

EXTENSION TASK

Displayed in close proximity to the described tool or machine, an SOP gives vital information about the possible risks, how to manage them through appropriate use and the PPE required. Create an SOP for a tool or item of machinery you have used recently.

Your SOP should include:

- the name of the tool or item of machinery
- a picture of it to help with easy identification
- a list of the possible hazards when in use
- advice on how to minimise the risks when in use
- the PPE required to safely use the item.

PRACTICAL TASK

During your time in Design and Technology classes, you will be required to demonstrate your ability to safely use a range of hand tools, power tools and machinery on a regular basis. This now includes advanced manufacturing equipment such as 3D printers, CNC milling machines and laser cutters.

To demonstrate your competence with using such equipment, you are to create an instructional video to show how to set up, operate and shut down an item of equipment of your choice.

Remember, you must:

- have completed all required theory, testing and training as instructed by your teacher prior to commencement

- produce a storyboard of what needs to be in your video, to be checked prior to filming by your teacher
- be wearing/using all required personal protective equipment
- ensure that the equipment is in good working order and any safety equipment, like guards, are in place
- not include any intellectual property that is not yours, such as images or audio downloaded from the internet.

10 Selecting and using a range of technologies

KEY TERMINOLOGY

- **Criteria**
- **Document**
- **Equipment**
- **Evaluation**
- **Justify**
- **Materials**
- **Peer assessment**
- **Requirements**
- **Self-assessment**
- **Success**
- **Techniques**
- **Tools**

This chapter explores the selection and use of a range of tools and equipment, materials and techniques, for designing and producing. It discusses how to document and evaluate decisions made throughout the design process using specified criteria for success. Addresses self-assessment and peer assessment on designed solutions and looks at how to reflect on students' learning in the design projects.

This chapter addresses **Outcome DT5-10** in the New South Wales *Design and Technology Years 7–10 Syllabus*. It deals with the content areas **Realisation of design ideas** and **Evaluating**.

Note that the dot point on designing and producing projects in a safe manner was covered in Chapter 9.

10.1 Realisation of design ideas

The design process in Design and Technology includes a realisation or production section, which involves you as a student learning skills or techniques to make your product, system or environment. The following criteria have been identified as the steps students need to take in the realisation of design ideas.

Figure 10.1 A digital presentation to the target market is required to get feedback.

You need to be able to develop one final chosen idea that is best suited to the requirements of a brief or project. Select a final idea that:
- satisfies the requirements of the brief or project
- takes full account of target market feedback and research conducted
- meets targets/deadlines via a management plan.

Consider:
- the purpose or identified need
- how choices can generate new directions
- creative and innovative combinations/applications
- traditional materials put to new uses
- budget/resource implications
- safe working practices.

You need to develop a final proposal considering, for example:
- initial sketches, 3D visualisations, a representation of what things might be like (e.g. a digitally manipulated image or drawing of your design)
- choice of materials/techniques
- using other designers' work to support informed decisions
- applying innovative and creative thinking
- evolving a personal approach/style
- how the final piece will be produced (e.g. timing, costs).

You will need to be able to present a final proposal to the target market for feedback and approval. Things to consider for this presentation:
- explanation of how meaning, purpose, thoughts and feelings might be conveyed to the audience

- sample material (e.g. maquettes, mood boards, design boards, sketchbooks, digital presentation)
- awareness of suitable materials/technology.

Take into account feedback, considering:
- suitability of proposed final idea to meet the client's requirements/preferences
- permission to proceed with final outcome
- use of any target market feedback to refine final proposal
- where appropriate, how to modify/refine the final idea.

You need to be able to produce a final outcome that meets the requirements of a client brief or project. To do this, you must:
- use materials, techniques and technologies safely
- monitor progress to meet targets and deadlines
- identify opportunities for improvements as work progresses
- consider practical restraints and aesthetic qualities.

You need to be aware of where the location or nature of work requires an outcome to be done to scale. The outcome could be presented as a prototype/maquette/

model, showing how the work would be seen when finished (e.g. a digitally manipulated image).

You need to be able to evaluate the success of the final outcome. Consider, for example:
- how well the brief was satisfied
- target market/audience reaction
- effectiveness of the original research
- how knowledge gained could influence future work

- final product against the original intention
- conflicting demands of the brief or project
- practical constraints/suitability of materials and processes
- effectiveness of the management plan
- conflicting demands of client preferences.

Source: https://cambridge.edu.au/redirect/8517

Design situation

Elements of design from past eras are repeated and contemporised in modern designs. During the twentieth century and in the first decades of the twenty-first century, many products became design classics or icons from the moment they were produced. This has often led to the product being the defining image associated with the decade it was created in and, as a result, influencing other forms of design within that period. Inspired by these antique, vintage and retro looks, products are continually redefined and reinvented for a more contemporary marketplace. This is evident in the selection of forms, materials and technologies used from fashion to interior design. Design is often cyclical, returning full circle to a contemporary version of a historic piece.

Design icons are popular products that have retained a timeless quality and gained popularity over the years. These products were deemed to be unique at the time of invention, memorable in their shape and classic in leading an entire design movement. Such designs are viewed as works of art, despite their functional purpose. The designs were based on new ideas at the time and often embraced creative ways to develop and manufacture products. Design icons from the late nineteenth century to the present day are often classified by the decade in which they were produced.

Figure 10.2 One iconic design is the Anglepoise lamp, a balanced arm lamp with joints and spring tension which allows the lamp to move in a range of positions.

Design classics include:
- Coca-Cola bottle
- Eileen Gray table
- London Tube map
- Bertoia wire chair
- Anglepoise lamp
- iPhone
- Alessi Juicy Salif Citrus-Squeezer
- Eames chair
- Marc Newson Qantas Skybed
- Marc Newson Lockheed Lounge.

CASE STUDY 10.1

Design movements

Interior designers focus on our living and work environments, catering for our needs, different tastes and styles. There are a variety of design movements that have emerged over time that can form inspiration for designers.

Design movements timeline

1850 1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2007

Arts and Crafts Movement 1850–1915

Art Nouveau 1880–1910

Modernism 1880–1940

Futurism 1910–1945

Art Deco 1910–1940

Bauhaus 1920–1934

Surrealism 1925–1930

Streamlining 1930–1950

Organic Design 1930–1960 and 1990–Present

Scandinavian Modern 1935–Present

Contemporary 1945–1960

Pop Art 1958–1972

Space Age 1960–1969

Minimalism 1967–1978

Postmodernism 1978–Present

Memphis 1981–1988

Deconstructivism 1988–Present

Choose a design style or movement from the timeline resource. You will research it as part of this case study, and also use it as the basis for the next designing activity. Using your chosen style or movement, conduct research to answer the following questions:

1 Explain the origins of the design style or movement.
2 Identify key designers and examples of their work.

3 Identify the features that most represent your chosen style/movement.
4 Locate online a series of images of products and interiors that use this movement/style. Copy and paste the images into a document and label the key features, referring to the elements and principles of design.

Present your work as an A3 poster using the Adobe Creative Suite software (e.g. Photoshop, InDesign, Illustrator).

10.2 **Technological processes**

People, cultures and societies globally rely on technologies in the following ways:
- information management
- communication
- knowledge creation
- transportation
- food and fibre production
- energy and water management
- construction
- manufacturing
- health and wellbeing.

You have access to a broad range of technology processes and production skills to design, produce and evaluate products, services and environments. Because the choices are so broad, you may want to take one of these approaches when deciding on a technology or project:
- concentrating on specific materials such as metal, ceramics, timber, electronics or food
- focusing on a specific type of product, service or environment, such as a wholly natural or wholly digital environment

- focusing on a single area of specialisation, such as engineering, food technology or architecture.
- using knowledge from other fields, such as history, art or science.

The initial selection of a technology from a range of possibilities is key to the successful operation of any design project – technologies are unlikely to function adequately if inappropriate choices are made at the start. Although this is understood by many, people often underestimate how difficult the choice can be. The design brief is intended as a guide to selecting the most appropriate options; the brief should alert you to any problems and give you an indication as to what possible solutions might be.

Figure 10.4 A proper, well-informed brief can help designers decide the best technology to use.

Below is a list of things to keep in mind once you have your design brief and are ready to select your technologies for the project.
- Know your brief/objective and your target market. Who are you targeting your project towards? Define what technology is needed in your design project.
- More expensive does not necessarily mean better. Do some research on prices and add this information to your finance plan.

Figure 10.3 Wearable technology, such as smartwatches, now permeates our lives.

- Determine what is out there and available; narrow the field. Research your products/technologies and do a comparison. Place this information in the research section of your design portfolio.
- Core functionality: How does this technology meet your needs? Does it need to integrate with other products?
- Keeping in mind your target market use, project success and project timelines, how will the technology be implemented?
- What technologies are needed for ongoing support? Research this and purchase accordingly.

Some of the technologies that are available to you as a Design and Technology student include:

- 3D printing – rapid prototyping
- laser printer
- infographics and logo design
- software applications
- prototypes
- modelling, jigs, vacuum former and vinyl cutter
- silicon moulds, urethanes and resins
- ICT – programming, coding, electronics, photography and image manipulation
- agriculture, aquaponics, garden design and horticulture
- computer-aided design (CAD)/computer-aided manufacturing (CAM)
- computer numerical control (CNC)/computer-integrated manufacturing (CIM)
- textiles – costume design, hand stitching, hand embroidery, pattern making, beading, dyeing fabric, screen printing, riso prints and upholstery

- textile cutters and embroidery machines
- sublimation textiles printer
- architecture – contoured land development, renders, animations, elevations, plans, fly-throughs, model making
- blow-forming machine, saws, drills, grinders
- green screening area
- laptops, scanners, printers and tablets
- smartphones and applications
- freeware and podcasts
- web-based technologies (e.g. wikis, blogs, Moodle)
- social learning technologies (e.g. Pinterest, Edublogs, Skype, Wikispaces)
- presentation and portfolio preparation tools (e.g. Google Docs, YouTube, TED, Prezi)
- organisation and communication online tools (e.g. Dropbox, Evernote, Google Earth, Twitter, Facebook, SlideShare, Google for Education)
- digitising tablets and digital cameras
- drawing – sketching, contraction drawings, rendered pictorial drawings.

Figure 10.6 A 3D printer can help produce a prototype quickly.

Figure 10.5 Price is a consideration in a new design but is not everything.

Figure 10.7 Social learning technologies, such as Pinterest, can be used as design aids.

Issues to consider when using technologies

As with other design projects, when working on projects involving technology we need to consider a range of factors, including health and safety concerns, consumer and client needs, cultural beliefs and values, and commercial realities. Apart from creative designs, designers are also responsible for the ethics of their designs and solutions.

Changes in technology require us to critically examine how those changes might influence our ideas, projects and actions as designers. Products and services, and the use of those products and services, are a manifestation of our changing

societies, but also change us and our environments in return.

It is therefore important to be critically aware of technology processes and how they might contribute to positive social change through design. Designers must always consider what the impacts of design solutions on the world around us are.

It is important to make ethical decisions about the use of these technologies and develop solutions to ensure a sustainable future for all Australians.

ACTIVITY 10.1

1   Research a particular commercial enterprise and identify three technological processes that are crucial to its ability to develop design projects.
2   Reflect on a design project you have completed. Identify a particular technological process that would be valuable if you were scaling the project up for commercial production.

COMMUNICATING

Figure 10.8 Changes in technology influence design and should be taken into account when considering new ideas and projects.

10.3 Materials, resources and techniques

Stage 5 focus areas of design include the following:

- fashion, accessories and jewellery
- environmental, agricultural, landscape and marine areas
- aeronautical, industrial, structural, engineering and transport areas
- architectural, interior design and furniture areas
- graphical, communication, digital media, information systems and software areas
- packaging and promotional areas
- food and medical areas.

When designing and creating products, you have the responsibility to select and use appropriate and effective tools and equipment, materials, technology and data systems. The products, systems or environments you design should be healthy, safe, socially acceptable, and economically and environmentally sustainable.

Design and Technology materials, resources and techniques can be divided into categories as shown in Table 10.1.

Table 10.1 Examples of materials, resources and techniques from different categories

SHAPE	DRILL	JOIN	FINISH	MEASURE	TRANSFORM	MANAGE
• Bandsaw • Bench folder • Dressmaker's scissors • Hatchet stakes • Jeweller's saw • Jigsaw • Metal lathe • Paper patterns • Piercing saw • Pinking shears • Plane • Rasp • Scroll saw • Tenon saw • Tinman's rolls • Tinsnips • Twisting • Unpicker • Wood lathe	• Drill press • Forstner bit • Hole saw • Metal lathe – boring • Metal punches • Solid punch • Spade bit • Twist drills	• Bolting • Buttons, studs, hooks and eyes • Constructing frames • Dovetail joints • Glued joints • Hot melt glue • Knockdown fittings • Machine sewing • Mitre joints • Nuts and bolts • Overlockers • Sewing and stitching • Soldering	• Applique • Embroidery • Food presentation • Plastic coating • Polishes • Spray paints • Stains • Vegetable oil • Water-based sealer	• Checking squareness using a try square • Constructing and marking out angles other than 90° • Estimating weight and measuring length, width and thickness in mm • Marking and measuring angles to suit a design brief • Measuring tapes	• Casting • Drying • Fabricating constructions (e.g. carcase, framed, laminated) with emphasis on accuracy and strength • Freeze-drying • Injection moulding • Mixing lists of ingredients (e.g. blending, folding, whisking, kneading, steaming, boiling) • Modifying recipes • Moulding • Preserving	• Blade sharpening • Carrying/lifting • Catering • Consumer protection • Devising equipment for using materials (e.g. jigs) • Dietary guidelines and consumption • Duty lists • Health and safety issues with materials/ingredients • Labelling • Material budgets • Materials/ingredients

Tools and equipment

Once you have planned the manufacture of your product, system or environment, you should be ready to turn your idea into reality (also known as realisation). Hopefully you will find this the most enjoyable part of Design and Technology. If you have planned and prepared thoroughly, the realisation of your project should be straightforward. The stages of manufacture will have been identified and broken down in a detailed working schedule. This schedule could also be called an action plan.

Quality is the key issue to keep in mind throughout your project. In both your portfolio and your practical realisation, you should always aim to produce work of the highest quality. This starts with the selection of tools, equipment and materials and the initial marking-out stages. Each job, such as marking out, cutting and joining, has its own special tools. As part of your planning, you will need to consider carefully which tools to choose. This will lead to greater accuracy when starting to cut and join separate parts. There may be times when you need to modify or alter your idea due to limitations and constraints placed on the project. This might be a result of the material or manufacturing processes you have available in your school. Record all the modifications you make in your portfolio.

Materials

Your design project will be affected by the type of materials you have access to. Sometimes your preferred choice of material may be unavailable, or too expensive, and you will need to look for an alternative, or adapt your design project. For example, you may need to make your jewellery out of silver rather than gold, due to cost. You may also discover that the material you originally planned on using is unsuitable for some reason – perhaps your prototype didn't perform as well as you hoped – or you may limit your choices due to personal ethics, such as only wanting to use Fair Trade materials.

Sometimes thinking laterally, and using materials not immediately obvious for your project, can produce innovative results. Consider Case studies 1.2 (paper made out of stone) and 8.2 (cups made from concrete). As you saw in Chapter 2, you need to clearly establish the resource requirements for your project in the design brief. This will assist in planning the whole project, including the financial costs (as discussed in Chapter 8). So it is crucial to research and calculate your material requirements at the start of the project. Careful advance calculations can help ensure you purchase the right amount of material, so you are not caught short, or left with too much surplus.
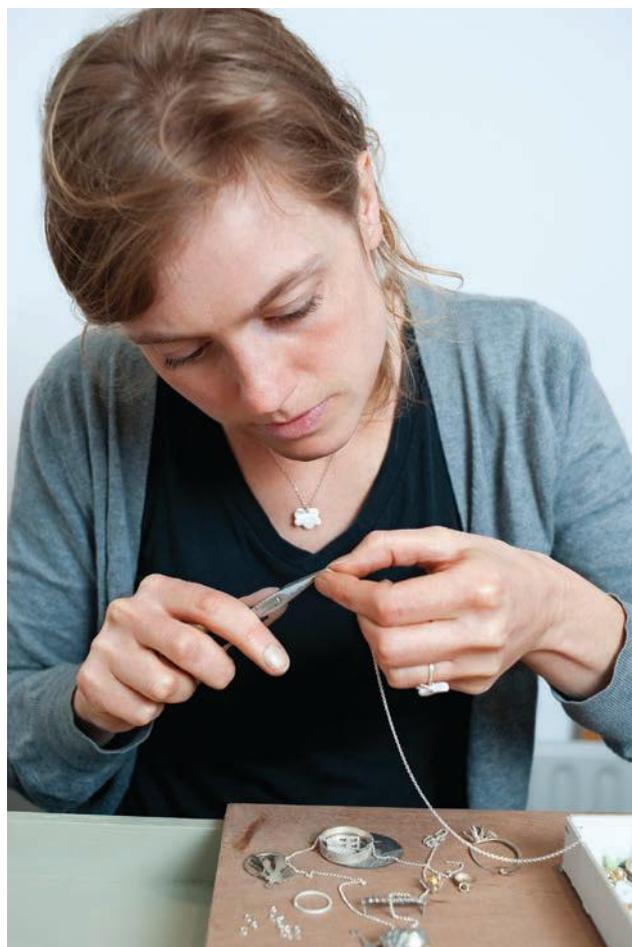
Figure 10.9 When working on jewellery, one materials decision is whether to use gold or silver.

Design techniques

A technique is a way of carrying out a particular task. It is the execution of a skill or ability in a particular field. There are two types of technique: specific and general. With specific skills, the technique would usually be associated with a particular occupation. For example, a surgeon would need a steady hand and would have learned to identify visually how to make repairs on the intricate internals of our bodies. In the general skills area, an example may be strategies you have employed and implemented to ensure that you complete your homework before the due submission date. The focus groups in Design and Technology consist of skills or techniques you need to master in order to complete design projects in these areas.

Figure 10.10 Architectural techniques include renderings and sketching.

Some skills and techniques are listed in Table 10.2.

Table 10.2 Various techniques and skills in Design and Technology

FOCUS AREA	SOME OF THE TECHNIQUES AND SKILLS YOU WOULD NEED TO SELECT OR LEARN IF COMPLETING A DESIGN PROJECT IN THIS AREA
Architecture	Researching; sketching; project management; mastering an architectural software package; libraries; fly-throughs and animations; rendering; printing
Digital media	Researching; sketching; project management; mastering software packages in digital imagery; digital video; video games; web pages and websites, including social media; data and databases; digital audio (e.g. MP3s and e-books); saving and managing files; packaging; CAD, CAM, CIM; marketing the files
Fashion	Researching; sketching; project management; sourcing and costing materials; pattern making; grading and fitting; cutting; marking and measuring; toiles and prototypes; basic construction and sewing skills (e.g. darts, seams, waistbands, collars, cuffs, facings, pockets, buttons, buttonholes, zips, plackets, hems, linings, pads, sleeves); ironing and finishing
Furniture	Researching; sketching; project management; sourcing and costing materials; cutting list; using marking-out tools; cutting; filing; sanding; finishing; upholstering; powder coating; using the 3D printer; using the laser cutter; measuring and shaping
Graphical	Researching; sketching; project management; sizing and manipulating; mastering software packages in photograph manipulation; drawings; line art; graphs; diagrams; typography; numbers; symbols; geometric designs; maps; engineering drawings; combining text, illustration and colour; the deliberate selection, creation or arrangement of typography alone (e.g. in a brochure, flyer, poster, website or book); rendering; printing

Increasingly knowledge is becoming more complex, and developing skills and techniques requires an understanding of the technologies required for the solutions. These include materials, tools and equipment, systems, technologies and social factors. Knowledge and understanding should come from both contemporary and historical sources of:

- the properties and characteristics of the tools and equipment, materials and systems that are central to technologies, whether traditional, contemporary or emerging, and factors that may restrict their use
- the combinations of the connections between tools and equipment, materials and systems that create solutions to problems or identify new opportunities
- the ways in which people develop and use technologies to provide solutions to meet their needs
- social factors, including economic, ethical and environmental issues that affect the relationship between technologies and people (individuals and communities, whether local, national or global) both positively and negatively.

Activity 10.3 will allow you to explore interior design and industrial design in the form of an accessory.

As a designer you need to consider a number of factors that will influence your design. You will have limitations set on the materials you use and you will need to design for a particular space of your choosing.

You have seen in Table 10.2 that there are a number of general skills and techniques that apply across several focus areas: sketching, for example. Many of these have been discussed in earlier chapters, but we will briefly revisit six of them.

SKETCHES

Sketches include thumbnail drawings, rough and developmental sketches, technical drawings, exploded views of construction/form, and computer-aided drawing forms.

TECHNICAL DRAWINGS

Technical drawings are finalised conceptual sketches that feature all necessary construction information, such as measurements of size and weight. Features in technical drawings need to be identified using the specialised graphical language set by ISO standards. Often, technical drawings are constructed on computer software, such as CAD.

COMPUTER-GENERATED RENDERING

Computer-generated rendering (or computer-generated imagery – **CGI**) is an increasingly common commodity used to professionally communicate a design to a marketing firm, or simply to create a professional visualisation for the client, company or entity. The advantage of CGI is that a design is instantly marketable, which increases productivity due to the time lapse between production and advertisement.

CGI (computer-generated imagery) using computer software to create and assist in the development of visual elements used in art, printed media, video games, films, television programs, commercials, videos and simulators

Figure 10.11 3D computer-generated renderings help showcase how the final product will look and operate in real life.
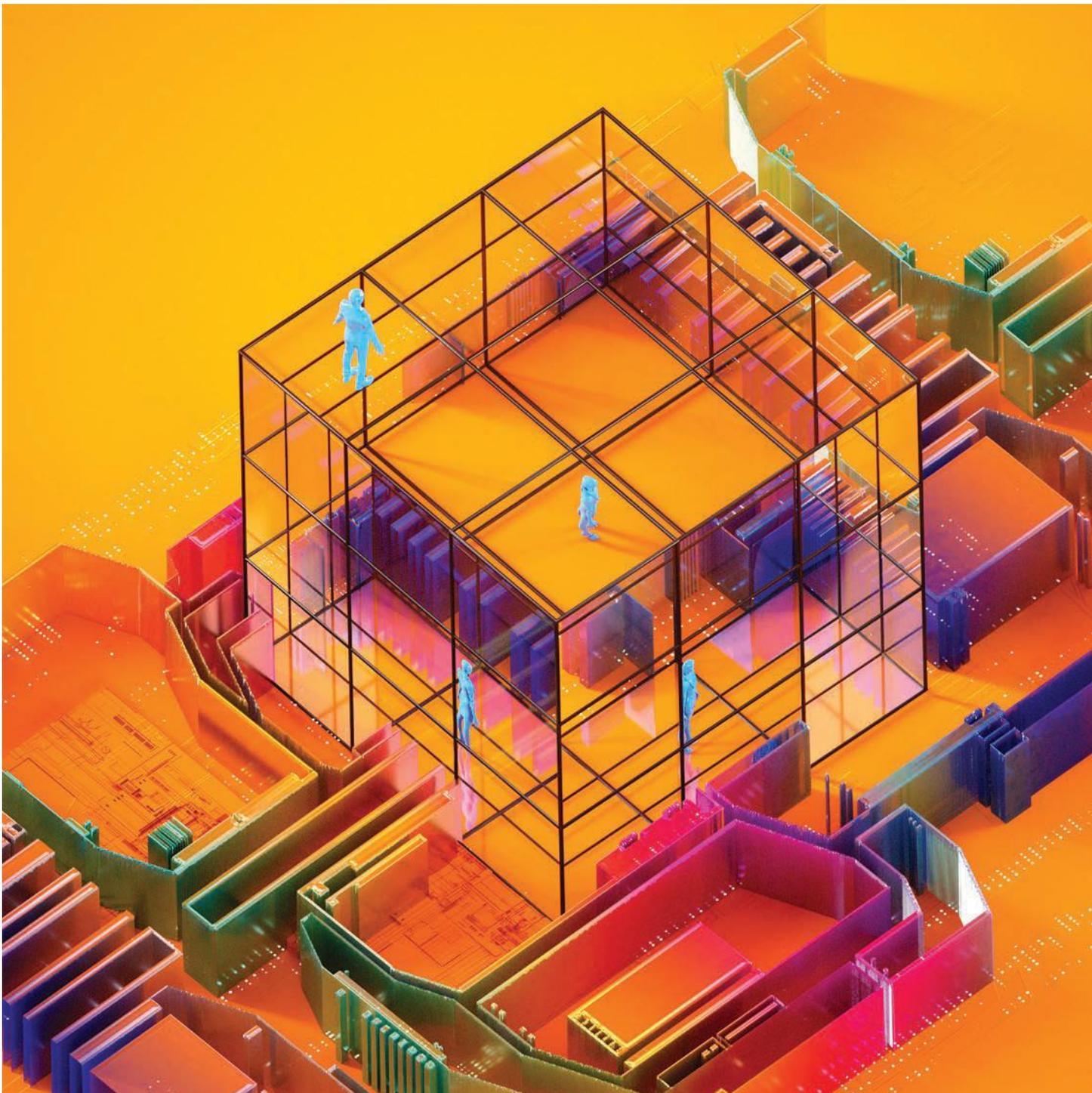
STORYBOARDS

Storyboards are a series of sketches or photographic evidence that visually illustrate how the design solves the problem it is being created to solve. Often, storyboards feature visualised actions that are framed in various stages to properly communicate how the design physically operates.

DEMONSTRATIONS

Demonstrations are a trusted method used to show how a design will function. Demonstrations of a design often accompany sketches, technical drawings, CGI, storyboards and prototypes to effectively communicate ideas to a client, company or entity.

PROTOTYPES

Prototypes are miniature or scaled-down model samples, which can either be functional or non-functional. Essentially, the purpose of a prototype is to represent in 3D, and to communicate to the client, company or entity, the design and/or aesthetically related issues using the convenience of a scaled-down portable model.

Figure 10.12 A practical demonstration of a prototype helps showcase the design to the client.

ACTIVITY 10.2

1   What are two ways you could calculate how much material you would need to make a bedside table? What are some tools that could aid you in your materials calculation? List five attributes a resource plan could include.

2   Complete the table below to assess the requirements for the design projects listed.

	DESIGN PROJECTS	TOOLS AND EQUIPMENT NEEDED FOR THIS DESIGN PROJECT	MATERIALS NEEDED FOR THIS DESIGN PROJECT	TECHNIQUES NEEDED FOR THIS DESIGN PROJECT
a	Design and make a vertical garden using Arduino temperate gauges and self-watering systems.			
b	Design and make a marketing/corporate identity kit for a new business. The kit must include a business card, flyer, 'with compliments' slip, letterhead and pamphlet that could be used for the launch of a new business.			
c	Design and make a range of unisex teenager clothing, aimed at ages 13–15. The range must include pants or shorts and a top to be worn by a male and female teen. It needs to have a chosen theme present throughout the range.			
d	Design and produce a container to use in your home for growing herbs. There should be at least five herbs that could be produced. The container should be made from metal and timber.			

3   Discuss why it is important to select the right tools and equipment, materials and techniques for your design project.

4   Think about a design project you have completed at school. List all the tools, materials, equipment and technologies you used. Evaluate whether they were the right resources for the project. Make five evaluative statements.

COMMUNICATING

Figure 10.13 Doing sketches is an initial step in a fashion design project.

Communication techniques

The selection of appropriate communication techniques ensures that the target market's requirements are met. Communication between the designer and target market will not only ensure that the objectives of the project are achieved, but can also help identify any problems and resolve them.

An architect would select a combination of appropriate techniques, such as oral communication, sketches and CAD designs, and prototypes or scaled models of the building being designed. A vehicle designer would select a combination of appropriate techniques, such as attending company briefings, oral communication, communicating with engineers in writing and physical meetings, and presenting the design via sketches, CGI, prototypes and models.

The key to successful communication is the selection of the right techniques to communicate with the target market to realise the transition from an idea to finished product or intended objectives of the project.

Figure 10.14 A vehicle designer should communicate with the engineers who will be working on the final product.

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ACTIVITY 10.3

In this activity you will plan the design for a themed clock.

Design brief

Design a themed analogue clock, considering a particular space where it is intended to be used. The theme should be influenced by the design style or movement you researched for Case Study 10.1.

Questions to think about when designing the clock:

- How can I challenge myself as a designer?
- How can I make a statement?
- What will draw the client's attention?
- Will my design be wall hung or sit on a table?
- What emerging technologies and materials can I use?
- What tools, materials and equipment are available to me to design my clock?
- How can I apply the elements and principles of design to enhance my design?

Requirements and limitations

Your clock must follow these requirements:

- The clock must be constructed primarily from timber and perspex
- Perspex and metal detail can be added for texture/shape to suit the chosen design movement; for example, the numbers
- Size limitation not to exceed 400 mm x 400 mm x 300 mm
- Elements and principles of design must be incorporated
- The clock must reflect the chosen space environment and design movement.

Tools and equipment needed to make a themed analogue clock:

- marking-out tools – ruler, centre punch, scribe
- hacksaw
- coping saw
- pedestal drill
- laser cutter
- vinyl cutter
- various grades of files
- drill press
- magna bender
- cold saw
- plasma cutter
- computer and software to present research work
- paper and pencils to sketch ideas.

Materials needed to make a themed analogue clock:

- 3 mm Perspex
- radiata pine
- various coloured scrap pieces of Perspex
- various materials – timber, plastic, miscellaneous nuts, bolts, wire, springs, etc.

Continued

ACTIVITY 10.3 *(Continued)*

Techniques needed to make a themed analogue clock:
- sketching and researching
- marking out
- cutting and shaping
- joining
- finishing processes
- possibly the use of new technologies such as electroplating and powder coating of metals.

Once your clock is finished, please complete the following:
1 Justify your final design.
2 Give reasons for your decisions.
3 Clarify how your design idea reflects the brief and the design movement you chose.
4 Identify the elements and principles of design you have applied to your final idea, and evaluate your decisions.
5 Identify each component (material) and the appropriate manufacturing processes to achieve shape and form on your design.

GO

An assessment grid for this activity is available in the Interactive Textbook.

Figure 10.15 A themed analogue clock based on the Art Deco design movement

DESIGNING

ACTIVITY 10.4

GO

This activity, in which you will design an e-book about innovation and emerging technologies, is available in the Interactive Textbook.

DESIGNING

10.4 **Justifying the selected techniques and resources**

You will be asked to justify the materials, components, processes and other resources you have selected for the development of your design project. You are to present logical reasons for your choice of materials, components, processes and other resources by following the steps below:

- Use the headings shown in Figure 10.16 below so that you can complete this section correctly.

- You must provide options in all the categories before you can justify your choice.

Reasons (justification) must be given for your choices, and these reasons must be based on substantial research and experimentation, which should be documented in the research section of your portfolio.

Figure 10.16 Example of selection and justification of materials, processes and components for a chest of drawers

SELECTION AND JUSTIFICATION OF MATERIALS (LIST ALL OF THE MATERIALS USED IN YOUR PROJECT AND FOR EACH STATE THE OPTIONS AND JUSTIFY YOUR SELECTION)		
OPTIONS	**SELECTION**	**JUSTIFICATION OF SELECTION (BASED ON DOCUMENTED RESEARCH)**
FRAME		
• Solid timber • Veneered MDF • Plywood	Solid timber	• Timber has the required strength to support the top • Timber can to be joined using strong joints to increase the durability of the project.
DRAWERS		
• MDF • Plywood • Radiata pine • Hardwood	Hardwood	As the drawer sides won't be seen, and to save on costs, timber was not selected. Hardwood was selected, as it will last longer and is cheaper than the chosen timber.
JOINING LEG TO APRON		
• Dowel joint • Biscuit joint • Mortise and tenon joint • Loose tenon joint	Mortise and tenon joint	The mortise and tenon is one of the strongest joints because of its large gluing surface and the shoulders add strength and stability to the joint.
DRAWER RUNNERS		
• Metal slides • Timber slides • Plastic slides	Metal slides	• Strong • Durable – long-lasting • Smooth operation • Self-closing • Simple to attach

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ACTIVITY 10.5

Your brief is to design and produce a small piece of furniture that will store magazines and newspapers. It will stand in a hallway. Consider how a range of different materials and processes might be used to produce the styling and structural features required.

Complete a table like the one below for this design project.

SELECTION AND JUSTIFICATION OF MATERIALS		
Options	Selection	Justification of selection (based on documented research)
SELECTION AND JUSTIFICATION OF PROCESSES/TECHNIQUES		
Options	Selection	Justification of selection (based on documented research)
SELECTION AND JUSTIFICATION OF COMPONENTS/TOOLS AND EQUIPMENT		
Options	Selection	Justification of selection (based on documented research)

DESIGNING

Figure 10.17 You are designing a piece of furniture for a hallway.
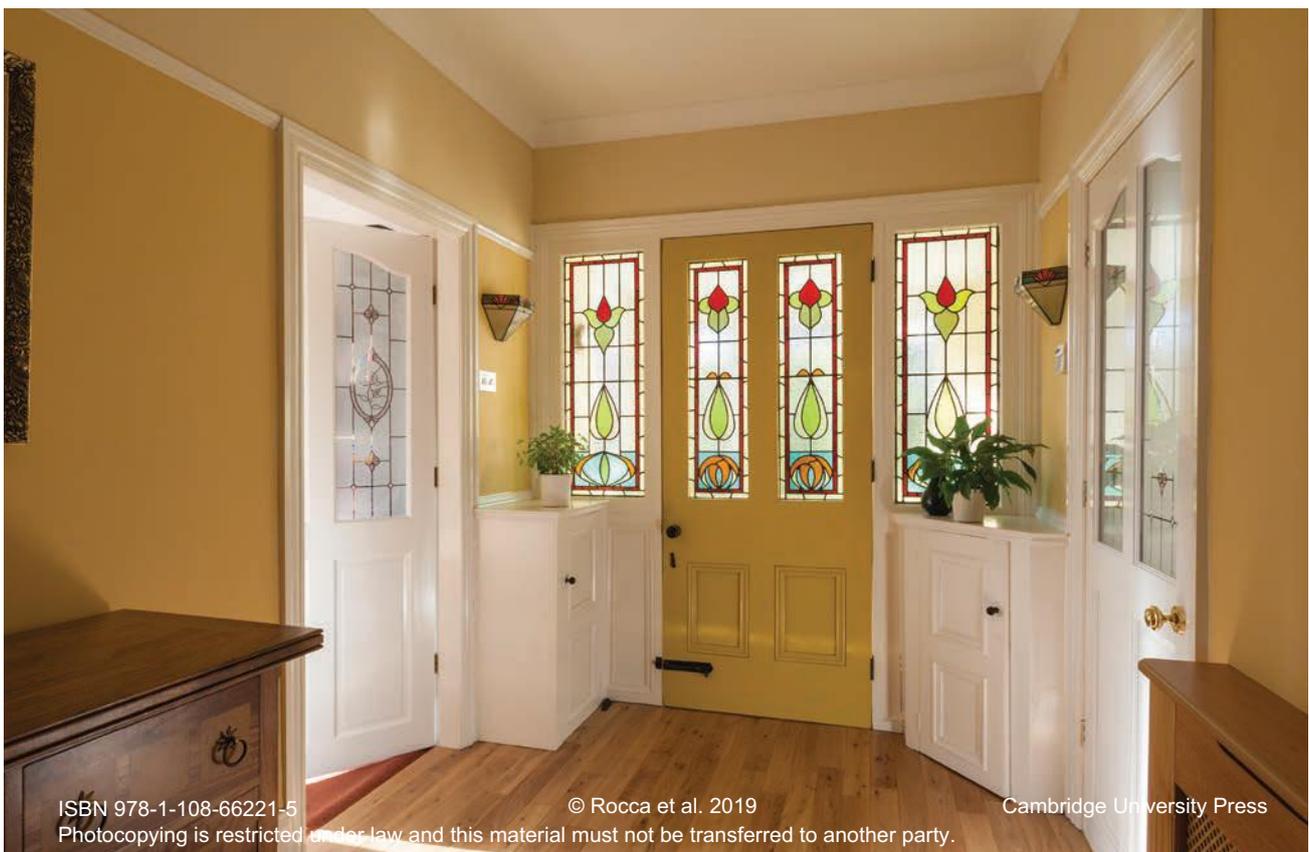
10.5 Evaluation and self-assessment

Evaluation is one of the most important steps in the design process. It will help you to look back at your work and determine what was done well, what areas there are for improvement and whether the overall target was achieved. In order to effectively evaluate your work, it is important to monitor your progress and keep records of all actions. By doing this, you keep abreast of whether the inputs are producing the planned outputs and whether the design is remaining true to the design brief.

When evaluating your project, it is best to always refer back to your original design brief and use your criteria for success to measure your progress. Analyse the aesthetics and test the function of the project, always referring back to your listed criteria.

Evaluations do not need to be completed only at the end; it is imperative to the success of your project that you evaluate at each stage of the design process. However, an overall evaluation should be completed at the end.

Consider the following points when completing a final evaluation:

1. Are you happy with the overall design? What would you change?
2. Did the materials you chose create the outcome you intended?
3. Is the colour scheme suitable?
4. Relook at your criteria to evaluate success, did it all happen and look like you said it would?
5. Did you complete the project within the timeline? If not, what alterations could be made to ensure timeliness?
6. Is your design safe?
7. Did the techniques you used suit your project? Did you have to alter techniques?
8. Does everything work? Are there any design faults?
9. Did you address the target market's needs?
10. Does the design look right?
11. What external and internal feedback have you received?

Figure 10.18 Once feedback has been received, it is time to do an evaluation.

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Criteria for success

The criteria for success is a list that states clearly the important function and aesthetic features of your planned design. The criteria for success should be completed at the beginning of the design process and should be referred to throughout the entire process. It will be an important tool in achieving your intended design solution and for your final evaluation. Depending on your overall design, your criteria for success will include a range of things. Some areas you may consider when developing your criteria include:

- functionality
- aesthetics
- ergonomics
- safety
- cost
- target market
- durability.

Figure 10.19 A product should include both function and aesthetics in the final design.

Once you have established your criteria, the most effective way to display them is in a table (see Figure 10.20). For each criterion you have listed, you need to justify why it is important to the success of the project, then describe how you will test or evaluate whether or not the criterion was met.

Figure 10.20 An example of criteria for success for a design project

DESIGN PROJECT: A VIDEO SHOWING PEOPLE HOW TO RECYCLE IN THEIR OWN HOMES		
CRITERIA	**JUSTIFICATION**	**METHOD**
FUNCTIONAL CRITERIA		
It must hold the audience's attention and keep them interested for the entire duration. Should not be tedious or monotonous.	Studies show that people lose interest in videos if they are longer than three minutes. In order to engage their full attention, it should be a short film and this will impact the viewing engagement time.	Show the film to groups and record their reactions while they watch.
It must create a strong impression on the viewer.	Use statistics and facts about waste and pollution and this will then lead to increased education of these issues.	Research statistics and facts about waste and pollution.
It must show the possibilities and potential of digital media.	Discover new ways to share video and use popular applications such as YouTube or Instagram.	Test the video on different platforms to choose the most suitable one.
By the end of the video, the viewer should be clear on how to recycle in their own homes.	Main purpose of the video is to be informative and to provide education to the target market.	Show the film to groups of people and quiz them on their recycling knowledge afterwards.
AESTHETIC CRITERIA		
It must include a balance of genders and people of different backgrounds.	Appeals to a broader range of people and promotes inclusion.	Inspect the video on completion.
It must have an effective set of graphics.	Helps the viewer to digest facts and statistics.	Show the film to groups of people and quiz them on their recycling knowledge afterwards.
It must include Australian products.	This will make sure the video is relatable to the audience.	Research the most popular products in Australian households.

Evaluation techniques

There are a range of ways to evaluate your projects. The technique you use will likely depend on the overall project and what exactly you want clarified at the end. Some evaluation techniques may include the following procedures:

- At the beginning of your project, create a checklist of everything you want to achieve when you have completed the design. Go through the checklist and check off items if they have been achieved.
- Create a questionnaire to gain external feedback. The questionnaire could include questions similar to ones used previously in this chapter or include questions more specific to your project.
- Conduct interviews with the people you have worked with on the project to gain their perspective and learn from their experiences. You could also interview your target market, present them with the designed solution and record their reactions.
- Extensive testing and experimenting will alert you to any design faults.

Figure 10.21 Evaluation should include extensive testing and experimenting which can also help eliminate design flaws.

You can divide your evaluation into three sections – individual (you), society (your target market) and the environment (where the product, system or environment will be used). You can apply the questions in Table 10.3 to your project.

Table 10.3 Evaluation questions for your design project

INDIVIDUAL	SOCIETY	ENVIRONMENT
• How does it affect you?	• Does it satisfy the target market's needs?	• Did you consider ecological issues and sustainability?
• Does it make your life easier or more valued?	• How has it affected society or the community?	• Did you consider paper supplies and pollution?
• Does it increase your quality of life?	• How does it relate to use by society? Cost? Influences?	• Did you consider non-renewable and renewable resources?
• Does it affect your behavioural buying?	• Are people better off because of it?	• Did you consider environmental effects?
• Does it affect other people in your demographic or geographical area?	• Are people happier or safer because of it?	• Did you consider planned/built-in obsolescence?
• Does it increase your skills and knowledge?	• Are people more aware or wealthier because of it?	• Did you consider cradle-to-grave analysis?
• Does it substitute low cost over quality?	• Does it give people more leisure time or increased status?	• Did you conduct a life-cycle analysis?
• Who set the budget? Did you keep to it?	• How will it be used by society?	• Did you consider the environment in which it will be used?
• What was the nature of your work? What skills did you learn?	• Do people possess greater skills, knowledge or understanding because of it?	• Could it be better used in the environment for which it was designed?
	• Does it relate to social or moral conscience?	• Was there a shortage of raw materials?
	• Did it address technological change?	• Did it address increasing government intervention laws?
	• Did it address ethics and privacy?	• Did it address tropical deforestation?
	• Did the advertising connect with the target market?	• Did it address waste/water pollution?
		• Did it address resource consumption?

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An example of a student self-evaluation is provided below.

Design brief

Conduct an investigation of ways that people have adorned their bodies for different occasions, places and times. Select a culture and research the importance of body adornment. What meaning does the adornment carry for the wearer? Reflect on this and develop necklace design ideas using a range of sources of inspiration.

Example of student self-evaluation

As part of the design process of jewellery technology, it is important to evaluate not only our process, but also our product. This is imperative in determining the success of my product, which is a South American-inspired necklace. Evaluating a design is a necessary part of the design process. This process will help me measure my skills and understanding of jewellery technology, things that could be changed, how well I worked individually and how I would approach something like this again in the future.

I will evaluate different aspects of the design and parts of the process that led to it. This will include:

- the purpose of my work
- aesthetics
- materials and finish
- improvements to be made.

Purpose of my work

This design process, like many successful design processes, included a design brief that I was required to create, analyse, evaluate and follow throughout the process. I needed to consider this during the design and development of my end product so that it was a success and followed course guidelines. The design brief specifically stated that the purpose of our work was to design, produce and evaluate a piece of adornment using a chosen culture as inspiration. Analysing this brief as a class, we discovered that the design brief was saying that we have the choice of designing for whomever we want and that we should select a particular culture with notable jewellery styles and source our products from this. It also meant that we needed to consider carefully what is meaningful to us in terms of expression and adorning ourselves. We also had the opportunity to think about what kinds of jewellery we like and the different cultures around the world that we respect and are inspired by generally. The brief also stated that we would be working with resin or silver, so therefore our work was a resin/silver jewellery piece. Our work also has the purpose of combining a number of other materials, including copper, fabric and beads, to create a unique product made from diverse materials. The brief also stated that the product will include the elements and principles of design, which are:

- elements of design: line; colour; shape; texture (visual arts); space; form
- principles of design: unity; point, line and plane (plp); balance; hierarchy; scale; dominance; similarity and contrast; movement, rhythm/pattern.

ACTIVITY 10.6

Answer the questions below based on the following design brief: *Design and construct a model CO_2 car that is made out of wood.*

1   Make a list of the research that would need to be completed before starting the project.
2   Compile a list of criteria against which you would measure the success of the wooden car.
    The criteria list should start with 'My car must …'
3   In a table like the one below, list the materials, tools, equipment and techniques that would be used.

MATERIALS	TOOLS AND EQUIPMENT	TECHNIQUES
•	•	•
•	•	•
•	•	•
•	•	•
•	•	•
•	•	•
•	•	•

4   Complete an evaluation of the possible things that could go wrong in the design and construction of the wooden car, and how these could be managed.

DESIGNING

Figure 10.22 Planning a project before you begin can help your design succeed
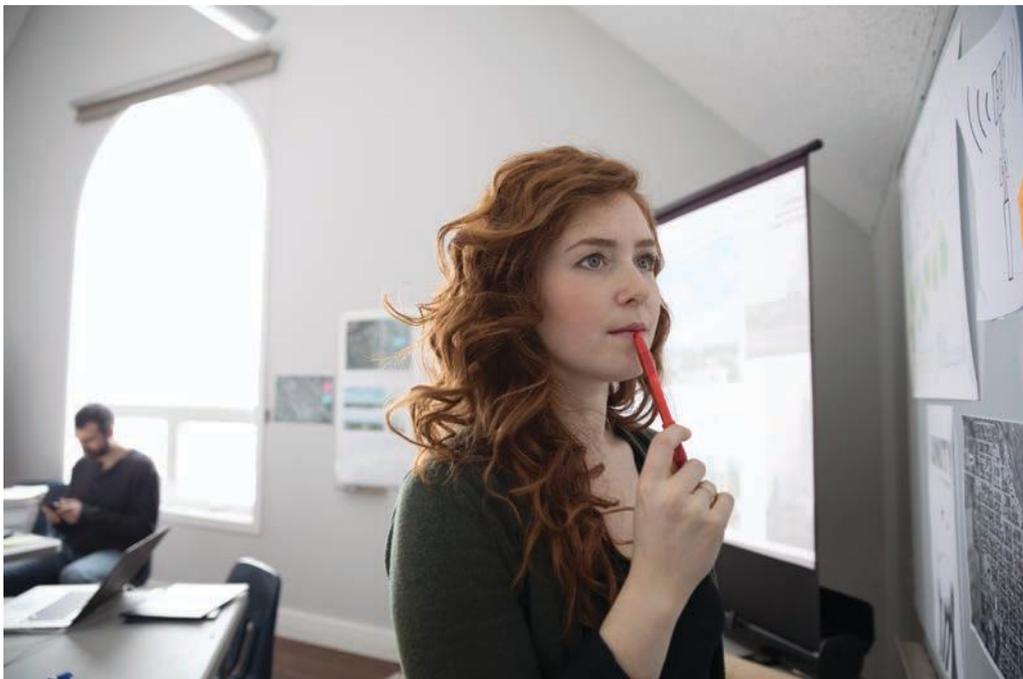
Justifying and documenting decisions

Justification and documentation of decisions are achieved in the design rationale, a document recording the reasoning used in the design process, which should be included in your portfolio. It should carefully list all decisions and the reasons for reaching them. Its main aim is to support the designer in communicating arguments for decisions in the design process. The design rationale should contain for each decision:

- the other alternatives considered and their advantages and disadvantages
- the arguments behind the decision and the reasons and justification for it, including how the decision helps achieve the aims of the product.

Nothing backs up design decisions like data. Often someone else has already done something similar in principle. Find a case where a similar design decision worked and document it in the ongoing evaluations or at the end. It is also important to validate your decisions yourself with experimentation and testing.

Design decisions, especially for something like a chosen colour, have a subjective and emotional side to them. Consult your teacher, your target market and peers in the decision-making process to help with the decision. Even with all their opinions and their views, the key is to move the focus from feelings to a more objective, functional aspect of design.

Design is essentially problem-solving. If you can prove that your solution is optimal, and if this is tested, you clearly have an advantage. In essence, you are not just showing the end product, but the context and the reasoning behind your decisions.

Backing up your decisions and justifications with research data is also good practice.

In the example of colour, studies have been done in psychology and consumer behaviour. Talk about how and why a specific colour can

Figure 10.23 Peer assessment and consultation should be a part of the decision-making process, as working alone can be too subjective.

help differentiate your design from those of your competitors, and how it will generate a particular experience for the end user when using your product, system or environment.

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Peer assessment and self-assessment

Peer assessment is a form of assessment that involves you making decisions on assessment about other students' work, and accepting assessment of your work from other students. When you make decisions on assessment about your own work, it is called self-assessment. These forms of assessment both involve self-development, and are therefore considered forms of reflective practice. They can involve assessing work in the form of presentations, exams, essays, reports and design projects. Peer assessment and self-assessment can form a major part of **formative assessment**. They can also contribute to **summative assessment** and help provide the following outcomes:

- **intrinsic motivation** – a desire to learn
- **extrinsic motivation** – a need to learn
- learning by doing (through practice and being allowed to make mistakes)
- learning via feedback from others.

Peer assessment and self-assessment are important for the following reasons:

- they increase the likelihood that students will engage with the work
- students develop their interpersonal skills and not only learn to receive and give feedback in a positive, constructive way, but also to learn from that feedback
- research has shown that, when given a clear marking scheme, the marks given by students on their own and others' work are usually fair
- students can gain an insight into, and an appreciation of, their own and others' approaches to projects
- they allow students to be more aware of how their work is perceived by markers, thereby leading to possible improvements in their work.

Evaluation does not end with your project. In order to grow as a designer, you should also evaluate

Figure 10.24 Self-assessment is an opportunity for a person to reflect and learn.

yourself. Self-assessment means looking back on your own actions, attitudes and performance to gain a better understanding of your design skills and experience as a designer. This can be a rewarding experience where you take the time to acknowledge your hard work and successes as well as identify areas you can improve, ultimately making you a better designer. Questions you may like to ask in your self-assessment include:

1 What did you find most challenging?
2 What did you find easy?
3 How did you handle any issues that arose?
4 What could you do differently next time?
5 How do you rate your performance?

formative assessment a range of formal and informal assessment procedures, including diagnostic testing, conducted by teachers during the learning process in order to modify teaching and learning activities to improve student achievement

summative assessment the assessment of participants where the focus is on the outcome of a program; contrasts with formative assessment, which summarises the participant's development at a particular time

intrinsic motivation when a person is motivated by internal factors (e.g. job or task satisfaction)

extrinsic motivation when a person is motivated by external factors (e.g. money)

ACTIVITY 10.7

Choose one of the reflective activities described below in Table 10.4 and complete it for the most recent design project you worked on.

Table 10.4 Reflective activities

REFLECTIVE ACTIVITY	WHAT IS INVOLVED IN THIS REFLECTIVE ACTIVITY?
Journal of learning	'Journal' here is used in the sense of a diary or log, in which you record each task or key stage of the project, noting how it went. You should reflect on and write down not just what went well and was achieved, but also what did not go well and what improvements you could make. Mistakes should also be noted so that they can be learned from. Learning journals are also useful for group activities and processes, to record what each member did as well as your own achievements.
Checklists	Checklists should be created as preparation before each task. The items should then be ticked off to record what has been achieved during the task. The information gained can be used to write up the learning journal and any reports or documents required in the portfolio. As well as being essential to organise individual and group work, checklists, like the learning journals, help you see how important reflection is to learning.
Peer review	You should review your own performance in individual tasks and others' performance in group tasks, listing strengths, weaknesses and areas for improvement. Peer review is another reflective skill that helps you learn principles of effective working and behaviour in teamwork.
Class discussion	Class discussion can be used to communicate reflections and thoughts on your own and the group's performance, especially how improvements can be made.
Responses to teacher feedback and peer review	In your responses, you should say what you have done in response to feedback from the teacher and in the peer review, saying in particular what you have done or will do to improve your own performance as an individual or in groups.
Report (reflective paper)	A report on individual and group processes helps you learn through reflection. For group work, consider points such as: • how you got to know each other's ideas and strengths at the outset • how you allocated tasks and organised your time • how you developed the group presentation. For individual work, reflect on: • what you did well, what were your strengths • what you did not do well, what were your weaknesses • what you learned from peer reviews or other groups' presentations • what you could do to improve performance next time.
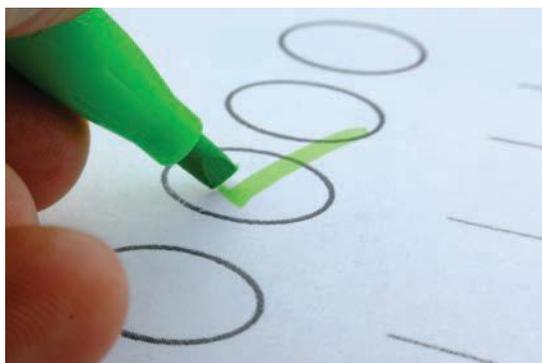
Figure 10.25 Checklists should be prepared before each project, to mark off each task as it is completed.

DESIGNING

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10.6 **Consequences of design projects**

There are factors that you need to constantly check to ensure that you stay on track in your design project, including resources, your management plans (time, action, resources and finance), and your practical project and its progress. As is sometimes said, sometimes the inspiration gets lost in the perspiration. It can be easy to lose sight of the problem that you initially set out to solve if you are not careful, and you could find yourself getting lost in the details of the work you are doing. Questions to ask yourself include:

- Will my solution solve the problem?
- Is my work of high quality?
- Have I chosen the most appropriate resources, processes, finishes, materials, tools and techniques?
- Have I done enough research to know that I have chosen the right resources?
- Has someone else done this before?
- Have I researched all existing design solutions?
- Is the solution reliable, safe and functional?
- Is the solution aesthetically appropriate to the design project?

- Is the solution cost and time efficient?
- Am I making the most of the latest or emerging technologies available to me?
- What are the factors contributing to the success of this design? How can I maximise the use of these factors?
- Are there any factors detrimental to this design? How can I overcome these difficulties?
- Have I considered at every point the impact on the individual, society and the environment?
- Is this a clever and ingenious idea? How can I make it cleverer and even more ingenious?

All of the points above need to addressed, but most importantly you will need to address the impact of the final product, system or environment, both in the short-term and in the long-term.

Bear in mind that what constitutes 'short-term' and 'long-term' may vary depending on the type of product. For example, for a digital product, 'long-term' might be anything more than a year, but for a large building or infrastructure project, three or four years are still within the 'short-term' period.

Impact on individuals and society

The digitalisation that has occurred over the past 15 years has fundamentally changed society and individual lives. It has affected not only our behaviour, but also the foundations of virtually every organisation. A trend has developed about people connecting with one another, with products and services and with organisations. It impacts on resource selection when completing design projects and on designers when choosing what materials, tools and techniques they will include in their designs.

The mantra 'less is more' is not relevant in an era of abundance. There has been a gradual growth in the amount of both information and things that

we accumulate as a result of the third industrial revolution, mass production and the internet. However, research has demonstrated that the ideal number of choices is actually lower than we might assume. Filter mechanisms are required in this world of abundance where consumers are overwhelmed.

When considering how our society has changed with technology, innovations and emerging technologies, an era of abundance and digitalisation, we can also look at our designing at school and examine some of the choices we have made in our design projects.

Consider these questions:

- Does your design fill a specific need or want from within society? Does it make completing a task more time-efficient? Is it a redesign of an existing product from within the market? How will it be in direct competition within the marketplace?
- A significant contributing factor in the development of a design is social and moral values associated with the design in the society. Does your design cause offence to a particular niche in society? As Australia is a multicultural society, this needs to be considered seriously. Also, colours and symbols may hold vastly different meanings in different cultures.
- Is your design ethically responsible? For example, consider if there may be links to child labour and exploitation of workers on low wages in developing countries for cheap manufacturing of products.
- How did you go about selecting your resources? What research did you do? How do you justify your choices?
- Finances and your finance plan: Is the product, system or environment only available to a select range of people? Are you redesigning an existing product to be more cost-effective so as to be made available to a wider market?
- Do the answers to any of these questions change depending on whether you are considering short-term or long-term consequences?

Figure 10.26 In a multicultural society, the meaning of symbols in different cultures needs to be recognised.

Figure 10.27 A design that incorporates animal products such as fur and leather could be regarded as morally and ethically irresponsible.

Impact on the environment

When we discuss the environment, this not only refers to the natural environment but also the physical or virtual environment the design is intended for. An example of this is hospital beds. For easy mobility they have wheels on the legs, and handles to assist in the speedy transportation of patients. The beds are made from steel for durability.

Environment also refers to responsible environmental design, and moral values associated with the design. Some questions you can ask yourself are:

- Does your design incorporate any materials that are environmentally damaging?
- Is your product or any of its parts recyclable?
- Will it contribute to landfill once the design life-cycle has ended?
- Is the design sustainable and appropriate?
- Are any hazardous chemicals used, such as harmful colourants that will ultimately end up being washed into the natural water cycles and the environment?
- When considering textiles, will you be using natural fibres, such as cotton, as opposed to synthetic fabrics that cannot be recycled as effectively?
- Does the design incorporate animal products such as leather or fur? This may be offensive to animal activists and be seen as morally and ethically wrong as well as environmentally damaging.

- Does the product, system or environment restrict its end use? For example, is it too large for the environment it is designed for?
- Does the design consist of suitable materials for its environment? For example, for a child's play tent, the materials used would have to be durable, and the coating on the tent must not be harmful to children.
- Do the answers to any of these questions change depending on whether you are considering short-term or long-term consequences?

Figure 10.28 An environment in which hospital beds would be moved around frequently was factored into this design.

ACTIVITY 10.8

1 Explain the implications of a new technology that has been launched recently, and consider any socio-cultural influences.
2 Identify the indicators of when a product is nearing its end of life.
3 What are some steps that need to be undertaken to choose the most appropriate resource?
4 What are some strategies to engage the target market?
5 Each target market will differ in play. Explain the key concerns of each of the following target markets:
   a millennials
   b women between the ages of 20 and 30
   c boys between the ages of 4 and 8
   d tweens.

COMMUNICATING

SUSTAINABLE BUILDING DESIGN

Increasingly there is an expectation that designers/ architects will be accountable for the impact of their work on society and the environment. The concepts of sustainability and sustainable design are now commonplace and are considered an integral part of the design process.

Sustainability is a trait of an action or situation that can be continued at an acceptable level for an indefinite period. It is a term that is often used when discussing the environment. Sustainability within design asks questions such as: What actions can be taken to tackle climate change? What agricultural practices can be adapted for food production and how can we as humans ensure that we can live in a world that doesn't impact negatively on plants and animals? It is also about considering the future needs of generations to come.

Sustainable design (eco-design, green design) considers compliance that encompasses factors such as economics, social needs and ecology. Sustainable design can be applied to products, buildings and environments.

Figure 10.29 One Central Park in Sydney received a five-star rating from the Green Building Council of Australia.

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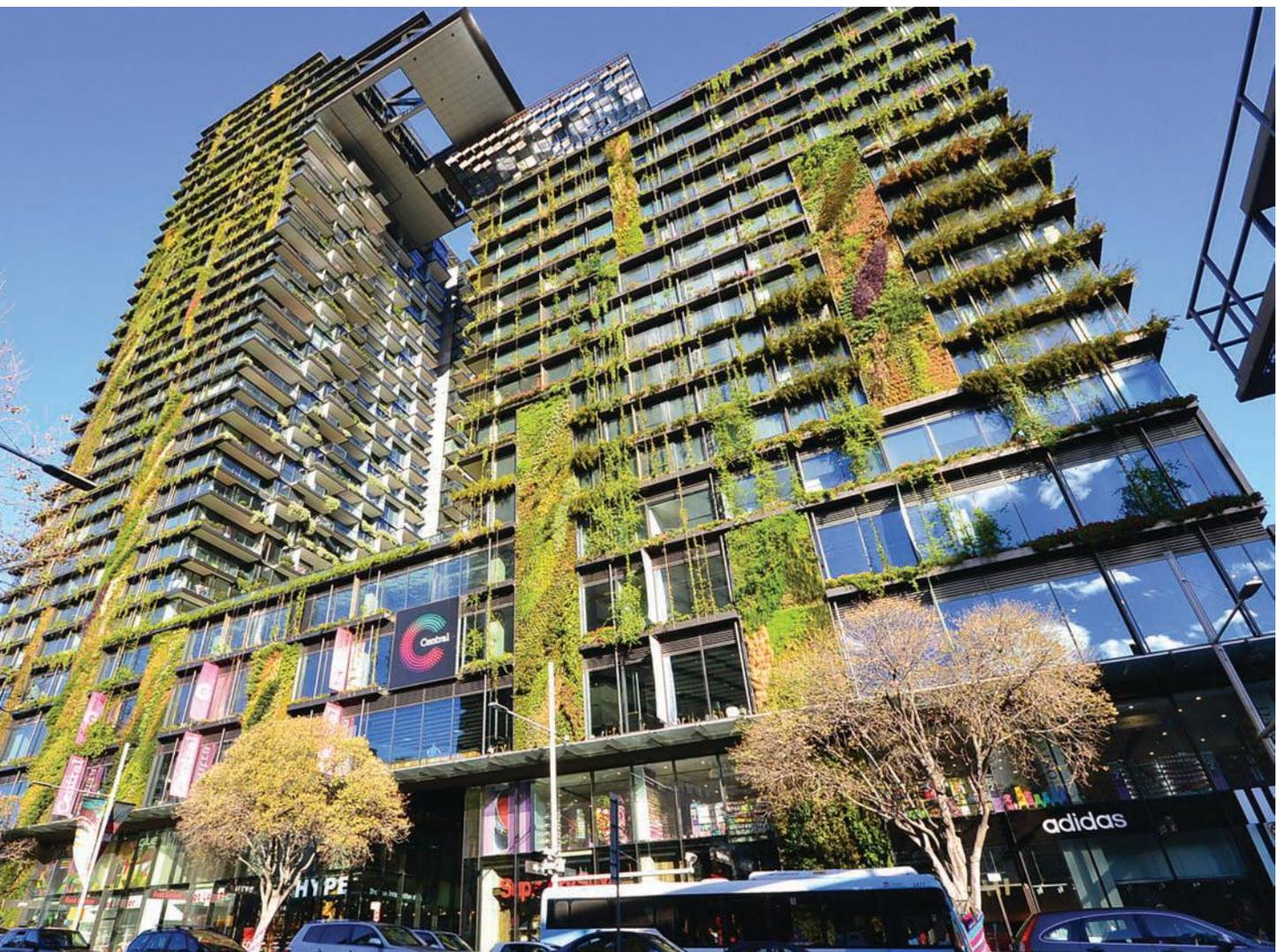
ACTIVITY 10.9

Design and evaluate an innovative architectural building model that uses the principles of sustainable design. Answer the following questions to help with the design process.

1   What does innovative mean? How can you incorporate this into your architectural building design?
2   What does sustainable design mean? How can you incorporate this into your architectural building design?
3   In a table like the one below, identify the resources needed for this project.

MATERIALS	TOOLS/EQUIPMENT	TECHNIQUES/PROCESSES
e.g. Foam board for modelling the building	e.g. Stanley knife	e.g. Marking and measuring

4   Analyse the impact of the resources identified in question 3 on the end design solution, the individual, society and the environment. Complete a table like the one below.

RESOURCE	END SOLUTION	INDIVIDUAL	SOCIETY	ENVIRONMENT
MATERIALS				
e.g. Foam board used for modelling my sustainable building				
TOOLS/EQUIPMENT				
e.g. Tenon saw				
TECHNIQUES/PROCESSES				
e.g. Marking and measuring				

DESIGNING

CHAPTER SUMMARY

The initial selection of a technology from a range of possibilities is the key to the successful operation of any design project – technologies are unlikely to function adequately if inappropriate choices are made at the start.

- You are required to justify materials, components, processes and other resources you have selected for the development of your design project. You are to present logical reasons why you have chosen the materials, the components, the processes and other resources.

- Once you have planned the manufacturing process of your product, system or environment, you should be ready to turn your idea into reality (also known as realisation).

- Some appropriate techniques typical of most of the focus areas in Design and Technology and the design projects that can be selected and used are sketches, technical drawings, CAD, CAM, computer-generated rendering or CGI, storyboard generation, demonstrations, prototypes and selection of appropriate communication techniques.

- Criteria for success can be divided into two categories: functional and aesthetic. The criteria should outline all the necessary principles of your design, list the justification as to why it is important and explain the method to be used when evaluating.

- Evaluation is an ongoing process throughout the realisation of your design. It will help you determine what was done right, what areas there are for improvement and whether the overall target was achieved.

- Your evaluation method will vary depending on your project. There are a range of evaluation techniques you can employ, including:
  - using a checklist
  - creating questionnaires
  - conducting interviews to collect feedback
  - testing and experimenting.

- Peer assessment is a form of assessment that involves you making decisions on assessment about other students' work. When you make decisions on assessment about your own work, it is called self-assessment. These forms of assessment both involve self-development, and are therefore considered forms of reflective practice. They can involve assessing work in the form of presentations, exams, essays, reports and design projects.

- A design rationale is a document recording the reasoning used in the design process that lists all decisions and the reasons for them. Its main aim is to support the designer in communicating arguments for decisions in the design process.

- Digitalisation has created a society where everyone is connected. The impacts can be observed from an individual level to an organisational level. Digitalisation impacts resource selection when completing design projects and designers when choosing what materials, tools and techniques they will include in the designs.

DEFINE KEY TERMINOLOGY

In your own words, define the following key terms in one or two sentences.

1 Criteria
2 Document
3 Equipment
4 Evaluation
5 Justify
6 Materials

7 Peer assessment
8 Requirements
9 Self-assessment
10 Success
11 Techniques
12 Tools

REVIEW TASKS

1 Give five suggestions why it is important to select the most appropriate materials, tools/equipment and processes or techniques for your design projects.

2 List 10 technologies that are available to you in a Design and Technology classroom. Explain what each technology could be used for and how you would use it.

3 Look around your Design and Technology classroom and describe five tools/equipment that you have used before. What did you use them for?

4 Explain what realising your project means. List the steps followed for realisation of a design project you have completed in Stage 5.

5 Why is justifying your resources important?

6 When planning your project, what are four plans that could assist you to project manage?

7 Analyse the process of evaluation within design and producing design projects.

8 If you were asked to design a bedside table, what would be the criteria for success? Use 'It must …' statements. Include 10 criteria.

9 Explain the term 'evaluation techniques'. Give five examples of these techniques.

10 Looking at the impacts on individuals, society and the environment, analyse the social changes that have happened since the launch of the television. Use the table below to plan your response.

INDIVIDUAL	SOCIETY	ENVIRONMENT
-	-	-
-	-	-
-	-	-

11 Define the terms 'development' and 'management' in the context of selecting and using a range of technologies in the development and management of design solutions. Discuss how you would undertake these two processes when completing design projects.

EXTENSION TASKS

In a table like the one below, identify the positive and negative impacts that the elements listed have on the individual, society and the environment. You will need to do some research on the design.

DESIGN		POSITIVE IMPACT	NEGATIVE IMPACT
Children's playground swing set in a local park	Individual		
	Society		
	Environment		
Plasma TV	Individual		
	Society		
	Environment		
North Connex connecting the M1 to the M2 in Sydney's north	Individual		
	Society		
	Environment		
Gladesville Bridge	Individual		
	Society		
	Environment		
Coca-Cola bottle – plastic or glass	Individual		
	Society		
	Environment		
Thermomix	Individual		
	Society		
	Environment		
Dannii Minogue's Target Petites range of clothing	Individual		
	Society		
	Environment		

PRACTICAL TASK

Marketing hands-on practical task

You are a designer working with the Environment Protection Authority (EPA). You have been commissioned to create a promotional marketing package to present to your school about an environmental or sustainable issue.

Some ideas about what the launch could include:

- Buy Nothing Day
- Earth Hour
- Promote waste reduction in your school
- Three Rs: Reduce, Reuse and Recycle
- Dr. Seuss and resource use: featuring *The Lorax*
- Ways to help the environment
- Plastics in the oceans
- Composting ideas around the home
- Limiting rubbish and landfill
- Waste-free lunches at your school.

The EPA have asked that you follow a process, as set out below:

1 Write a design brief
2 Explore the problem, show some initial research about the issue
3 Write criteria to evaluate success – include 10 'It must …' statements
4 Project management: complete four plans – action, time, resource and finance
5 Idea generation: sketches, brainstorms, cognitive organisers, storyboards, mind maps etc.
6 Research and experimentation: materials, tools and techniques, processes
7 Justification of resources with evaluative statements
8 Realisation: making the product
9 Evaluation: review the criteria to evaluate success and make some evaluative statements about your process, end product and your design journey in problem-solving.

The EPA have given you a list of possible inclusions in your promotional package:

1 Logo
2 Business cards
3 Website
4 Social media launch – Facebook, Pinterest, Twitter, Instagram
5 Letterhead
6 Envelope design
7 App
8 Posters
9 Pamphlets
10 Brochures
11 Postcards
12 Cinema trailers
13 Billboards
14 Videos on Facebook, YouTube, Instagram
15 Train station animated boards
16 Magazine or newspaper advertisements.

These possible inclusions can be added via the following:

- Online app software
- Adobe Creative Suite such as Adobe Photoshop, Adobe After Effects, Adobe InDesign or Adobe Illustrator
- Microsoft software, for example Publisher, PowerPoint or Word.
- Social media applications: Facebook, Pinterest, Twitter and Instagram
- Website production sites such as Weebly or Wix.

GLOSSARY

aesthetics branch of philosophy dealing with the nature of art, beauty and taste. It is more scientifically defined as the study of sensory-emotional values, sometimes called judgements of sentiment and taste. Aesthetic judgement is concerned with the visual impact or appeal of a product or environment and is influenced by social, emotional and demographic factors.
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annotations notes made on a drawing to describe particular points of interest

appropriate fitting, suitable to the context

appropriate technology encompassing technological choice and application that is small scale

Arduino micro-controller based kit used to build devices and interactive objects

artificial intelligence (AI) a subfield of computer science which aims to develop computers so that they can perform tasks that could previously only be done by people, such as speech recognition, decision-making, and learning.

biodegradable able to break down naturally in the environment into chemical components

biomimicry an inspiration of functions found in nature for use and adaptation in the design of a product, service or environment or to solve human problems. For example, Velcro fastening was inspired by small hooks on the end of burr needles. Termite mounds that maintain a constant temperature through air vents inspired architects to design cooling for buildings.
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CGI (computer-generated imagery) using computer software to create and assist in the development of visual elements used in art, printed media, video games, films, television programs, commercials, videos and simulators

cognitive organiser a visual diagram of interacting ideas, thoughts or elements

collaboration working together with others on a project for a common goal

computer-aided design (CAD) software used by designers, architects and engineers to create lines, shapes and planes that can be combined, moved, rotated, adjusted and rendered. Measurements and calculations can be included. Computer-aided drawing can be used to create two- and three-dimensional models and drawings such as floor plans, interior and garden designs, and to represent objects and structures.
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concept sketches the first ideas produced when using a design process to develop a solution to a design brief

concise brief and clear

configuration the arrangement of elements in a particular form, figure or combination

consultation a meeting with the purpose of reaching an agreement

consumer pull interest in a specific product created by a particular target market

contemporary belonging to or occurring in the present

control in an experiment, control variables stay the same for all tests (e.g. type of hammer, type of nail) so they don't affect the outcome; the independent variable is the factor that you change for each test (e.g. type of wood), and the dependent variable is the outcome that you are measuring (e.g. depth the nail penetrates) to see if the independent variable has any effect

create develop something completely new; combine existing elements to make a coherent or functional whole; make a new pattern or structure by reorganising existing elements

criteria standards by which a design project may be judged or decided

criteria for success a descriptive list of essential features against which success can be measured. The compilation of criteria involves literacy skills to select and use appropriate terminology.
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design an idea, sketch or plan to show the look and function of an object, system or environment

design brief a statement outlining what has to be achieved

design for disassembly products that can be easily dismantled so that parts can be reused and/or recycled

design portfolio a document used to record the design process used when producing a solution to a design brief

design process a framework, or series of stages, used to develop an understanding of the design problem

design thinking using strategies for understanding design problems and opportunities, visualising and generating creative and innovative ideas, and analysing and evaluating those ideas that best meet the criteria for success and planning.
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designed solution in Design and Technology, a product, service or environment that has been created for a specific purpose or intention as a result of design thinking, design processes and production processes
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discrepancy an instance of inconsistency or difference

discrimination the unfair treatment of a person or group

durability the ability of an object or system to withstand or resist wear, pressure or damage over a long period of time and remain in good condition. For example, long-lasting outdoor furniture made of suitable materials and construction methods to withstand rain, heat and light from the sun; a sports uniform made of suitable materials to withstand frequent washing and wear-and-tear, from the movement of the sportsperson.

emerging technologies new technologies that are currently developing or will be developed and that will substantially alter the business or social environment

entrepreneur a person who sets up and manages new commercial enterprises to make a profit

environment one of the outputs of technology processes and/or a place or space in which technology processes operate. An environment may be natural, managed, constructed or digital.
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ergonomics understanding of the activity of humans within systems or in an environment to maximise the wellbeing of humans and their productive use of those systems or environments
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ethics moral principles that govern a person's behaviour or how they conduct an activity

evaluate measuring performance against established criteria. Estimating nature, quality, ability, extent or significance to make a judgement determining a value.
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extrinsic motivation when a person is motivated by external factors (e.g. money)

formative assessment a range of formal and informal assessment procedures, including diagnostic testing, conducted by teachers during the learning process in order to modify teaching and learning activities to improve student achievement

Gantt chart a detailed grid that displays the tasks to be undertaken and time allocated, and maps these on a specified timeline

globalisation the process of economic, financial and cultural interaction and integration around the world

hardware the physical machines and infrastructure related to digital technology

hazard something that is potentially dangerous

human capital the skills and knowledge embodied in the ability to perform labour to produce economic value or a final design and product

humanities the study of human culture

hypothesis a statement of an intelligent theory with little evidence, which explains how a prototype will work. Experimentation will support or refute the hypothesis.

improvisation spontaneously acting on or creating something

incentive a payment or concession to motivate or encourage action

innovation something new or different

intellectual property legal ownership of the intangible creative, intellectual, scientific and industrial activity in a product; also includes cultural expression of individuals and communities

interdependent relying on each other

interdisciplinary the interaction of two or more areas of knowledge

interface a program that enables the user to operate different technological systems

intrinsic motivation when a person is motivated by internal factors (e.g. job or task satisfaction)

invention something made through original ideas

investigate students critique, explore and investigate needs, opportunities and information

LED light-emitting diode which creates high-powered light using a small amount of electricity

legislation a law passed by an elected government

life-cycle assessing all stages of production from manufacture to disposal of the product

limitation a restriction or rule that prevents progress

market niche a specialty area to address the needs and wants of consumers

market push marketing techniques employed by companies to promote their products

materials substance from which a thing is or can be made. Natural (e.g. animals, food, fibre, timber, mineral) and fabricated (e.g. metal alloys, plastics, textiles, composites) materials. Materials are used to create products or environments and their structure can be manipulated by applying knowledge of their origins, structure, characteristics, properties and uses.

mechanism a system of parts working together

microtechnology miniaturisation of computer circuits and microchips

multiculturalism the presence of a diverse culture made up of various races, religions or other groups

multifunctional having more than one use or fulfilling multiple needs

need a requirement by an individual or a group

optimum a favourable or best outcome

peer review an evaluation of your work by others in the same field

personal protective equipment (PPE) equipment used or worn by a person to minimise risk to the person's health or safety; for example, goggles, ear muffs, face shield, hard hat, apron, gloves
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pictogram a simple picture used to describe something

primary research research conducted first-hand

principle an accepted or professed rule of action or conduct

process actions or steps taken in order to achieve an end result

project a set of activities undertaken by students to address specified content, involving understanding the nature of a problem, situation or need; creating, designing and producing a solution to the project task and documenting the process. Project work has a benefit, purpose and use; a user or audience, which can provide feedback on the success of the solution; limitations to work within; and a real-world technologies context influenced by social, ethical and environmental issues. Criteria for success are used to judge a project's success.
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project management a responsibility for planning, organising, controlling resources, monitoring timelines and activities, and completing a project to achieve a goal that meets identified criteria for judging success
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protocols a set of rules and acceptable behaviours for a particular situation; may be based on ethical principles

prototype a trial product or model built to test an idea or process to inform further design development. A prototype can be developed in the fields of service, design, electronics or software programming. Its purpose is to see if and how well the design works and it is tested by users and systems analysts. It can be used to provide specifications for a real, working product or system rather than a virtual or theoretical one. *Prototype* is derived from Greek terms that, when translated, mean 'primitive form', 'first' and 'impression'.
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qualitative data descriptive information, often based on the opinions and emotions of individuals

quantitative data numerical information that can easily be analysed in tables and graphs

rendering drawing that shows a relative relationship of elements or a form of objects using texture, colour, light, shade and tone (lightness or darkness of a colour). Rendered drawings are used, for example, in architecture to show what a building will look like or to show the form and shape of the body of a proposed car design. Rendering can be done by hand, or using computer software such as computer-aided drawing.
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resources assets needed which can include people and/or materials that can be accessed and applied in order for the design to function effectively

responsible design a practice in which social, environmental, moral or ethical considerations inform the design

risk a situation that may expose someone to danger, harm or loss

secondary research information already gathered and presented by other people

simulation the model of an action to determine the reaction. Computers are often used to generate a simulation program.

skills the specific techniques, strategies and processes in a learning area

social media websites and applications that allow users to create and share content through social networks

society a body of individuals living as members of a community

software programs and operating information required for the control of computers and technology

solar thermal plants power stations that use the thermal power of the sun to heat reservoirs of fluid and power turbines

stakeholder someone who has an interest in something through time, money and/or energy and will gain from the final design

summative assessment the assessment of participants where the focus is on the outcome of a program; contrasts with formative assessment, which summarises the participant's development at a particular time

target market a specific group of consumers at which a product is aimed

technologies the materials, data, systems, components, tools and equipment used to create solutions for identified needs and opportunities, and the knowledge, understanding and skills used by people involved in the selection and use of these
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tooling the process of acquiring the manufacturing components and machines needed for production
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trends the gaining of popularity or a development in the market demands relating to colours, textures, designs in fashion

virtual technologies technologies used in the creation of a virtual (rather than actual) version of something

Wi-Fi computer code to allow devices to connect to the internet wirelessly

zero waste living to not make, or produce as little waste as possible

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