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INTERACTIVE TEXTBOOK INCLUDED

Design and Technology:

STAGE 6

SECOND EDITION

Arna Wesley
Dave Ellis
Michael McLean
Romalina Rocca

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FOREWORD

The need to develop the skills and capabilities demanded by a rapidly changing technological society is commonly recognised. We accept that technologies have evolved and been developed to such an extent that they impact on most aspects of our lives. The study of Design and Technology will develop your capacity to think critically and respond to the challenges of the age in which you live. You will examine and appreciate how technological activity impacts on the individual, society and the environment, making you a competent and informed consumer who considers the consequences of technological developments. The syllabus integrates both procedural and conceptual knowledge, based on a holistic view of design, and provides the opportunity for you to apply technologies to solve problems and create ideas and solutions. This subject has a strong focus on innovation and the development of innovative ideas, supporting the global trend to creative environments that encourage innovative thinking and hard work.

This textbook supports you in building on practical learning by providing content mapped to the New South Wales *Design and Technology Stage 6 Syllabus* outcomes and assisting you in your preparation for the Higher School Certificate (HSC). Its authors are dedicated teachers, who hope that your study of Design and Technology will lead to a love of learning and inspire you to become an innovative and ethical designer of the future.

Dr Arna Wesley

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ABOUT THE AUTHORS

Dr Arna Wesley

Dr Arna Wesley, Ed.D, M.A, B.Ed, Dip. Teach, is an experienced teacher who is passionate about technology education. Her doctoral thesis investigated the impact of mandated curriculum reform on teachers and she is aware that teachers need support in the delivery of curriculum. After retiring as Technological and Applied Studies (TAS) Co-ordinator at Loreto Kirribilli in 2006, Arna worked on a sessional basis with pre-service teachers at Australian Catholic University as Lecturer-in-charge of Technology Curriculum and Teaching and lead ICT workshops for 10 years. In retirement, she maintains a strong commitment to technology education.

Dave Ellis

Dave Ellis, Masters in Urban Development & Sustainability (MUDS), B.Ed (Secondary Industrial Arts), is completing his PhD study into the professional learning of technology educators. He is the Deputy Course Coordinator for the Bachelor of Technology/Bachelor of Education program at Southern Cross University, and has lectured in this program since 2009. His research interests reside in teacher expertise where he has collaborated in STEM/STEAM and maker projects, as well as a number of publications in academic books and journal articles. Prior to his work in higher education, Dave was a Technological and Applied Studies Coordinator, working in schools across the Lismore Catholic Diocese as well as the NSW Public Education system. In that time he has successfully taught and marked Stage 6 Design and Technology major design projects and thoroughly recommends teachers engaging in HSC marking for professional learning purposes.

Michael McLean

Michael McLean, Dip. Teach Industrial Arts, B.Voc Ed, is currently Head Teacher Industrial Arts and Vocational Learning at Chester Hill High School. He began teaching in 1992 after working in private industry and has been involved in the delivery of Design and Technology since 1996. A three-year secondment from 2004 as a Vocational Education Consultant in South Western Sydney allowed extensive engagement with a number of schools that were actively involved in the delivery of practical, hands-on courses including Design and Technology. His active involvement with industry/educational partnership programs has allowed him to have an industry-based design perspective that supports student learning and creativity as an experienced teacher delivering a range of Technology-based courses at Stages 4, 5 and 6.

Romalina Rocca

Romalina Rocca, B.Ed (Secondary TAS), M.Ed (Management and Human Resource Development), teaches at a Sydney school, where she is the Director of Student Well-being and the previous Head of TAS. She has several years experience teaching senior Design and Technology to HSC level. She also teaches the mandatory Stage 4 Technology, Stage 5 Design and Technology and Information and Software Technology, and Stages 5 and 6 Food Technology. Romalina is currently teaching STEM and has had extensive experience in both written and itinerant marking.

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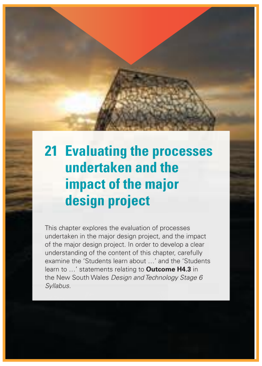
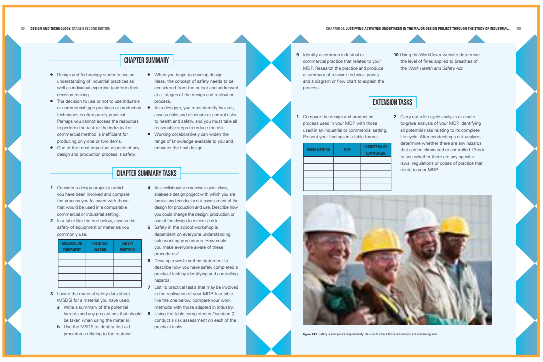


Chapter openers introduce the outcomes addressed in the chapter and prepare students for the activities ahead.

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. **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 chapter summary tasks as well as extension tasks to test your knowledge through the reinforcement of key outcomes and application of skills.

For a list of websites and links related to this book, go to: www.cambridge.edu.au/designtech62ed

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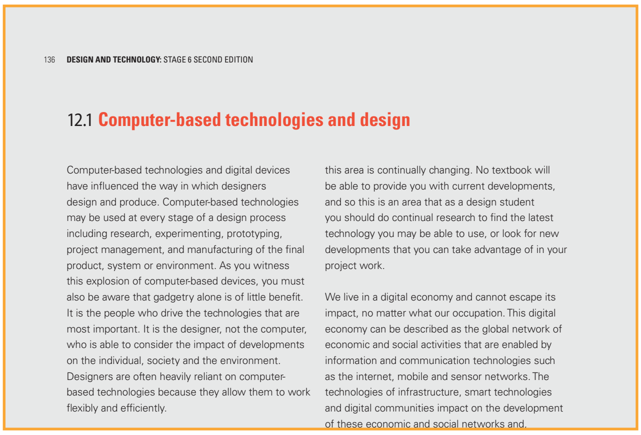
Scan **QR codes** with your phone or tablet camera to watch selected videos on a chapter content.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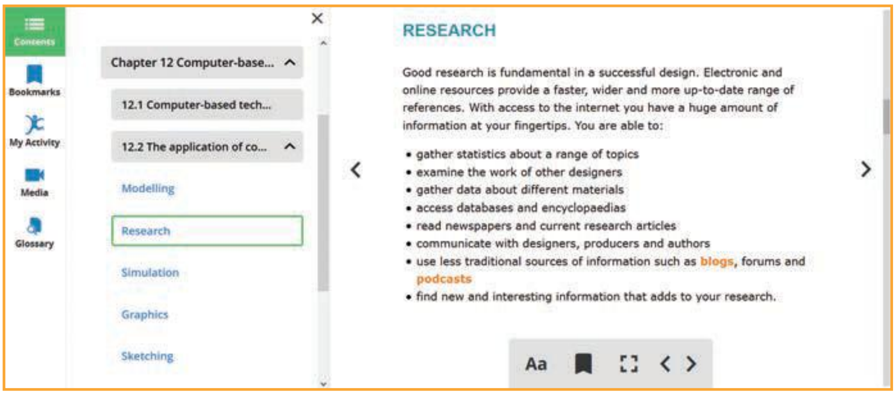
12.1 Computer-based technologies and design

Computer-based technologies and digital devices have influenced the way in which designers design and produce. Computer-based technologies may be used at every stage of a design process including research, experimenting, prototyping, project management, and manufacturing of the final product, system or environment. As you witness this explosion of computer-based devices, you must also be aware that gadgetry alone is of little benefit. It is the people who drive the technologies that are most important. It is the designer, not the computer, who is able to consider the impact of developments on the individual, society and the environment. Designers are often heavily reliant on computer-based technologies because they allow them to work flexibly and efficiently.

this area is continually changing. No textbook will be able to provide you with current developments, and so this is an area that as a design student you should do continual research to find the latest technology you may be able to use, or look for new developments that you can take advantage of in your project work.

We live in a digital economy and cannot escape its impact, no matter what our occupation. This digital economy can be described as the global network of economic and social activities that are enabled by information and communication technologies such as the internet, mobile and sensor networks. The technologies of infrastructure, smart technologies and digital communities impact on the development of these economic and social networks and

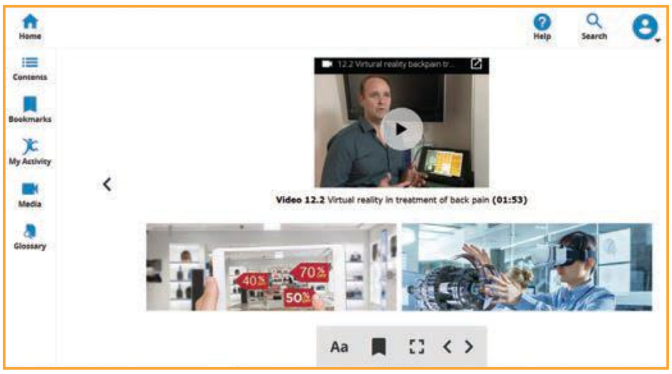
Numbered chapter headings allow easy navigation between the textbook and the interactive version.




Additional case study


Interactive Textbook content

Icons in the margin of the book show where additional case studies, videos and other additional material is available in the **Interactive Textbook**.



- **Videos and galleries** help enhance your digital learning experience.
- **Interactive activities** (e.g. drag-and-drop questions) assist the development of knowledge, understanding and skills.
- **Weblinks** provide links to external sites.

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PART ONE

PRELIMINARY YEAR 11

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1 Design theory and practice

Designing and producing forms the foundation of this subject, and in this chapter we will explore design theory and practice, considering the factors that impact on the work of designers. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P1.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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1.1 Design is everywhere

- What impacts on the design of our city infrastructure?
- Why is the Sydney Opera House the shape it is?
- How can we prevent erosion on our coastline?
- What is 'the cloud'?
- Who decides this season's fashion colours?
- How can I redesign my study area to make it less cluttered?
- Who designed Carriageworks?

When we try to answer these questions, we are studying design and technology.

Look around and you will begin to see solutions to problems that you may have never thought about. Good design is about solving problems. Whether the need is for high-speed communication or a smoother ride on the train, people have been applying the principles of design and technology to everyday needs since humans began complex thought. Consider the wheel and its impact on our lives! How has the smartphone changed the way we live?

Consider Figure 1.1. There are many concepts to reflect on – a lot more than are mentioned here. These images promote thought about ideas, **function**, safety, **aesthetics**, environmental impact and many other design considerations. Many different designers and many different technologies are involved in the development of a community space.

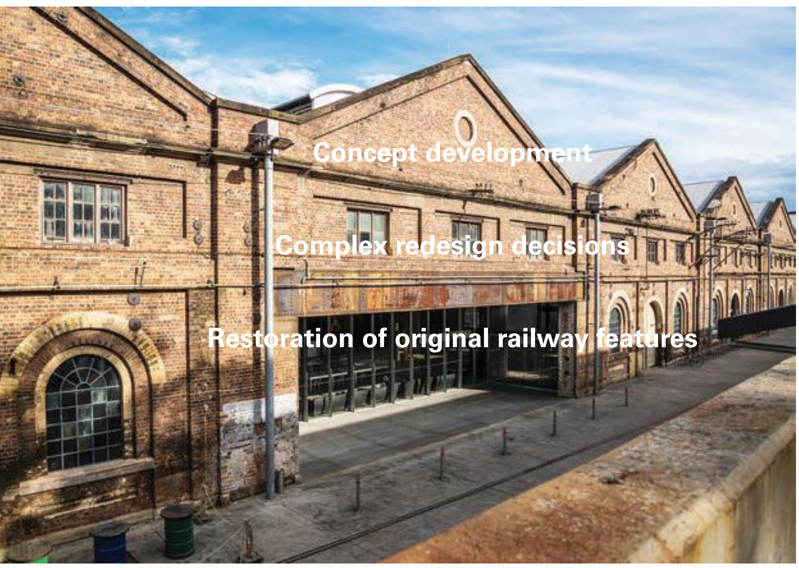
function the action or use for which something has been designed
aesthetics how something looks, particularly how visually pleasing it is

In 2002 the NSW Ministry of Arts purchased the carriage and blacksmith workshops at the Eveleigh Railway Workshops in Sydney with the aim of reusing the space to house numerous contemporary arts practitioners. Carriageworks was officially opened in 2007.

Imagine how many different designers were involved in this creation. Only a few of the concepts are listed here. The development of an unused site into a popular venue for community arts is a sound concept for good design.

In May 2020, Carriageworks went into voluntary administration in response to the 2020 COVID-19 crisis.

Figure 1.1 How much design is involved in Carriageworks?



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1.2 Investigating designers and the nature of their work

CASE STUDY 1.1

P.E Nation

This popular design company began when Pip Edwards voiced her idea to friend Claire Tregoning for clothing she could wear beyond the gym – design driven pieces that she could wear on the street. The pair launched their fashion-focused sportswear range in 2016. The concept stemmed from their own needs. They are both working mums who like to keep fit, so the goal was to develop a range of sportswear that responded to their lifestyle and their desire to remain trendy. The range offers high-quality clothing that can be worn in everyday life. It is functional, comfortable and fashionable.

Edwards and Tregoning have responded to the concept that health and appearance was the main motivator for the purchase of active wear. Their designs consider the two active wear categories of outfits for exercise and outfits for everything but exercise.

For 12 months the pair worked solidly to get the brand off the ground. Their combined skill sets as experienced designers enabled them to have a successful launch. Claire was able to draw the designs and develop the samples to finalise the designs, and Pip worked on entering the market and making the sales. Pip is quoted as saying about the success of the product: 'We are design driven. It has all the performance qualities but it is actually design driven.'

Initially, young mums like themselves were the target market, but they soon found a more diverse range of women became keen customers. These two women have personalised the brand. They live and breathe it. Their enthusiasm for the concept of comfort, quality and fashion is infectious.

Marketing has been an important aspect of their success as they compete in a market where sales of active wear have been increasing for a number of years. Social media, especially Instagram, has been a powerful ally. The domain is full of images of Pip exercising in P.E Nation and wearing her products around Bondi. The images are beautiful and aspirational – appealing to their market. Social media has allowed them to create a presence in a world traditionally dominated by the sporting giants.

The P.E Nation products reflect the company's interest in sustainability and environmental considerations, introducing natural fibre because of its biodegradability. Wool has proven to be an excellent fabric for active wear as it regulates the body temperature. Technological developments have added to its success, with better circular knitting machines and the creation of seamless fabric. The success of the product has led to partnerships with other companies around the world. P.E Nation stockists can be found in all corners of the world – USA, France, Italy, UK, Belgium and others, as well as Australia.

There is a rising demand for top quality fashionable sportswear and P.E Nation is there to take advantage of it.

Figure 1.2 Function and aesthetics incorporated in design

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CASE STUDY 1.2

Tin&Ed

Tin Nguyen and Ed Cutting began Tin&Ed as soon as they graduated from university and today work between New York and Melbourne. This multi-talented and versatile duo interact between the digital and physical worlds creating images, objects and installations. How technology can be used to promote new understandings of the world around us forms the basis of their work. They create playful projects and experiences that bring people together.

Their designs may be described as bright and quirky. Speaking at the Design Indaba Conference 2019, they discussed the many ways their work evolves in and out of the real and digital world.

'We believe in the interconnectivity of everything; where it's art, design, nature, technology, work, play, the universe, everything,' they explained.

Trained as graphic designers and self-confessed 'science nerds', they pride themselves on their curiosity, which has resulted in the duo experimenting across various design forms and mediums.

One look at their work and it's easy to see the big influence of nature and science. 'We really believe that we're all connected and we're not separate from nature, we're really a part of it, and that includes our cities and our technology.'

Another element Tin&Ed hold dear in their creative process is collaboration. With a lot of their work being experimental, they're first to admit that if they don't know how to do something, they'll get the right person to do it properly, contributing to a better whole.

And collaborate they did, on a 600-metre long mural through the contributions of 20 designers from across the world, and a dash of generative technology. They saw the project as an opportunity to speculate on the future role of designers in an increasingly automated world – designer becomes curator.

After the collaborators submitted their unique pieces, Tin&Ed created parameters so that the system could generate infinite outcomes using machine learning and automation.

'The idea of the technology brought us all together and it helped create a piece that wasn't just ours, it was everyone's.'

One project, 'We Come In Peace', was launched at the Design Indaba 2019 festival, and uses 3D scanning to create AI-controlled dancing avatars. It's a fun, frivolous experiment, but it bears a greater purpose of celebrating the joy and euphoria of coming together.

They speak of making the world better through their work: 'There's so many forces acting on us that are pulling us apart, so our work is about trying to find ways to bring us all together and connect with each other and nature and the universe ... and doing it in a way that is playful and inclusive.'

Source: Design Indaba

Figure 1.3 Ed Cutting and Tin Nguyen. Photo by Sean Fennessy.

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1.3 Design and production career opportunities

It is important to realise that while specific occupations in design exist, they are not the only jobs that involve the use of design and technology skills and knowledge. The list below presents some of the occupations that may be classified as design and production careers.

innovation using an existing material or technology for a completely different purpose or to develop a new material or technology; something new or unprecedented in a market or society

graphical relating to visual art

ARCHITECT

Architecture is a classic design profession where the balance of aesthetics and functionality needs to be in harmony. An architect needs to know virtually all facets of building design including load-bearing walls, concrete strength, toilet function and drainage. Only if the whole package is considered does a building truly function.

FASHION DESIGNER

Fast-paced and ever-changing, fashion is whatever a designer wants it to be. Fashion design is not a job for the conservative, as you may need to look past what is here now and find what the look of the future will be.

Figure 1.4 Computer technology is important to graphic artists.

FURNITURE DESIGNER/MAKER

Furniture design involves producing new and exciting furniture that meets the needs, opportunities and fashions of now and the future. It concerns not just the building of furniture, but design and **innovation** to lead to something new and exciting. Incorporating new materials and techniques as well as relying on old tried and true methods will take the furniture maker into the future.

GRAPHIC ARTIST

Graphic design involves developing and producing **graphical** images for communication-based companies, such as advertising agencies. This career requires a higher level of artistic talent than some other design occupations. We can all learn to produce clear and informative images, but some people have natural abilities that allow them to excel in this job.

INDUSTRIAL DESIGNER

Industrial design usually involves designing and realising functional machines and processes. It is varied and includes fields as diverse as mining, food production, metals, building products and electronics. In this field, specific design jobs may be narrow and purpose-driven.

INTERIOR DESIGNER

An eye for colour and detail is a must as an interior designer that moves with social trends and opinions. A clear brief from the client is essential to create the look they want. What is popular and acceptable this year may, like fashion, not be so in a few years.

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WEB DESIGNER

Web design involves producing interesting, functional and diverse web pages while keeping pace with fast-moving technologies. This occupation combines cutting-edge technology with artistic and visual flair. Web design is popular among young people because it is an environment with which they are familiar and comfortable.

ELECTRICIAN

Design of installation is something an electrician undertakes before every job. The components of the design could include power loadings, load balancing, mood lighting and security services. Often details are predetermined, but decisions still need to be made along the way and these decisions must be well thought out.

LANDSCAPE DESIGNER

Landscape design and layout must take the many considerations of climate and position into account. Clients will want their garden to be special, so creativity links with horticultural knowledge to design an inviting space. While some of the time working as a gardener will be spent pulling weeds and cutting grass, ongoing care and layout need careful consideration.

RETAIL SPACE DESIGNER

The design of retail spaces considers shop layouts and merchandising as well as marketing and research. These designers need to understand how retailers work, as well as the standards their **environments** must comply with. They need to try to think like a customer and design features that encourage purchases and fit with the overall space.

environment the total of surrounding things, conditions or influences; especially the combination of external physical conditions that affect and influence our growth, development and survival

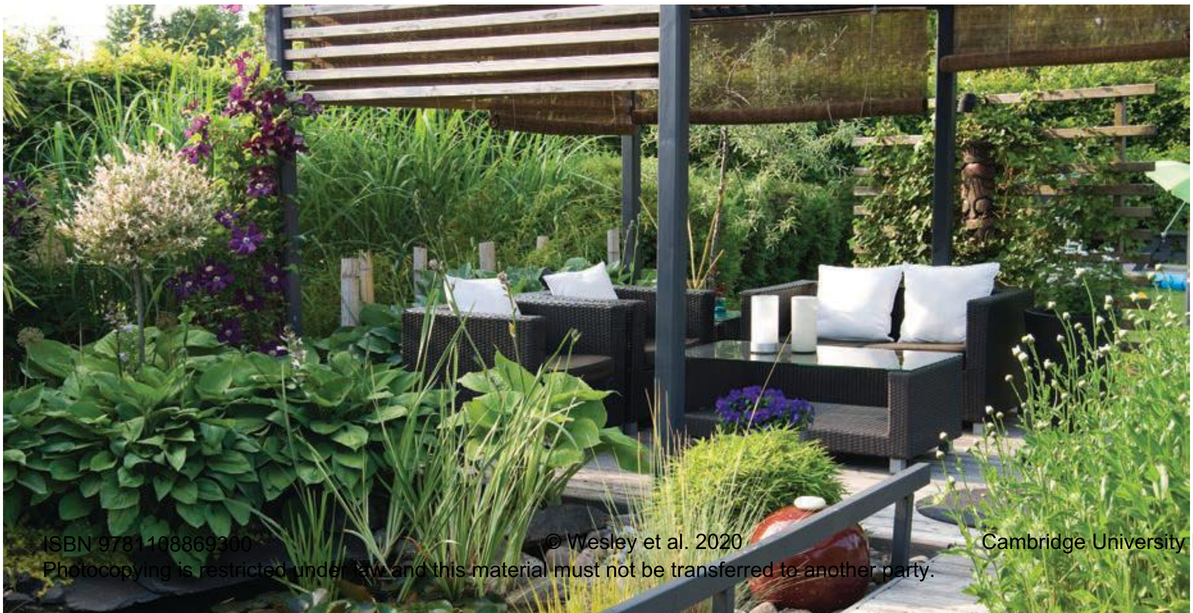
collaboration working together with others on a project for a common goal

ADVERTISING CREATIVE

A marketing function needs to be closely associated with all designs. The process of advertising the product, system or environment to the potential customer is important. Involvement in the advertising industry should develop creative flair in visual communication.

This list is not conclusive but illustrates the diversity of occupations that utilise the principles of design while using available technologies. Remember that most design is completed through **collaboration**. Many tasks are far too big for one person and the coordination of projects is a job in itself.

Figure 1.5 Water gardens are a popular part of landscape design.



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ACTIVITY 1.1

1 Visit websites such as CareerOne, JobSearch and Probono Australia or use the Job Outlook website to find a range of occupations that relate specifically to design.
2 Using the same resources, find occupations that make use of design.
3 Research local papers and other job markets, such as internet employment sites, to measure the availability of such jobs.
4 Interview friends and family and ask them whether they use design and technology processes in their daily lives. (You may need to prompt them because they may not realise that they are using it.)
5 Write a list of the design-related jobs that would have been involved in the development of Carriageworks.

1.4 Processes undertaken when designing

The success of a design project is dependent on the planning and consideration that goes on beforehand. Careful planning and organising will help you to direct your thoughts, efforts and energy. By using a design system, you can ensure that no important area of design is left out. The processes may vary depending on whether the design is taking place in a domestic, commercial, community or industrial setting. A domestic design project may be simple and achievable by one or two people, while an industrial design project may draw upon massive resources and teams of professionals. The processes you use may depend on the availability of resources at your school.

specification detailed instructions on how something should be done or produced

Figure 1.6 A range of backpack designs are available.

IDENTIFYING NEEDS AND OPPORTUNITIES

Many items produced by humans have been created as a response to the challenges posed by the world around them. Design is part of the response. Since our responses to challenges around us often form the basis of design, we may begin with the need, opportunity or problem that is to be addressed. It is this need, opportunity or problem that forms the central or most important part of our thoughts and ideas. Design and technology may be about finding solutions to meet people's needs, utilising an emerging technology in a new or different manner, or recognising and responding to an opportunity.

THE DESIGN BRIEF

A design brief highlights the problem to be solved or the need to be met. It should be clear and articulate but should not identify possible solutions. It is important that a correct interpretation of the brief is made. A brief can be open-ended, where the designer has complete freedom; or it can be a design proposal that is very tight, where design **specifications** are given, and the designer has to work within very strict guidelines.

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Once the need, opportunity or problem has been established, you may create a statement, or series of statements, that clearly describes what you want to achieve. This is known as the design brief; it should be clear about what is to be attempted in the design challenge.

Care needs to be taken when wording a brief to ensure clarity for the designer and those working on the project. You can make simplistic statements like:

Design a car that drives for 20 kilometres on 1 litre of petrol.

However, this simple statement does little to guide the designer. There are too many questions left unanswered, including:

- How many people should it hold?
- How strong does it need to be?
- Can it use alternative fuel?
- How fast does it need to go?
- What safety considerations are there?
- Where will it be used?

The design brief should combine as many details as possible to create a brief statement, or series of statements, that covers all considerations. So an alternative brief may be written as follows:

Design a car that drives for 20 kilometres on one litre of petrol and conforms to Australian design standards for motor vehicles. It must suit Australian conditions. It must be able to carry four × 100-kilogram people safely and use at least one form of alternative fuel.

These statements now guide the designer on a more specific and achievable path. The brief answers some of the questions the designer might pose and provides clear guidance.

When you create your own design briefs, ensure you have made them as clear as possible about what it is you want to achieve.

THE CONSTRAINTS

Constraints are additional details that create boundaries and guide the project. They should be specific, such as:

constraint a limitation or control that must be followed

The vehicle must have a ticket price no greater than $45 500. The design should be completed by 21 January 2021. The design budget is not to exceed $550 000.

Now the designer can begin to get a team together that will work within the constraints towards the goal. It cannot be a team of 200 people, because the budget will not allow it; nor can it go on for years, due to time limits. The brief has not changed, but it is now much clearer for the designers involved.

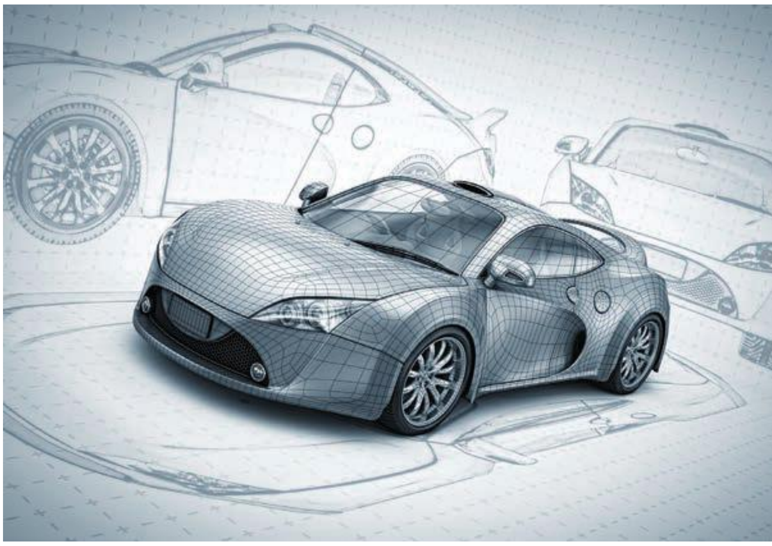

Figure 1.7 Will the car's design meet the elements of the design brief?

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RESEARCH AND INVESTIGATION

Once the problem is understood, extensive research needs to be carried out. This involves collecting information that considers all aspects of the problem. Information can be found in magazines, books, catalogues, manufacturers' information, past design ideas and so on. Remember, research must be ongoing during the design process. The investigation process begins to look at all the ways in which the project may be achieved. For a project such as the car described previously, there would be several teams of people, each working on a particular area. Positions and teams involved in investigating designing a car could include:

- team coordinator
- engine team
- **chassis** team
- aerodynamics team
- styling team
- prototyping team.

chassis the base frame of a car
criteria (singular: criterion) a list of requirements and specifications
ergonomics the science of designing machines, products and systems to maximise the safety, comfort and efficiency of the people who use them (and minimise harm or physical damage)

These teams would work collaboratively and in their own groups to produce results. The team coordinator brings together ideas, resolves conflict and guides the project's direction. For your projects the same applies, but you need to wear all the hats and be proficient in all the occupations.

DESIGN SPECIFICATION

After the research stage, it should be possible to extract handy hints, advice, design features and any technical information needed for careful analysis. You should be able to make a list of special features and the main points you need to include in your design consideration.

The design specification consists of the concept, **criteria** and constraints you need to consider when you start designing.

- Design concepts are the design ideas, variations and the final design proposal.
- Design criteria are specifically related to the outcome and include quality of outcome, user behaviour, user benefit, maintenance, safety, purpose, aesthetics and **ergonomics**.
- Design constraints are related to the design process, and they are time, budget and quality of resources.

DESIGN INSPIRATION

Inspiration can come from a variety of sources and research. Brainstorming can be a good inspiration technique to come up with initial ideas. Inspiration can come from social media, magazines, booklets, videos, personal experience, and even from nature.

INITIAL DESIGN IDEAS

Initially, all ideas should be considered and documented, no matter how outrageous. Detail at this stage need not be considered; quick sketches can be used to show design ideas.

ADAPTATIONS OF IDEAS

Adaptation of ideas involves sorting through ideas and selecting the ones that are most promising for further development. This refinement includes form, addition of detail and clarification of how certain aspects could go together. Human, material, financial and equipment resources should now be considered. Resources can be what you have or what you can get, depending on the project.

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Resources are not limited to just materials. Peers, family and friends, teachers, the internet and other media, finance, available technologies and your own personal skills are all resources that can be used in a project. These resources should be acknowledged during your work and particularly for your major design project (MDP).

Every designer works through a process to achieve a quality solution. This process can differ according to the situation, but some basic steps do occur in most design processes. They are not always in the same order, and it is often a cyclic process with the designer returning to different stages throughout the process. Successful designers test, reflect and evaluate constantly to improve their final solution.

Figure 1.8 A design process wheel

FACTORS AFFECTING DESIGNING AND PRODUCING

There are many factors that affect design and how it produces quality outcomes. Some factors to consider when producing design solutions are:

- appropriateness of the design solution
- needs
- function
- aesthetics
- finance
- ergonomics
- work health and safety
- quality
- environmental consequences
- obsolescence
- life-cycle analysis.

You may be able to think of other factors that have impacted on your designs. These concepts should not be looked at in isolation but as part of the overall process.

In order to create successful design, the designer should be aware of and study the work of those around them. Analyse existing products, systems or environments to see how they work. Look for commonalities and comparisons that may be adapted to your project. When analysing your own work, try to make use of others' thoughts and opinions – it can be difficult to be objective when looking at your own work. Continue the process now of looking around you and making critical appraisals of all things.

ACTIVITY 1.2

Select a design activity in which you have been involved. It may be a design project you did in earlier years, a party you organised, a fancy-dress outfit you created, a story you wrote or a card you made. Think carefully about the process you went through to reach your design solution. List the steps involved in your design process and create a graphical representation of that process.

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CASE STUDY 1.3

Shark protection

Video

After hearing about shark attacks – some fatal – entrepreneur Hamish Jolly began exploring ways to protect ocean-sport enthusiasts. As a kitesurfer this need was personal to him. He conducted in-depth research in collaboration with the University of Western Australia neurobiologist Nathan Hart and industrial designer Ray Smith. Jolly found that biologically, many species display banding or patterns to warn against being attacked, not the least of which is the pilot fish which spends a large part its life very close to sharks. On the human side, Walter Starck, an oceanographer, has been painting his wetsuit since the 1970s, and anthropologically, Pasifika peoples painted themselves in bands in a sea snake ceremony to ward off the shark god.

Figure 1.9 Clever Bouy, another shark detection technology developed by SAMS

Although sharks use a number of sensors when they engage for attack, Jolly found that the sight sensor is the one they use to identify the target in the last few metres before attack. He consulted with experts in shark vision and shark neurology and confirmed that sharks see in black and white or greyscale. The group then conducted scientific research into the physical characteristics of the eyes of three different sharks – great white, tiger and bull shark. Computer modelling was done on what the eye can see at different depths, distances, light conditions and water clarity in the ocean.

The next step was to convert these findings into a wetsuit that surfers would accept. They were happy with the design that attempts to create a disruptive profile in the water column. Testing the design with a predatory shark in its natural environment posed obvious problems. A scientific test was run using a perforated drum full of bait that was wrapped in a striped neoprene skin. Stereo underwater cameras were used to document how the shark engages with the drum. A control test was run with black neoprene skin.

Jolly's company, Shark Attack Mitigation Systems (SAMS), is now selling these suits, with a caution that it is impossible to guarantee that all sharks will be deterred under all circumstances – they are, after all, dangerous and unpredictable creatures.

Other products have been developed to protect surfers from sharks: Sharkbanz wearable technology, shark repelling surf wax, Anti-shark 100 repellent. You may know of others.

ACTIVITY 1.3

Research five different desks. Considering the factors that affect design and production, analyse the design of each desk.

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CASE STUDY 1.4

Ship design

Naval architecture is the term used to describe the art and science of designing boats and ships. The naval architect will develop a design to perform the missions of and to meet the requirements laid down by the prospective owners and operators. Thus the first step will be to carefully analyse the design brief set by the operator. There are many questions that need to be answered through the brief. How much cargo does the ship need to carry? How many passengers does the ship need to carry? What are the requirements for manning the ship? Are there specific requirements regarding speed of the ship? What must be ship's cruising radius, in terms of days as well as distance? The wide variety of missions for watercraft produces a great number of distinct and specialised types.

Designing a ship involves knowledge of mechanics, hydrostatics (physics involved with pressure exerted by a fluid on an immersed body), hydrodynamics (physics that deals with the motion of fluids and the forces acting on solid bodies immersed in fluids), steady and unsteady body motion, strength of materials and design of structures.

After determining the ship type and approximate size, the designer selects combinations of hull type, machinery and structural material.

Most designers will first develop small scale sketches. These will usually show the arrangement of spaces and equipment in profile elevations and deck plans. The line drawings depict the external shape of the underwater and above-water hulls. In preparing these drawings, the naval architect must determine whether each design proposal satisfies the performance and naval architectural requirements. Based on this and a weight study, the stability can be checked.

After the preliminary designs are developed as far as possible on paper, models are used to depict further specifications. These models may be towed or self-propelled with a stock propeller to determine more accurately the ship's resistance and required propulsive power. Such tests enable the architect to gather further data to enhance the design and ensure the specifications are met.

Figure 1.10 An operational naval ship

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Computer programs have been devised for obtaining a number of alternative designs of the general type selected, in reference to the specification of the design brief: length, width, draft, depth, hull coefficients and shaft horsepower. Each of these designs will also meet the requirements regarding cargo capacity, speed and cruising range. These requirements provide the basis for a series of equations for the computer to solve. Sketches can be prepared for each of the alternative designs. The final selection of the optimum ship in consideration of costs may then be determined from a separate computer problem.

When a preliminary design appears to give promise of a ship that will meet all the requirements to everyone's satisfaction, the naval architect proceeds with the preparation of contract plans. These are intended to be sufficiently complete and comprehensive to enable the shipbuilders to make estimates of cost and time of construction. The next phase involves drawing up the working plans, fabricating the parts, and building the ship in accordance with the wishes of the prospective owner and the naval architect.

The construction of the hull is only one of a shipbuilder's responsibilities. As soon as a contract is placed, he must negotiate with subcontractors for the supply of items that shipyards do not produce – the electric plant, propulsion machinery, shafting and propellers, engine-room auxillaries, deck machinery, anchors, cables, and furniture and furnishings. Production planning and control is therefore a complex undertaking, covering subcontracts, assembly and installation, in which costs must be kept as low as possible.

Interior design is another aspect of the architecture. The positioning of electronic equipment and weaponry will determine much of the design of a war ship. A cargo ship will have less emphasis on interior design – function being the main purpose. Safety issues will be a priority whatever the purpose. If a ship is to carry paying passengers much thought will be given to cabin interiors and also the inclusion of restaurants, entertaining and sport areas. Some large liners are like a city in themselves and town planning concepts will form part of the brief. Safe and easy movement of thousands of people are an important consideration.

A good naval architect or ship designer must have experience in a number of fields of engineering as well as in the field of engineering economics. The architect must also understand the characteristics and properties of construction materials and be familiar with the latest and best methods of fabricating parts and joining them. Like other branches of engineering, naval architecture involves estimates and predictions of the final performance of the ship and all its parts, and of initial and operating costs. Such calculations must be made while the ship is still in the paper stage in the form of plans and specifications.

The RSV Nuyina is Australia's new Antarctic icebreaker, designed to be the main lifeline to Australia's Antarctic and Sub-Antarctic research stations and the central platform for scientific research in that area. The name 'nuyina' means 'southern lights' in *palawa kani*, a language of Tasmanian Aboriginal peoples.

This ship includes important scientific functions, including the ability to find marine organisms (krill, fish, jellyfish) beneath the ship and map the seafloor and surrounds. Different acoustic instruments are mounted in its hull and

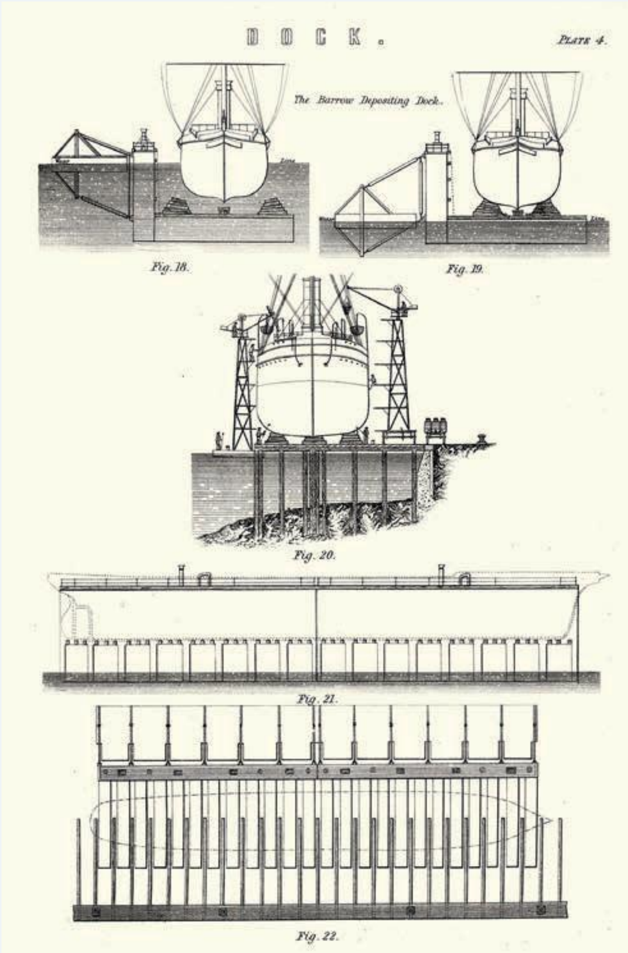

Figure 1.11 Preliminary designs

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there are two keels that drop below the hull, sending pings of sound and listening for the returning echoes to create images. The success of this technology depends on a quiet environment, so much work has gone into the design of the ship's hull and propulsion system to reduce noise.

Another specific design requirement relates to the use of specially equipped helicopters or unmanned aerial vehicles used to assess the ice sheet. An added design feature is the retractable boom which extends 10 metres in front of the ship where the ship breaks the ice. Sensors are mounted on the boom to provide real-time information on snow and ice thickness as the ship travels.

This ship is a world leader in combining icebreaking capability into a multipurpose platform capable of supporting scientific research and cargo or logistic functions. It offers greater flexibility than the icebreaker it replaces (Aurora Australis), being more capable in the shoulder and winter seasons when ice conditions are more difficult. It also has larger cargo capacity and 70% greater fuel capacity. Its range of 30 000 nautical miles gives it enhanced capabilities for future research. Imagine the range of design decisions that were involved in the development of this vessel!

Consideration of the role of naval architecture shows the complexity of design and the need for effective communication between all parties involved, from the concept through design considerations to the launch of a ship.

ACTIVITY 1.4

Consider the number of different designers involved in the processes described when designing a ship. Write a list and outline their role.

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CHAPTER SUMMARY

- Design forms an integral part of many occupations, and there is often interaction and overlap in design professions.
- We can all contribute to the concept of good design.
- Design often begins with a need, opportunity or problem.
- Design is about the application of process. The design process may vary, with some processes occurring concurrently or in varying order to achieve a solution.
- The design process may differ in domestic, community, industrial and commercial settings.
- There are many different factors that affect designing and production.
- Collaboration may lead to an improvement in a design.

CHAPTER SUMMARY TASKS

1. List five occupations not mentioned in this chapter that involve design.
2. Of all the design occupations mentioned in this chapter, which one would appeal to you most? Explain why.
3. List three organisations that support designers.
4. Write a design brief that you think may have been given to chef Neil Perry when he was asked to design a menu to be served on Qantas aircraft.
5. Compare five designs of the same type of item, such as a chair.
6. Research one Australian and one international designer and describe the nature of their work.
7. In small groups, analyse the school lockers you use and describe factors that impact on their design and manufacture.
8. List five people who could assist you in analysing a project of your own.
9. Identify two buildings or structures that you like or dislike, and state why.
10. Investigate who designed the Dyson vacuum cleaner.

EXTENSION TASKS

1. Consider the kitchen area of your home. Appraise its functional and aesthetic qualities. Use sketches to show how you would improve these aspects of the room.
2. Clothing is produced in different settings. Compare and contrast the process involved in producing an outfit in the domestic setting and in the industrial setting.

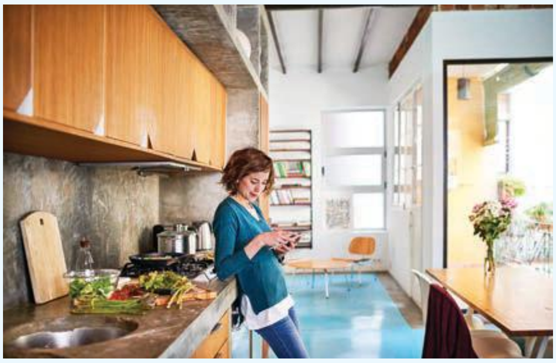

Figure 1.12 Even in our daily lives design surrounds us.

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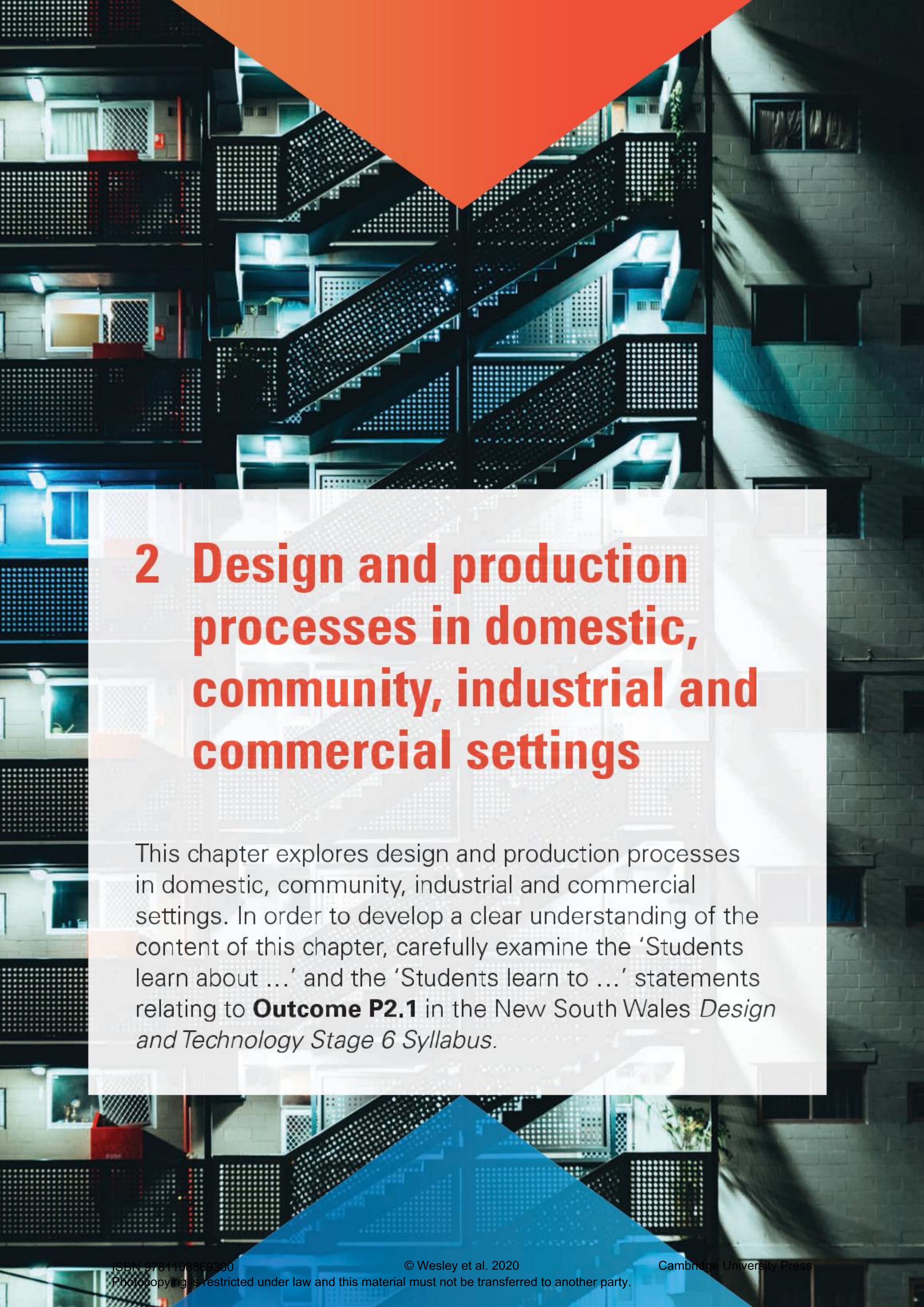

2 Design and production processes in domestic, community, industrial and commercial settings

This chapter explores design and production processes in domestic, community, industrial and commercial settings. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P2.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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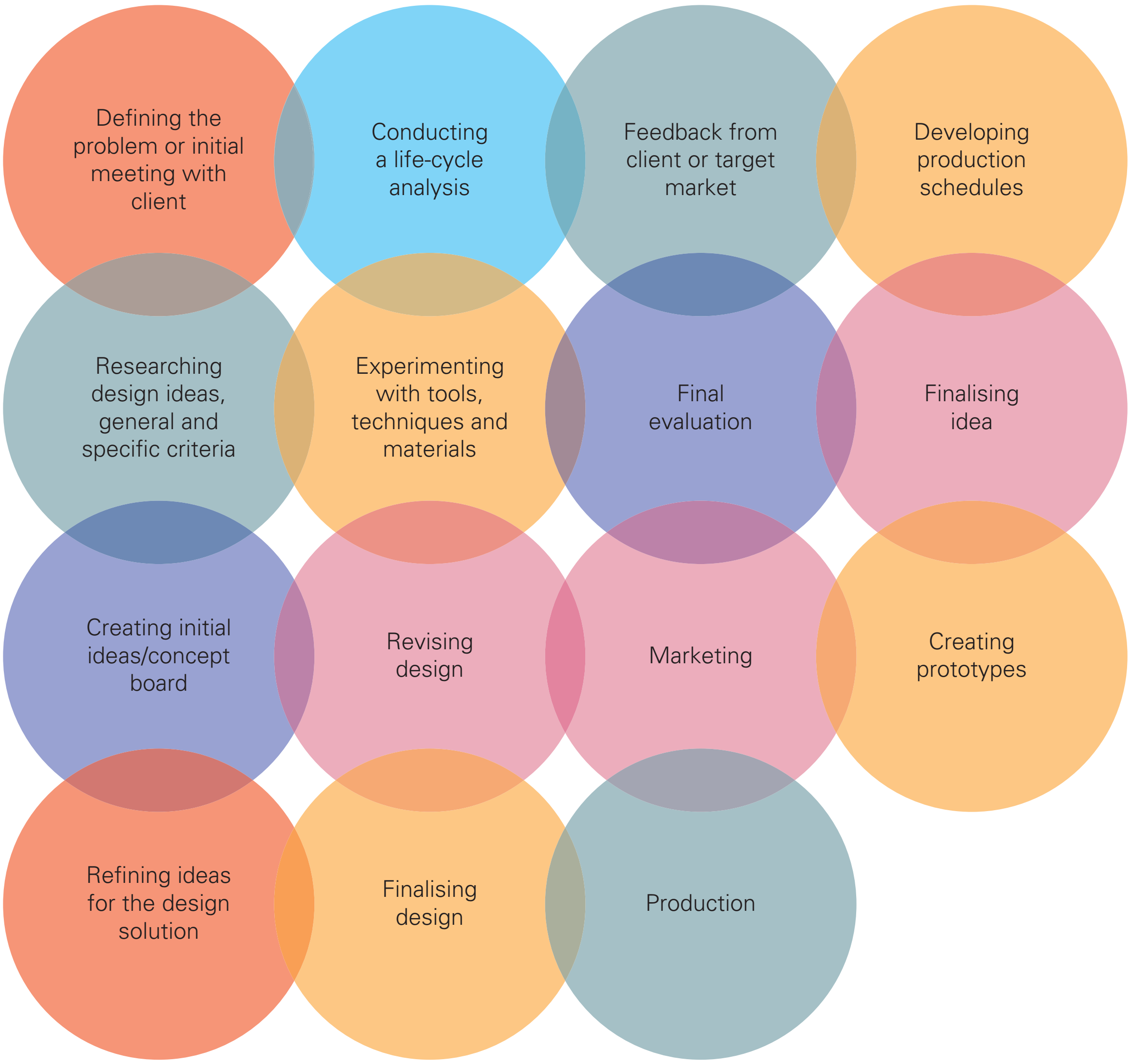
2.1 Understanding design processes and production processes

The design process may be familiar to you by now: the initial contact with the client or development of an idea, analysing the need and working through to a final product, system or environment. A design project may arise from a real need or an inspired idea, so the steps involved in the design process can vary for each design project.

In the field of design and technology, the terms 'design process' and 'production process' are employed constantly. These terms are also used widely in industrial and commercial settings. It is essential that you understand these processes so you can apply them in your Design and Technology course and to your own design projects. Today, as a result of advances in technology, design and production processes are more refined and more efficient than ever. Principally, the design process includes the stages shown in Figure 2.1.

It is important to note that ongoing evaluation occurs throughout all stages of the design process. This is critical to the success of the design project. It allows the designer to reflect on their process and modify management, tools, materials and techniques according to successes and failures.

Figure 2.1 Stages of the design process



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ACTIVITY 2.1

Consider a project or a case study with which you are familiar. This may be one that you are working on or studying. In a table like the one below, outline the steps that were undertaken in the production process. Ensure that you include all the tools, techniques and safety issues needed.

STEPS IN PRODUCTION	PROCESSES AND TECHNIQUES	TOOLS AND MATERIALS	SAFETY ISSUES

Design and production processes are used in all settings: domestic, community, industrial and commercial. Variables among the settings include the scale of production, the size of the company, the plant size and the manufacturing techniques adopted. Most production, regardless of setting, has one goal: to make a profit, thereby making it commercially viable. Here we examine these different settings in detail.

DOMESTIC SETTINGS

Activities of design and production in the domestic setting usually involve small-scale or one-off production. The operation may take place in a home or small factory, and the products are either sold at local markets or produced to meet specific client orders. The manufacturing techniques are often as simple as possible in order to keep the costs of production low. Tools and machines are often basic and suited to a domestic setting. For example, Faye Cahill, a cake designer, began her production from home. Initially she was able to meet client demand working independently. However, successful sales have led to the expansion of her business and she has had to employ others to assist in the production of her cake designs.

Figure 2.2 Turning passion into profit

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COMMUNITY SETTINGS

Video

'Community settings' refers to either a small community or interest group that develops a company or cooperative (co-op) for the common good of the local people or interested parties in the community. The scale of production varies according to the needs of the community. The association is not intent on making a profit. Rather, it seeks to provide a service or product for the community such as the creation of jobs. Rural and regional centres frequently engage in such types of production. In cities, community production is found in isolated patches. However, the concept of community gardens is growing. Community gardens offer locals the opportunity to grow and harvest their own produce, sometimes on the kerbside. The aim of such ventures is not only to have fresh produce but to cut down on 'food miles' – the carbon used to transport food from farms to consumers.

Read more about community gardens on the City of Sydney Community Gardens web page.

INDUSTRIAL AND COMMERCIAL SETTINGS

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 they employ large-scale machinery and tools. The products are more economically viable to manufacture, given the large scale. Industry, by its very nature, has more funds at its disposal to afford more sophisticated manufacturing processes and thus support heavier production costs.

Video

2.2 Technologies used in design and production processes

Technology plays a significant role in design and production. The introduction of new technologies often results in design and production becoming more efficient and effective.

Examples of technologies used in the design process include:

- **Research and data management:** research allows for the recognition of an opportunity or problem – digital cameras, scanners, the internet, databases and other software
- **Communication:** email, social websites, teleconferencing and videoconferencing, phone, fax, mobile phones, transfer of information using external digital devices
- **Idea development:** CAD software, 3D modelling, 3D printed models
- **Project management:** software, including project-management tools; spreadsheets; databases
- **Marketing:** media such as television, radio, print and the internet through social media accounts.

TECHNOLOGY USED IN PRODUCTION PROCESSES

Different design projects employ different machinery. Machinery is critical in developing designs; it allows for efficient and effective production.

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Using the designs produced in **computer-aided design (CAD)**, rapid prototyping scans sketches and then produces a 3D **prototype** of a product based on the measurements and the coordinates that it reads from the CAD software. This can only be achieved by linking the designs to **computer-aided manufacturing (CAM)** and injection-moulding machinery. The messages are sent from CAD to CAM and then to the machinery to rapidly produce a prototype. These prototypes allow the designer to see their product before it is sent to production. **Computer numerical control (CNC)** is software that controls cutting machines in computer-aided manufacturing. Using mathematical equations, it can pinpoint precisely where a product needs to be cut, ensuring accuracy.

The introduction of robotics in the manufacturing process has seen dramatic changes to the industry. Robots have replaced humans in many production lines. With the use of robotics, repetitive tasks can be completed quickly and easily. A robot can be programmed to aid in the movement of materials or carry out a specific task in the manufacturing process. This new technology has seen productivity and efficiency increase; however, we have seen loss in employment or the requirement of workers to retrain.

Figure 2.3 A range of technologies may be used in the design process.

Sensor technology has also been employed in the manufacturing process. Sensors are being used to monitor elements within the process – these may include temperature, colour and air quality, to name a few. The sensor detects changes and levels and sends the information to the appropriate people. Sensors provide accurate data for the manufacturer in a timely manner to ensure quality and safety.

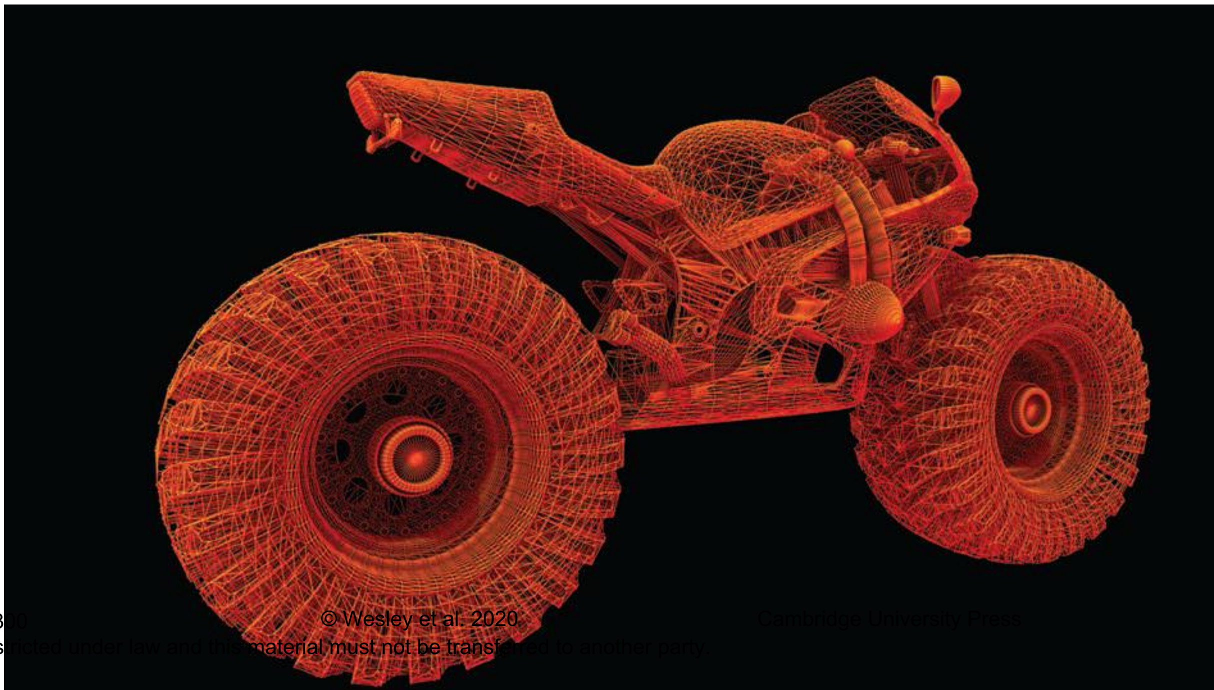
computer-aided design (CAD) an automated system for the design, drafting and display of graphic information

prototype the preliminary version of a product or design from which other versions are developed

computer-aided manufacturing (CAM) a computer program that makes manufacturing data from CAD drawings to automate the manufacture of a product by a computer-controlled machine

computer numerical control (CNC) the computer control of machine tools for the purpose of (repetitively) manufacturing complex parts for a product

Figure 2.4 CAD allows for elaborate drawings.



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ACTIVITY 2.2

Identify the machinery, tools and techniques you have employed in a design project. Research the machinery, tools and techniques that would be employed if this project were to be undertaken in an industrial or commercial setting.

BENEFITS OF USING TECHNOLOGY IN DESIGN AND PRODUCTION

Technologies benefit the design process in numerous ways. Project management has simplified the storage and transmission of information in recent times significantly. Such information may include supplier and client records, inventory and financial records; a budget, timeline and **action plan**. Project management has allowed this information to be readily accessible, and faster and easier to work with. Relevant information is quickly available to all people involved in the project.

action plan a list of tasks to be completed as part of a project

efficiency ratio of output or work done to energy used or input supplied

Developments in communication technologies have made instant 24-hour contact between designers and clients possible, breaking down the barriers of distance and time. This allows for collaborative work across different time zones, using the human resources available to both designer and client. Instant 24-hour communication is available via a range of portable digital devices.

The drawing (idea development and refinement) process has evolved due to technological advances. The production of ideas is more detailed and accurate. Elaborate designs are easier to achieve; a wider range of materials and colours can be introduced without redrawing every design; ideas can be shown in 3D. Modifications can be made swiftly before going to production, thus reducing potentially costly errors. Technologies such as CAD allow designs to be sent straight to the production plant.

In terms of research, communication technologies save designers time in searching for suppliers and materials. Tools and materials can be purchased conveniently from one's office, thus allowing more time for productive work. Technological advances have changed the whole face of marketing. In addition to modernising print and television marketing, new styles of marketing have emerged such as viral marketing using SMS and targeted email marketing using customer data and information about customer behaviour collected by tracking applications that monitor internet users. Many businesses today operate entirely online.

Another benefit of using technology in the design process is the ability to establish flexible work environments. People wishing to work from home have considerably more freedom and opportunity to do so, as information is much more portable. The higher **efficiency** created by technology allows for a shorter time between initial concept, client brief and time of production.

Production processes have also benefited considerably from advances in technology. The introduction of CAD and CAM has ensured that error-free designs are ready for production. The process of preparing the tools for the assembly line is referred to as tooling up. Given that the measurements are taken from the CAD drawings,

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they are accurate and thus allow for accurate tooling up. Such efficient design processes lead to efficient methods of production.

Robots can do jobs that in the past have been dangerous or repetitive and caused repetitive strain injury, also called **occupational overuse syndrome**. The benefit of rapid prototyping is that the production team and clients can see the final product. Technologies have allowed the introduction and enhancement of the assembly line, which enables a faster and larger volume of production, which in turn equates to more profit for the company.

Finally, the introduction of modern technology into production processes has allowed for upskilling of workers.

NEGATIVE IMPACTS OF TECHNOLOGY IN DESIGN AND PRODUCTION

We have outlined some of the benefits of technology in design. However, there are also some negative economic, social and environmental consequences of technology in design and production that require consideration.

- The initial setup of technology is very expensive. Small companies can be precluded from competing against larger corporations that have more funds at their disposal.
- Many low-skilled and unskilled workers have been replaced with machinery. The social problems associated with unemployment can be crippling for an individual or indeed an entire community dependent on income from unskilled labour.
- The maintenance and repair costs of machinery can be significant. Equipment failure that interferes with production runs can cause huge financial burdens for a company.
- The pollution caused by industries and large factories has a detrimental impact on the environment. Large-scale use of non-renewable resources to power these technologies is not **sustainable**.
- Extended use of electronic communication can lead to social isolation, which can be difficult to bear for some workers.
- In mass production, an error or a fault in one piece of technology can bring the whole production to a halt or introduce time delays.
- Companies must employ information technology specialists to create, maintain or improve the technology.

occupational overuse syndrome a range of conditions, including injury to, or discomfort or pain in, muscles or soft tissue

sustainable causing little or no damage to the environment or not using finite resources; therefore, able to continue for a long time

A component of the major design project (MDP) requires comparison of student design and production processes to those used in industry. As Design and Technology students, it is important to be aware of what happens in industrial settings. Thus a comparison and contrast of the tools, techniques and processes used in design in an industry and commercial setting is required.

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THE DESIGN PROCESS IN A COMMERCIAL SETTING

CASE STUDY 2.1

The Breville Citrus Press™

In 2004, Breville introduced a new style of juice extractor to the market. The Breville 800 Class™ Citrus Press combined a manual arm with a mechanised motor, giving a product that was easy to use, maximised juice extraction, and could handle fruit sizes ranging from limes to grapefruits. The 800 Classic received an Australian Design Award in 2005, and fifteen years later the original design elements are still the basis of a leading product. The BCP600 Citrus Press™ (itself the winner of a design award in 2015) was described as follows: 'Building on Breville's renowned Citrus Press technology, the BCP600 Citrus Press™ takes advantage of modern, lightweight materials and new manufacturing processes to make Citrus Juicing faster, simpler and more enjoyable'. The most recent version, the Citrus Press™ Pro, looks very similar to the original 800 Class.

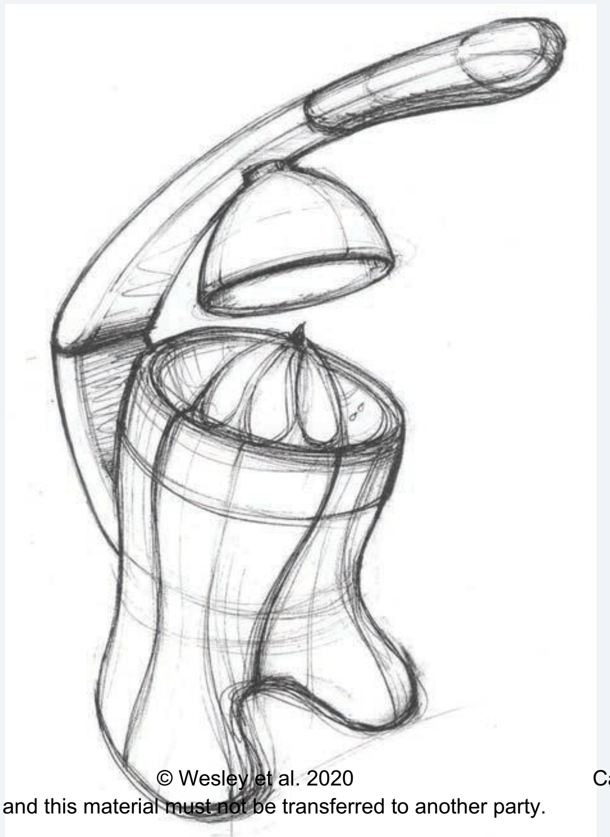
The principal designer of the 800 Class was Keith Hensel, who had previously worked for Sunbeam and Nielsen Design Associates. During his career (Keith died in 2013), he registered over 30 patents and won more than 25 Design Awards for his designs of household products. Many of the items you use today are based on his designs.

In 2005, as part of the Sydney Designers Unplugged exhibition at the Powerhouse Museum, Keith shared the processes that were undertaken in the design and production of the Citrus Press™. These processes are still valid today, although you may notice that some of the individual steps can now be streamlined through the use of modern technology.

Development of a need

There was a clear gap in the market for a high-end citrus juicer. Breville set out to create a no-compromise product that was best in its class. Efficiency and ease of use were key design criteria. The aim was to design a citrus press capable of juicing everything from limes to grapefruits without fuss, mess or muscle. Basically, what was required was 'maximum juice with minimum effort'.

Figure 2.5 An original design sketch for the 800 Class™ Citrus Press



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Design situation

The design situation was developed after research and the investigation of the need. After researching the market, Breville developed this design situation:

> Consumers are increasingly aware of healthy choices when buying appliances. Latest research has shown that drinking just a couple of glasses of freshly squeezed citrus juice every day may significantly reduce the likelihood of developing cancer, according to the results of a new report by the CSIRO [Commonwealth Scientific and Industrial Research Organisation]. The report shows that an increase in the amount of citrus fruits consumed could reduce the likelihood of developing chronic diseases, including cancer – a disease that affects more than 345 000 Australians every year.

They then made assessments of existing products on the market to help generate ideas.

Research findings

The first step was to analyse the positives and negatives of existing citrus juicers. The non-motorised citrus presses are nice sculptural items to have in the kitchen, but when it came to using them to juice, Breville found that the juice yield was very poor, they were awkward to use and they struggled with anything other than the average-sized orange.

Motorised citrus juicers showed much better juice extraction efficiency, due to the spinning reamer which breaks open the cells in the fruit. The downside is that these machines require strength, perseverance and dexterity. Different-sized cones are required for different-sized fruit, and they can also be quite messy to use.

Generation of ideas

Through a series of tests and experiments, sketches of the idea began to develop. From the research, some constraints were found in making their 'dream design'. The initial step was to simply combine the existing press technology with a motorised base.

It was found, however, that the downward force from the press stalled the motor. When the motor was enlarged to cope with the force, the juicer was far too tall for the average kitchen. The handle would hit users' overhead cupboards.

Innovation from their design

From the constraints, Breville identified several key areas where innovation was required for an ideal product.

1. The juicing arm: Needs a compact arm mechanism that swings out of the way while loading the fruit, but then moves in a straight line during the juicing action to maximise the juice yield and ensure large fruit, such as grapefruit, are not knocked off the spinning juicing cone.
2. Juice all fruit types without changing cones: Is it possible to develop a single spinning juicing cone and matching fruit dome that can juice all fruit sizes efficiently without changing cones? This would be a world first.
3. Safety: There was a need to develop a switching system that does not allow spinning to start as soon as the fruit is loaded onto the juicing cone (like traditional motorised juicers). The cone must also not start spinning until enough force is applied to the skin of the fruit to hold it stationary in the dome.

Generation of ideas through hand-drawn and computer sketches

Hensel completed hand-drawn sketches to get his initial ideas down. Then he used a combination of 3D computer modelling, 2D CAD, sketch layouts, and models created by hand and by CNC machinery to demonstrate the arm mechanism and movements. Consultation was made with other designers and engineers who were experts in particular areas. It was a team effort. Once the designs were finalised, it was ready for production.

Production processes

All the parts for the Citrus Press™ were designed in Sydney, but the production takes place in China. It is very difficult for companies to manufacture small appliances in Australia due to our high labour costs. Products such as the Citrus Press™ are very labour intensive to make. There may be as many as 500 people involved in making the parts to put one Citrus Press™ together.

While Keith Hensel was designing the product, he made six trips to China to work with the engineers and production people from the factory that was going to make the product to ensure that the product designed was suitable for their factory.

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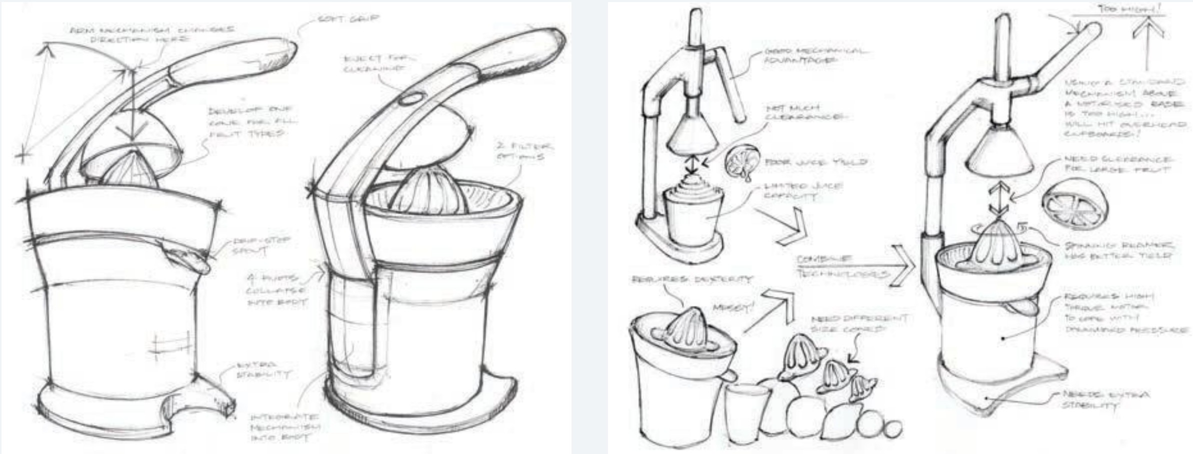


Figure 2.6 Annotated sketches of possible design solutions, outlining any issues or constraints

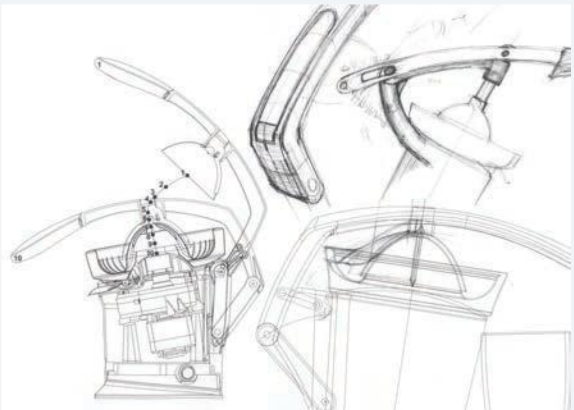
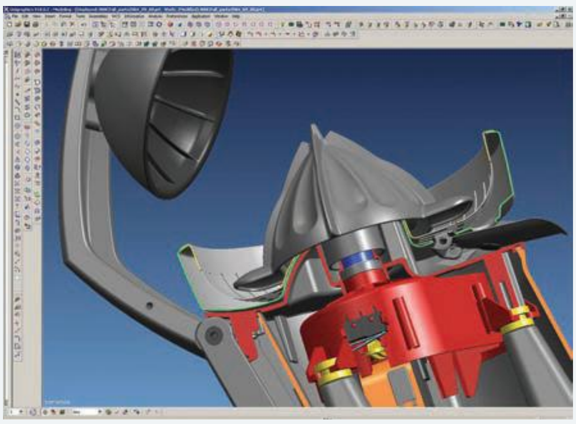


Figure 2.6 (*Continued*)



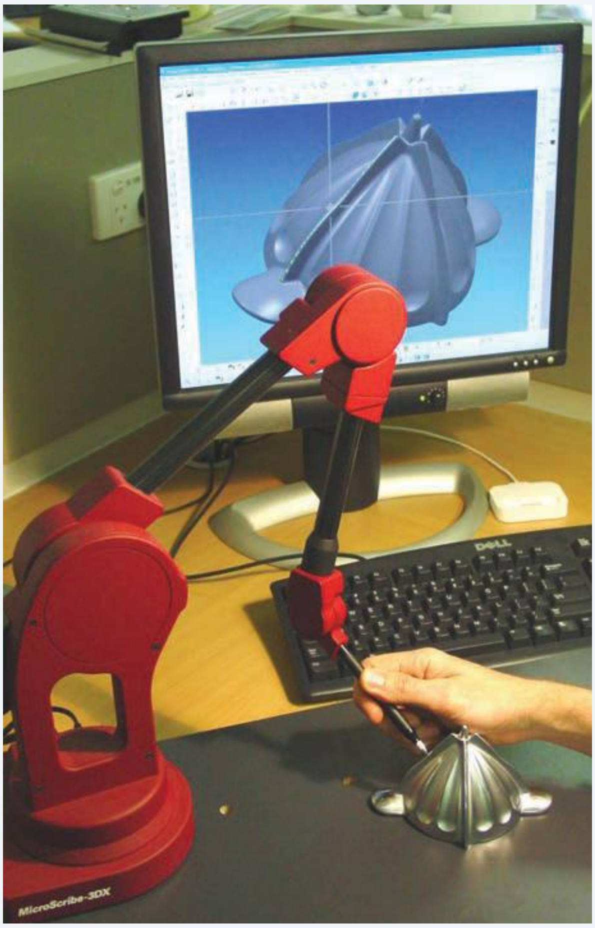


Figure 2.7 These images demonstrate the use of CAD/CAM in the production process.

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Different manufacturing processes are employed:

- **Die-casting:** The major external body components are die-cast zinc. Tooling is prepared so that the molten zinc can be injected into the dies to form the parts. The parts are then hand-finished to remove the gating (zinc inlet into part) and any defects (such as flash), and then they are chrome-plated. Without the chrome plating, the zinc would corrode upon contact with the acids in the citrus juice.
- **Injection moulding:** The soft 'elastomer' handle, the rubber feet, the gearbox housing and the internal gears are all injection-moulded from different plastics. These include nylon, ABS, TPE and silicon.
- **Metal pressing:** The stainless-steel pulp filters, the juice collector, the spout and the fruit dome are all pressed from sheet stainless steel. The pressing process can be quite complicated. For instance, the pulp filter is made in 13 stages, using 13 different press tools to change the stainless steel from a flat sheet into the required shape. Halfway through the process, the part is **annealed** to soften the steel so that it can be pressed further. There was a lot of consultation with the toolmakers in China when designing the pressed parts, and the part design was modified several times to suit the manufacturing process.

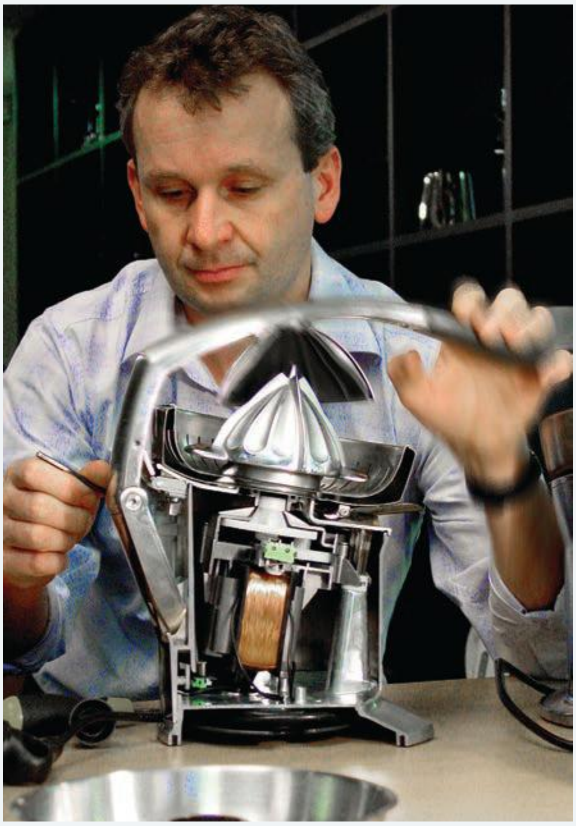

Figure 2.8 Keith Hensel and his prototype

Tooling-up for production

When the design of the parts was finished, the parts were released for tooling. This happens when Breville has prototyped the parts, tested the operation, and is confident that the design of the parts is correct, and the performance of the product is suitable. All the parts were designed on the computer in 3D. These digital files were emailed to the toolmaker. Because the files are digital images, the parts are defined exactly, independent of any language interpretation.

Breville also needs to have at least one contact person in the China factory who speaks English, so that they can translate any communications. The tooling took two to three months. The test run was the next crucial stage in production. A small run of each part was made; usually about 20–30 units. These were known as 'first-off parts' or 'T1 parts'. These parts were checked to see if the shape matched the design. If there were any variations, feedback was provided and the tools modified.

Breville then began to build the products. Four or five units were hand-assembled and used to check the basic functions. Where areas needed attention, the reason had to be identified: it might be a manufacturing problem of the part, an assembly problem when the parts go together, or a design problem with the part itself. Any adjustments were made to the 3D files on the computer and sent to the toolmakers. The tools were adjusted or 'tuned'.

anneal to make metal or glass soft by heating and then cooling slowly

The designers travelled from Australia with laptops that ran the 3D software so that modifications of the 3D part files could be made while in China and given to the toolmaker.

Setting up for production

The next step was to perform an 'engineering build' of approximately 30 units. These products were built by a team of engineers on a mini production line (not by assembly-line workers on a full production line). In the pilot production

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Australian Standard detailed technical documents developed by Standards Australia to ensure quality and common understanding

run, these units were used for testing the function of the product, the electrical safety, life testing and so on. They were also submitted to the **Australian Standards** body to ensure compliance had been met.

For this phase, the mini production line was set up in the factory. There may be up to 60 people on a production line for this type of product. This not only includes the people that assemble the parts together, but up to 15 people who check the function and quality of the product at various stages.

Note that all the individual parts were usually moulded, pressed and formed in other locations, so they needed to be brought to the relevant position along the assembly line, ready for assembly onto the product that is moving down the line.

The designer of the product from Sydney would normally attend the pilot run to check that the parts are assembled as intended when the product was designed. The designer may have envisaged that a certain part would be assembled in a specific way or using a special tool that he needs to communicate to the assembly team.

Presentation of final product

Breville always extensively tests products from the pilot production run. This includes setting them up on life-testing rigs that make the product perform thousands of operations to check that it is safe and will last a long time. The products are also packed in the final packaging and 'drop tested' to ensure they are well protected during transport. The product has a long journey and is handled many times from the factory in China to the customer's home.

Final production

Once the testing is complete, production can start. For a product such as the Citrus Press™, a standard production line should be able to build 500 units a day. When a small appliance is launched in Australia, Breville normally produces a launch quantity of around 10 000 units.

Figure 2.9 The development of the Citrus Press™

ACTIVITY 2.3

1. Identify and describe three technologies that have been employed in the design process of the Citrus Press™.
2. Discuss how the technologies employed during the design and production processes of the Citrus Press™ impact the final product.
3. Identify one step of the process that would be managed differently today, using more recent technologies.

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CHAPTER SUMMARY

- The design process covers the initial contact with a client or development of an idea through to a final product.
- The production process begins once the design idea is finalised.
- Effective production must involve a schedule. A number of tools, techniques and production processes are used.
- Production settings are divided into three sectors:
  - Domestic settings: small-scale or one-off production.
  - Community settings: small community or interest groups developing a company or cooperative for the common good of the people involved.
  - Industrial settings: large-scale production, using a large number of people and a variety of manufacturing techniques and machinery.

CHAPTER SUMMARY TASKS

1 Define the terms 'production process' and 'design process'.

2 Outline what characterises an industrial setting.

3 Identify an Australian designer you are familiar with and complete the following:

- **a** Create a table and list the steps involved in the design and production processes. Use the following headings: Technologies used in the design process; Technologies used in the production process; Impact on the design process; Impact on the production process.
- **b** Describe the technologies used at each step in the design and production processes. Your answer to part **a.** will assist you.
- **c** Compare and contrast the technologies and processes undertaken with your project and that of a professional designer. Explain the differences.

4 Discuss the importance of effective communication between the design and production teams.

5 Evaluate the role of pilot runs and prototyping.

6 Describe the benefits of 3D modelling.

7 'Designers are better off using machinery instead of humans.' Discuss this statement.

8 Describe technologies that designers can employ during the project-management stage.

9 Discuss the importance of designers documenting their idea development.

10 Debate the ethical issues that are raised by using offshore production.

EXTENSION TASKS

1 Describe the main differences between the industrial, commercial and domestic settings.

2 Explain the importance of project management in the design and production processes. Discuss how this may influence the success of the product, system or environment.

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3 The impact of design and technology activities on the individual, society and the environment

This chapter explores the impact of a range of design and technology activities on the individual, society and the environment. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P2.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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3.1 The impact of activities undertaken in the development of design projects

Video

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

Designers often respond to community pressures and highlight their eco-friendliness and **ethics** in an attempt to make their work more marketable. In considering the impact a design may have on the individual, society and the environment, we should investigate:

- personal values
- cultural beliefs
- sustainability
- safety and health
- community needs
- individual needs
- equity.

This is a working and variable list that may be added to or altered, depending on the product, system or environment studied. As an example, let's focus on the impact that a multimedia messaging app like Snapchat may have on the individual, society and the environment (see Table 3.1).

ethics a system of accepted beliefs that control behaviour, especially one based on morals

Figure 3.1 Snapchat

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Table 3.1 What are the advantages and disadvantages of Snapchat?

ADVANTAGES	DISADVANTAGES
TO THE INDIVIDUAL	
• You can potentially contact users and be contacted 24 hours a day. • You can upload and share personal photographs and videos, as well as links to other sites, quickly and easily. • You can control access to your personal information by deciding who sees what of your profile. • You can stay in touch with people you would not otherwise be able to because of distance and time. • You can keep up to date with news about your friends, their interests and relationships. • You can develop a large group of friends and contacts, with varied interests and expertise. • You do not have to write long messages. • It is quick and easy. • Your images and stories disappear after a period of time. • Friendships form during one-to-one streaks (consistently messaging someone everyday). • Friends can easily be added using snapcodes. • You can add lenses/filters to your photos.	• Other users/friends can try to contact you 24 hours a day. • You cannot control how other people share your snapchats and the inclusion of photographs of you that other users put on the app. • You can be exposed to undesirable people or online predators. • As certain users can see some of your activities on the app, as well as photographs and videos, you can lose your privacy as images can be easily shared with other users. • As you can see the activities of other users on the app, you may develop social insecurities if you are not included. • You can develop addictive behaviour or dependence on the app. This is because of the 'time-pressure' to view the messages before they disappear. 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. • You may feel pressured to accept friends with whom you would otherwise choose not to have contact.
TO SOCIETY	
• Social and networking groups can be created quickly and cheaply. • Users with common interests are brought together. • Users in rural areas are able to participate in activities and access information otherwise unavailable to them. • Users have an effective means of mass communication. • Users may be able to communicate with others more often. • Users are able to participate together in online activities and popular culture. • Businesses are able to directly target their demographic through advertising and marketing, and they can boost their online profile quickly and cheaply.	• Employers are able to spy on their employees, finding information about their weekend activities and relationships. • Users may not develop interpersonal skills. • Users can have their accounts hacked, and their personal data used for criminal activities. Status updates also alert potential burglars if users are on holiday or have made recent purchases. • Children may be at greater risk of grooming and attacks by online predators. • Some social groups may promote racist, sexist, violent or other antisocial behaviour. • Users can violate intellectual property rights by uploading content that is not their own.
TO THE ENVIRONMENT	
• Snapchat is a communication means that does not require paper. • Environmental groups can be formed, and support for environmental causes rallied quickly online with potential customers.	• Snapchat uses a range of quickly developing technologies, such as computers and smartphones, which may encourage materialism and become obsolete quickly or add to landfill.

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3.2 Considerations for the individual, society and the environment

PERSONAL VALUES

We all have differing values because they are largely informed by our upbringing, lifestyle, cultural background and individual life experiences. As designers, we must be aware that different values may impact on the acceptance of certain designs or create design-related issues. For example, certain groups in society place significant value on recycling and being environmentally friendly, whereas others may not.

CULTURAL BELIEFS

Cultural beliefs are predominantly influenced by the society in which we grew up or live in today. Geography, climate, religion, history, traditional practices, cuisine, mores (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 can offer. Religion can be a factor that determines design in fashion, jewellery, architecture and art. Also, some traditional customs are heavily design-based. Designers need to show sensitivity to the views of others. The use of sacred Aboriginal or Torres Strait Islander artwork in graphic design, for example, may be considered taboo.

SUSTAINABILITY

Sustainability involves addressing the needs of people today without negatively affecting the resources of people in the future. As designers, it is important that we think sustainably. We should avoid the use of finite natural resources wherever possible, and we should think about the effect the disposal of products will have. Designers complete a life-cycle analysis to monitor the energies used and environmental impact at each stage of the life cycle. It is important that designers use this information to try to minimise their carbon footprint through changing production practices or replacing materials with more sustainable alternatives.

ACTIVITY 3.1

For each technology listed, complete a table like the one shown below to explain the cause and the effect (impact) of the technology for the individual, society and the environment:

- KeepCup
- the internet
- nuclear energy
- satellite phone
- meat substitutes.

	CAUSE (WHY DID THIS HAPPEN?)	EFFECT (WHAT HAS HAPPENED AS A RESULT?)
INDIVIDUAL		
SOCIETY		
ENVIRONMENT		

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SAFETY AND HEALTH

The safety and health of the production workers and the final users of products are important and must be considered at all times. Procedures, tools and techniques must be correct, safe and **appropriate** and must comply with SafeWork NSW, Standards Australia and work health and safety guidelines. For example, use of medium-density fibreboard should be eliminated in schools and asbestos should not be used in building sites because of the negative health consequences of these materials.

appropriate suitable for an occasion or use

hazard anything that can potentially cause harm or loss

Testhub

Final products must meet all criteria stipulated by Standards Australia; this will ensure that the product is safe for the end-user. For example, toys created for young children should not have small pieces that could be a choking **hazard**.

ACTIVITY 3.2

After the oil and mining industry, fashion is the most polluting industry, and the ethical issues it raises (such as sweatshop labour), as well as its environmental impact, are a growing concern for consumers.

Every year, millions of items of clothing are thrown away instead of being repaired or recycled. However, things are starting to change.

Read the article 'Clothing rental could be the key to a stylishly sustainable fashion industry' on the website *The Conversation*.

1. What is sustainable design?
2. Outline the problem facing the fashion industry.
3. Describe the benefits of renting clothing as opposed to recycling.
4. Find five examples of sustainable design and describe what makes each of them sustainable.

CASE STUDY 3.1

Ecosia

Ecosia is like other search engines, except for one detail. Ecosia is trying to minimise their environmental footprint by planting trees with their profits.

Ecosia was created by Christian Kroll in 2009. Its search results are now provided by Bing, Microsoft's search engine. At least 80% of the revenue from the advertisements displayed next to the search results are donated to non-profit organisations that specialise in reforestation and preventing desertification. The remaining 20% are kept as backup reserves and are reinjected into the tree planting fund if they are not used. Christian Kroll and co-owner Tim Schumacher have both surrendered their right to sell or to make a profit out of Ecosia.

Since its launch, thanks to Ecosia, more than 75 million trees have been planted around the world where they are needed most.

In addition, Ecosia's servers run on 100% renewable energy and they are completely transparent regarding their advertising revenue, publishing monthly financial reports so that anyone can check their tree-planting receipts. Besides, since 2018, Ecosia has been privacy friendly.

Ecosia can be set up as the default search engine or as one of the options in several browsers such as Google Chrome and Mozilla Firefox, and it is also available as an app for iOS and Android devices.

For more information, consult the Ecosia website.

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COMMUNITY NEEDS

A community is a group of people who live or operate in the same location and usually share some common interests and facilities. Community-interest groups are usually made up of volunteer citizens who look out for the needs of the community. For example, the introduction of a new school bus route that will benefit a number of local schools and reduce traffic created by parents driving their children to school is a way community needs can be met. However, interest groups do not always service all community members.

Street libraries provide the community with an opportunity to share books that they have read with the community. Rather than a book sitting on a person's bookshelf collecting dust or being thrown out, this new program allows the book to have many lives, thus reducing the impact on the environment.

> 'Street Libraries are a beautiful home for books, planted in your front yard. They are accessible from the street, and are an invitation to share the joys of reading with your neighbours.'
>
> Source: https://cambridge.edu.au/redirect/8933

You can build your own street library using the guidelines and sketchup plan available on the Street Library website,or you can buy one of the kit versions of the shed to build and install for the enjoyment of your community.

You can also find existing street libraries in your neighbourhood using the Street Library map.

INDIVIDUAL NEEDS

When individual needs are met, the design of a product, system or environment is deemed to be successful. Determining individual needs may involve qualitative or quantitative research methods – methods integral to the design process. Good design can have a positive impact on the individual, reducing the financial burden or improving their health or quality of life.

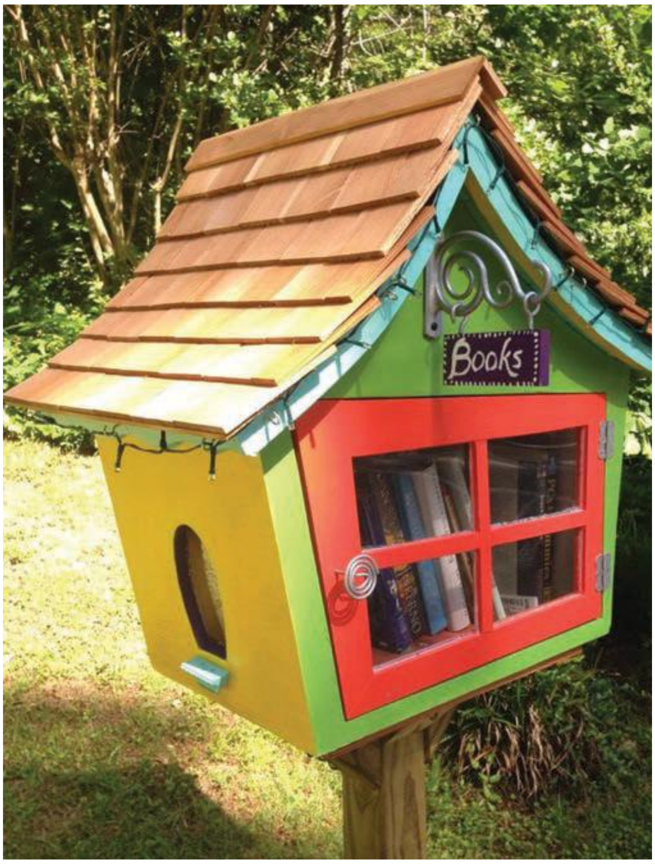

Figure 3.2 Street library

Figure 3.3 Designers must consider equal opportunity.

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EQUITY

Where relevant, a designer should strive to ensure equal accessibility to their product, system or environment where appropriate. The less able, minority groups or those living with a disability or who are financially challenged must be given equal opportunity to benefit from any new product, system or environment. An example has been the introduction of wheelchair ramps in public places.

ENVIRONMENTAL AND SOCIAL ISSUES

There is a plethora of innovations facilitating everyday life such as RagTagd, which addresses the social and environmental issue of lost property.

Video

> RagTagd is a service that provides ultra-simple RFID tags in kids' school uniforms and sensor-equipped bins to schools so that lost property can be tracked. When a kid's lost jumper ends up in a bin at their school, the second it hits the bin a text is sent to the child's parents letting them know where it is.

Source: https://cambridge.edu.au/redirect/8934

Some innovations such as the 'lua' smart planter, which aims to turn your plant into a pet, might appear less essential. Nevertheless, a crowdfounding campaign launched on Indiegogo in May 2019 was backed by more than a thousand people and raised nearly ten times the initial goal over three months.

> The 'lua' device is loaded with a series of sensors that let it trigger up to 15 different emotions, measuring everything from the soil's moisture, temperature and light exposure.
>
> The emotions are displayed via an 2.4 inch LCD screen located at the front of the smart planter. It displays a panting face if your plant needs water, a face with chattering teeth if the plant is too cold, and a sweating face if the plant is too hot.

Source: https://cambridge.edu.au/redirect/8935

ACTIVITY 3.3

Testhub

Research the concept of vertical gardens. Prepare a report describing how vertical gardens might contribute to sustainable living. Discuss the feasibility of an average Australian having a vertical garden in their home.

Figure 3.4 Vertical gardens in the middle of Sydney CBD

ACTIVITY 3.4

1. Visit *History of Australian Innovation* on the IP Australia website. Choose three innovations that you think address environmental issues.
2. Describe the innovation.
3. Sketch the characteristics and features of the innovation.
4. Evaluate the design and production processes used in these innovations.
5. Investigate other innovations on the internet. Think about the environmental and social issues they address.

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CASE STUDY 3.2

Plant-based proteins

Meat production affects the environment through its reliance on land, food, energy and water. The environmental impact of meat production has been widely discussed in the past few years and even though the percentage of vegans and vegetarians is still quite low globally, there is an undeniable growing interest in plant-based foods.

> 'Plant-based protein, foods for health and wellbeing, premium products and other emerging food trends could be worth $25 billion by 2030, new analysis by Australia's national science agency CSIRO predicts.'
>
> Source: https://cambridge.edu.au/redirect/8936

An increasing number of consumers are changing their food consumption habits, whether it is for personal values or for sustainability reasons.

In November 2019, the CSIRO and Jack Cowin, founder of Hungry Jack's, have collaborated to launch the plant-based meat start-up v2food™.

Its name (v2 standing for version 2) reflects its CEO Nick Hazell's sentiment that our current food system is not sustainable.

The new plant-based protein emulates the taste and feel of meat without a significant environmental impact. Their product, which they call plant-based meat, looks, cooks and tastes like meat even though its main ingredients are legumes, sunflower oil and coconut fat.

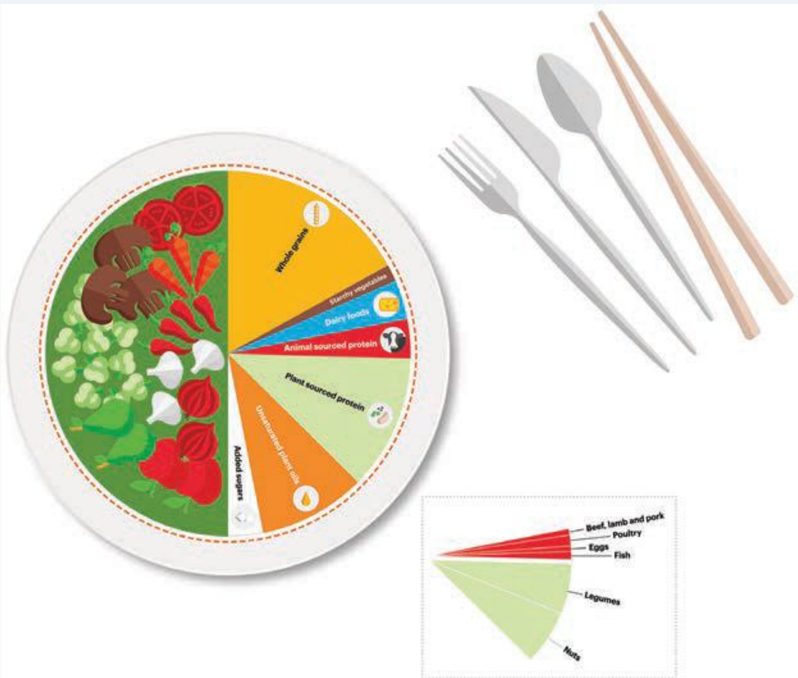
v2food™ is not aimed only at vegetarians and vegans – the company wants to entice meat eaters too.

v2food™ is designed to be healthy for the consumer as well as for the planet and to fit on the EAT-*Lancet* planetary health plate, which is an adult global recommendation diet illustrated by the content of a plate with around half of its content coming from vegetables and fruits and only a small portion coming from animal-based proteins.

This graphic was prepared by EAT and is included in an adapted summary of the Commission 'Food in the Anthropocene: the EAT-*Lancet* Commission on healthy diets from sustainable food systems'. The entire Commission can be found online at https://eatforum.org/eat-lancet-commission.

For more information, research v2food™ and the EAT-*Lancet* Commission on the Eat Forum website.

Figure 3.5 The EAT-*Lancet* planetary health plate



Video

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CHAPTER SUMMARY

- All products, systems and environments impact on an individual, society and the environment throughout the design and production stages.
- Factors such as personal values, cultural beliefs, sustainability, safety and health, community needs, individual needs and equity all impact on the way in which a product, system or environment is designed and produced.
- 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.

CHAPTER SUMMARY TASKS

1. Construct a mind map or infographic to show the impact that plastic has had on individuals, society and the environment.
2. How does the production of alternate meats impact on society and the environment? Consider each step in the design and production processes.
3. How do you think a designer can incorporate sustainability in their work? What steps would you consider taking to make your design process more sustainable?
4. Develop and discuss your own strategies that industries can undertake to ensure the conservation of natural resources.
5. Outline some of the health and safety issues that impact on the design of a city skyscraper.
6. Explain the importance of community groups, and how it helps social groups.
7. Why do you think the design of a product or system should take equity into account?
8. Find an innovation that has been developed in response to social issues such as the anti-terrorism garbage bin or soundproof windows. How were the needs of the community met by this innovation?
9. 'The cultural beliefs of consumers can impact on the success of a product, system or environment.' Conduct an investigation, such as online research, to find examples that support this statement. How did cultural beliefs affect the overall success of these designs?
10. All designs must consider their accessibility to all minority groups. Discuss the implication this has on the designer during the design process.

EXTENSION TASKS

1. Using an innovation or a case study that you have recently investigated, research and prepare a short report on the impact that this product or development has had on the individual, society and the environment.
2. 'There are no such things as environmental problems; there are only human problems.' Critically analyse this statement, giving examples of how sustainable design can respond to environmental issues. What is electronic waste (e-waste)? Outline possible ways to reduce e-waste.

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4 Investigating and experimenting with techniques

This chapter explores creative and collaborative approaches in designing and producing. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P3.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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4.1 Selecting and applying cognitive organisers

Today's designers and technologists have access to a huge variety of materials, processes and information sources. How these are used and the types of changes society accepts will be crucial to the future of our country. It is important that you are not only a creative designer, but that you have an understanding of innovation and **entrepreneurial activity**, so that you – as a decision-maker of the future – can make wise decisions. It will be beneficial to develop a toolbox of strategies to help you make wise but creative decisions, to encourage you to think outside the square and to look at things from different angles. You are encouraged to take risks with your thinking!

entrepreneurial activity making ideas for products or businesses into productive and profitable businesses

CREATIVE AND CRITICAL THINKING

Some people will view critical thinking as mainly evaluative, and creative thinking as generative, but others believe it is difficult to distinguish between them. They complement each other and have many of the same attributes. Good thinking will help you in quality assessment as well as the production of something different. While you are thinking creatively, you will be constantly evaluating the validity of your ideas critically.

It is a fallacy that creative people rely on effortless inspiration. Creative achievement requires self-discipline and dedication. Creative individuals are hard workers who devote time and effort to their pursuits. They are prepared to take risks and often reject obvious alternatives because they aim to push the limits of their abilities and knowledge. They will also be flexible thinkers who look at a problem from many different perspectives. We want to be creative thinkers so that our design solutions will be different from those of other people. As a creative thinker we aim to:

- be clear about our goals
- be well informed about the related issues
- consult a range of resources
- consider a variety of points of view, not only those we favour
- work to the best of our ability
- continuously reflect on our actions and decisions
- share our ideas with other people.

Successful designers are both critical and creative thinkers. They have developed a number of different strategies to enable them to consciously improve the quality of their thinking. They are able to successfully solve problems and think creatively – to think outside the square.

We are all thinkers. It is natural for us to think about things. However, much of our thinking can initially be biased, distorted, uninformed or even prejudiced. In the development of our designs we each want to become a motivated, disciplined thinker who conceptualises, analyses, synthesises and applies information. This means that we will become self-disciplined and active in the process, constantly responding to information, issues and processes. We want to become critical thinkers with intellectual integrity. As critical thinkers we aim to:

- investigate problems
- question traditional solutions
- evaluate information
- assess sources and resources
- accept abstract ideas
- test ideas and develop conclusions
- justify solutions
- be open-minded and listen to others
- communicate effectively
- reflect on our learning.

ISBN 9781108869300 Cambridge University Press

Explore these mind mapping apps on the internet: Popplet, SimpleMind, MindNode and iThoughts.

You can think of your brain as your mental toolkit. You want to use the tools that promote the logical mode as well as the creative mode of thinking. You want to be able to deliberately set out to solve problems in a logical manner, but also appreciate the benefits of the deeper thinking that meanders, moves off in tangents, is contemplative and is often full of gaps. Reflection is a valuable tool in the thinking process. Take time to think through your ideas. The more time you spend in the idea-development stage of your design projects, the more successful your final solution will be.

COGNITIVE ORGANISERS

Many strategies have been developed to encourage us to become more creative in our approach to thinking. A number of these are discussed below. They are designed to encourage you to think differently, to consider all aspects and look more deeply into an issue or problem. Some will suit your style of thinking better than others, but you should be sure to try those that you find more difficult in order to move your thinking outside its comfort zone. You never know, you might come up with an idea you would not have considered otherwise.

PMI

Plus – the good things you like about an idea
Minus – the bad things about an idea
Interesting – what you find interesting about an idea

ACTIVITY 4.1

Compare and contrast the lists of actions for creative and critical thinking given on page 40. Why do you think there are similarities and differences? Do you consider your strength is in critical or creative thinking? Why?

Lateral thinking proponent Edward de Bono suggests this method to ensure that you do not reject a valuable idea on the first introduction. On the other hand, it can help to remove bias – you may have difficulty seeing the negative side of an idea that you really like.

lateral thinking using creative or unexpected thinking to solve problems

Judgements are often based on emotion, so it is important to explore all aspects of an idea.

Video

Brainstorming

This strategy is used to ensure that we consider all options. It is best done in a group. The group members should feel comfortable suggesting all ideas that come into their minds. All options must be recorded and no comment on an option should be made during the brainstorming session. At the conclusion of the time spent brainstorming, discussion will occur and options that the whole group deems unsuitable may be removed from the list. If it is important to narrow your list, you could use some other thinking strategies, such as PMI, to help you shorten your list.

ISBN 9781108869300 Cambridge University Press

CASE STUDY 4.1

Nicole Velik: The Ideas Bodega

Nicole Velik comes from an advertising background where she learnt the importance of creating a new business pitch or new product development. She describes herself as a creativity and innovation facilitator, trainer and consultant. Her belief that we all want to work in a company that promotes creativity forms the foundation for her current occupation. She is a sought-after speaker at international conferences and has worked with companies from all corners of the world.

Nicole is the founder and director of The Ideas Bodega. This company lives and breathes creativity and innovation. The Ideas Bodega helps companies to enhance their creative process by providing people with the skills to generate new ideas.

The idea for this began when Nicole was working in New York City where she helped her clients create cultures where innovation would flourish. She willingly shares her ideas on the development of creativity with others from a wide range of occupations. Her ideas may help you to become a more innovative designer.

Below is an entry from her blog.

'SEPARATE YOUR THINKING'

The two most important styles of creative thinking and why you need to separate them …

This week I was up in Byron Bay training the team from the incredibly successful global fashion empire Spell and The Gypsy Collective. These guys are so successful that they won the Telstra Business Award for the best company Australia Wide.

I was there to train them in Creative Thinking. I taught them all the best techniques for innovation that I have. Some are quite complex and really help push the boundaries to creativity. At the end of the session I like to do a re-cap and I asked them what the biggest lesson was from the training. Their answer was very surprising as it's something so simple yet something we all forget to do.

The biggest lesson was, **separate your thinking**. Don't diverge and converge at the same time – meaning, don't come up with an idea and then slaughter it at the same time. I once heard it put this way – don't drive a car with one foot on the accelerator and another foot on the brake at the same time. No one would drive a car like that as you would get nowhere.

This is generally what happens in brainstorms or meetings when people are generating ideas. Someone says an idea and then straight away someone else will find a hole in the idea and say why it won't work. 'We don't have the budget for that' or 'The client will hate that idea' or 'We tried something like that in the past and it didn't work'.

I should explain that divergent thinking is when we allow our brains to flow freely and generate many different ideas. Convergent thinking is the analytical process of teasing, building, culling and choosing the best ideas to move forward with. Both phases are crucial in any creative thinking task. The problem is that as humans we are naturally very analytical and judgemental so even a team like Spell who are so kind, considerate and open, still needed to be reminded that judging ideas too soon is doing the business a disservice.

The danger of allowing both phases to happen simultaneously is that no new ideas see the light of day. All new ideas will have something wrong with them. In many cases the only ideas that get the green light at the end of the brainstorm are ones that are safe, potentially boring and ideas that we've heard before. I like to call them Business As Usual ideas. If we are re-hashing old ideas we stay trapped in the past, we don't innovate and risk falling behind our competitors.

There are two things we need to keep in mind. The first one is that ideas don't come out perfectly. It's a strange analogy but if you've ever been on a safari or watched a David

Attenborough documentary you may have seen a baby giraffe? When a giraffe is born it come out very gangly and takes its time to find its feet … much like our ideas.

The second thing to keep in mind is that some of the most incredible ideas that have graced our planet must have sounded completely crazy when they were first thought of. For example, an ATM. Just imagine that brainstorm. "We no longer need people to come into the bank, we'll put these boxes out on the street and fill them up with tens of thousands of dollars of cash … Or the founders of Airbnb who thought that strangers would stay in strangers houses!"

One of my favourite quotes is "Stupidity is the mother of innovation." So next time you hear a seemingly stupid idea remember to bite your tongue as it might just be the next big thing if you give the ideas a little time to breath.

By now you might be thinking how you can bring this idea of separating your Divergent and Convergent thinking into your next brainstorm. Here are a few tips that will have a huge impact on the success of your session.

1. Acknowledge that ideas can come from anyone. I always tell people to 'leave their titles at the door' when they walk into the room for a brainstorm
2. Tell participants that we are now in 'Divergent Mode' and that means that all ideas are accepted. No judging of other people's but especially their own ideas
3. We are going for quantity of ideas rather than quality. Sometimes I ask people to give me their crappest ideas as this gives them freedom to speak up even if their idea is half baked
4. Make sure that people know that after the session the ideas will be converged on. This puts people at ease. They feel comfortable that there is a process and that the ideas don't have to be perfect. They can now relax and enjoy the brainstorm.

The simple process of separating these two creative thinking styles will have a huge impact on the quality of your brainstorms. At The Ideas Bodega we train people to be masterful facilitators. If you'd like to know more about facilitating the creative process, get in touch with us!

Figure 4.1 Brainstorming can be performed in groups or alone.

ISBN 9781108869300

ACTIVITY 4.2

1. Conduct a PMI on each of the tracksuit designs shown below.
2. Sketch a design for leisurewear that you believe would be an improvement.
3. Ask a friend to do a PMI on your design.

Figure 4.2 Two different tracksuit designs

ACTIVITY 4.3

1. Form a group of three to five students. Select a student to record the suggestions.
2. For two minutes, brainstorm a list of articles that need to be carried in a sports bag to be used by one of your peers.
3. Reflect on the process. Were there any articles listed that you did not think of? Did you listen without interrupting? Did anyone monopolise the brainstorm session? Were you surprised at the number of things suggested?

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Futures wheel

A futures wheel can be used to enlarge your view – to get you to look into the future. As designers, we must consider the consequences of our products, systems and environments. This strategy will force you to think about the implications of your designs (or the work of other designers) on individuals, society and the environment. It should consider the short-term and long-term consequences of the design.

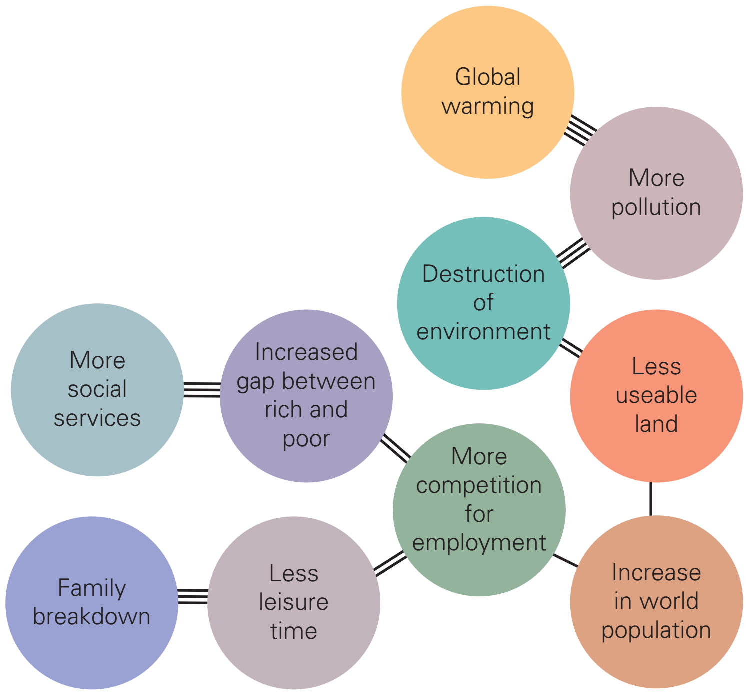

Figure 4.3 A futures wheel investigating the consequences of an increase in world population

ACTIVITY 4.4

Draw a futures wheel to illustrate the consequences of less water in our river systems like the Murray Darling Basin.

Mind map

A mind map is a graphical method of organising your thoughts. It is particularly useful for those of us who tend to go off on tangents when developing ideas. It is a strategy that enables you to list all the things you are thinking about and link them back to the original idea (see Figure 4.4).

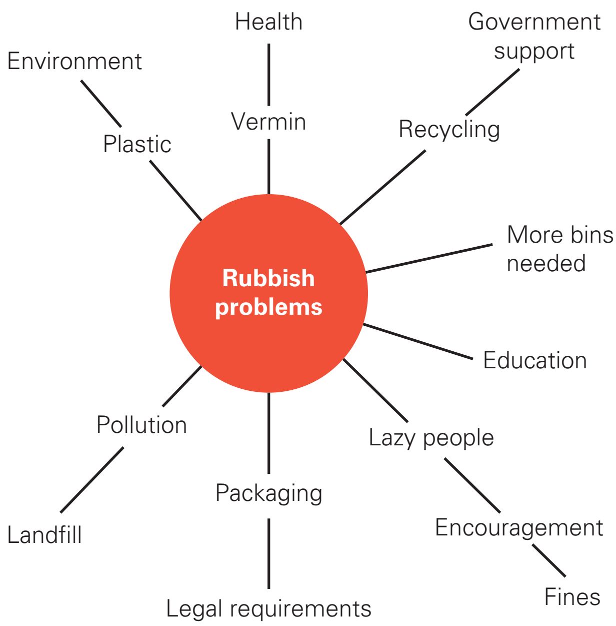

Figure 4.4 A mind map developing ideas relating to rubbish problems

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ACTIVITY 4.5

You have been asked to consider all the factors that affect the design of the Segway shown. Draw a mind map to plan your response. Search for Bubbl.us on the internet and use it to list all the factors that would impact on the design of a Segway.

Figure 4.5 Segway

Concept board

Often designers are inspired by an experience and incorporate this into their design. A **concept board** can be used to clarify the aspects of the concept that will be important to the final design. Many people believe that the design of the Sydney Opera House was inspired by the sails on Sydney Harbour. Others believe it was the waves of the sea. Its designer, Jørn Utzon, says he was inspired by orange segments. The important point here is that inspiration can play an important part in the development of designs, and a concept board helps clarify this inspiration.

concept board a cognitive organiser used to clarify the aspects of the concept that will be important to the final design

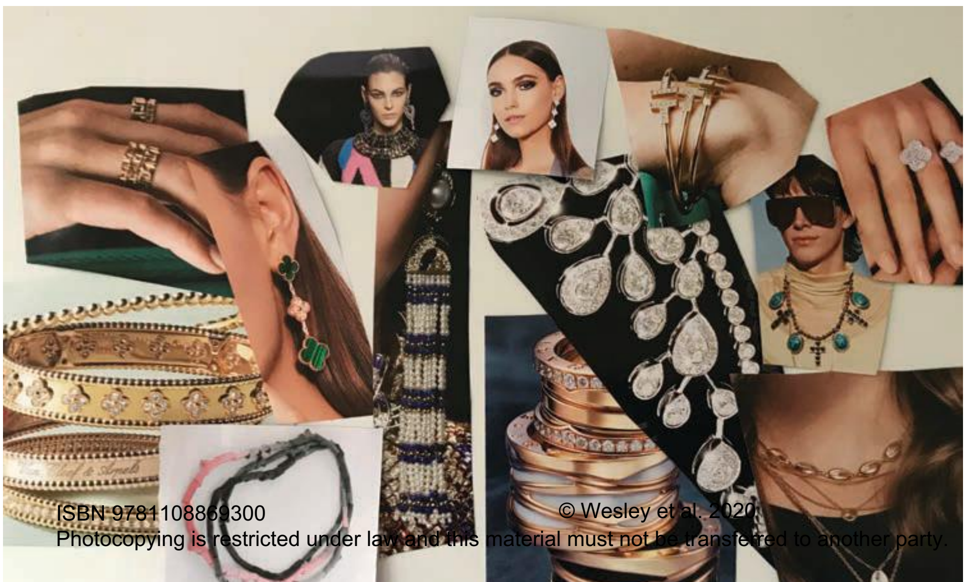
Explore Pinterest on the internet and save any pages that show images that interest you.

Search for Glogster on the internet and use it to create a poster that illustrates your idea of 'rainforest'.

ACTIVITY 4.6

1 Develop a concept board to illustrate the concept of drought.
2 Use your concept board as inspiration to design a cover for a book titled *Drought Dramas*.

Figure 4.6 A concept board developed prior to a jewellery project



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4.2 Applying problem-solving techniques to identified problems

We need to be able to solve problems in order to survive – many of the situations we encounter in our daily lives are problem-solving situations. In Design and Technology, you are often given a specific problem to solve in the form of a design brief. However, frequently during the development of your response to these design briefs you will confront poorly defined problems to solve: What material will you use? How will you get the arm to move? How can you join the pieces securely? A selection of general problem-solving processes is listed below. Some will be more useful than others; this will depend on the type of problem you are trying to solve.

1. Understand the problem. Ensure that you have the whole picture and have not focused on insignificant detail.
2. Remain open-minded. Do not make judgements too early in the process.
3. Use models, graphics, words or numbers to simplify the problem.
4. Try to look at the problem from a different angle or someone else's point of view.
5. Work backwards.
6. Ask yourself questions constantly.
7. Keep copies of all your trial solutions in case you need to return to them later.
8. Be flexible.
9. Talk to others.
10. Investigate how someone else solved a similar problem.

Do not forget to critically evaluate throughout the above process. Does this remind you of the design processes you use in Design and Technology? Can you identify any similarities and differences between this list and the lists given earlier for creative and critical thinking? Why do you think there is so much repetition in the process?

4.3 The advantages of cooperative structures

People naturally learn from each other; they do so all their lives. Good designers take advantage of the cooperative nature of learning. Rather than leaving it to chance, they will plan for it. For example, an ice-cream company is keen to introduce a new flavour to its range of ice-cream. An initial meeting may involve someone from the marketing department, a representative from production, a food technologist and members of the consumer group. Together they will be able to discuss various flavours, include all their different perspectives and come up with a range of ideas.

Sometimes a design team will consist of people with different skills. An architect of a new council library will work with the electrical engineer, the interior designer, a council representative, the builder, the librarian and any other people who will impact on the final design.

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CASE STUDY 4.2

Ceres Tag

Video

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a national body that works to solve difficult challenges through innovative science and technology. This case study describes the work they are doing in conjunction with Ceres Tag.

The livestock industry plays a crucial role in the national economy of Australia due to the rapid growth of Asia and the growth in demand for high quality Australian products.

Monitoring and locating of livestock has proved to be a time consuming and often costly challenge for livestock producers.

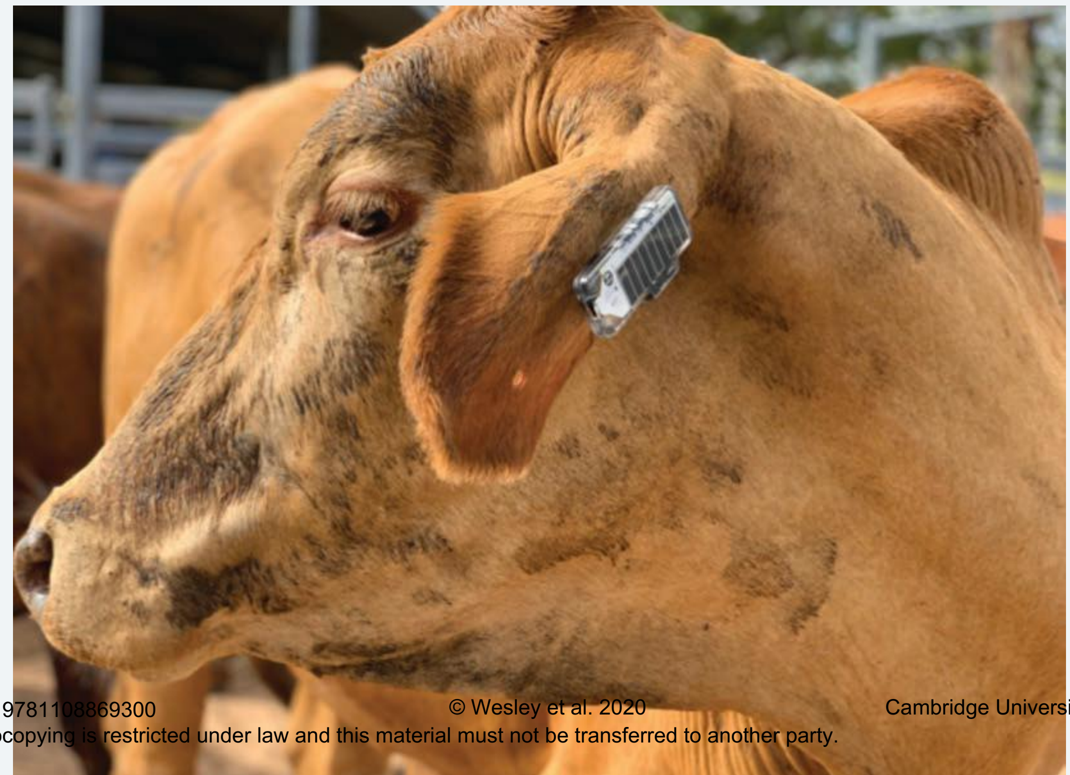
The CSIRO has contributed their technology expertise and science knowledge to a collaboration with commercial partner Ceres Tag to tackle this problem of livestock location. They report that wireless sensor network technology has enabled the location and activity of animals to be tracked at a high spatio-temporal resolution. Scientists have been using radio-frequency tags for animal tracking for some time, but previously downloading data from the tags has been labour intensive and/or expensive. In this development, the process of downloading data has been automated by deploying a fixed network of wireless receiver stations, base nodes or gateways. The data is downloaded and forwarded to a central server.

The Ceres Tag features geo-location for greater traceability and provenance of livestock, providing a platform for other possible applications. The data gathered can be translated into knowledge to improve management of both the livestock and the paddock. The ear tag will give producers greater control over grazing management and alert them to animal theft, illness or birth. It aims to reduce operating costs and increase efficiency.

The Ceres Tag is described on the company website as follows:

> Ceres Tag smart ear tag is the future of livestock industry data and information now and for the next generation of graziers. Our National Identification compliant ear tag delivers GPS positioning, movement and health monitoring. Ceres Tag provides competitive advantage and is underpinned by reduced loss and no battery replacement required. Ceres Tag is suitable for open pasture, dairy or feedlot for the red meat, dairy, wool and pork industries.

Figure 4.7 Ceres Tag © Copyright CSIRO Australia



ISBN 9781108869300

4.4 Factors that contribute to successful work and collaboration

A design team works together to achieve a common goal. It is essential that all members are able to collaborate, have respect for each other and work as a team. Commitment to the project is an essential ingredient. Many employers will require staff to be team players. They want people who can work together with a common vision. Your experience as a member of a design team will assist you to develop these required skills.

Communication between team members is essential for successful projects. The team leader should ensure that effective communication and information-sharing methods are agreed upon by all participants. These may include teleconferencing, videoconferencing, face-to-face meetings, email, an online forum and letters.

Working in groups or teams can be very useful for you as a Design and Technology student. You can all use each other to support the work you are doing.

Teams can be used to:

- generate ideas for projects
- discuss and solve problems
- share skills
- gather consumer reactions
- work on projects
- support each other.

Figure 4.8 Professional designers often collaborate on projects.

4.5 Working cooperatively

Below is a list of characteristics that should be evident in a successful design team. Can you think of any other characteristics to add to this list?

- Clearly defined goals
- Commitment to these goals from all team members
- Agreement on long-term and short-term objectives
- Sound communication strategies
- Skilled team members
- Relevant knowledge base
- Ability to focus on tasks
- Willingness to challenge oneself and each other
- Openness to change
- Power and authority used ethically and fairly.

Step 1: Consider the skills you are going to need and then select the team members.

Step 2: Write up a list of roles and functions for each team member. This is crucial, as it will save time in the long run. In industry, time is money!

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Step 3: Design the working plan. Remember that each member's contribution is equally valuable and that each person is responsible for the completion of the project. For the working plan:

- break the project into smaller tasks
- identify the help and resources you may need
- allocate time for each part
- determine the sequence of tasks
- decide who is doing which task
- produce a schedule and plan for the project and ensure that everyone has a copy.

Step 4: Document the methods of communication to be used. Develop a timeline to clarify when this communication will occur. (This step will need to be actioned in conjunction with Step 3, but as it is so important it has been listed as a separate step in the process.)

Step 5: Set up a process of evaluation. This should occur throughout the development of the project to ensure that each member is pulling their weight, the responsibilities are clear and that the project stays on track.

ACTIVITY 4.7

You have been asked to organise a design team to create a new school uniform for the senior (years 11 and 12) students in your school. You are asked to produce a prototype.

1 In a table like the one below, describe the team members.
2 Outline the methods of communication you, as the team leader, will set up to ensure a successful project.
3 Explain how working as a member of a design team will benefit this project.

ROLE	SKILLS	TASK

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CHAPTER SUMMARY

- Designers use a range of thinking strategies to enhance their creativity.
- When faced with problems to solve, it is best to plan a series of steps that will lead to a solution.
- Collaboration in design supports input from a range of sources.
- Communication between team members and clear goals are essential for effective team design.

CHAPTER SUMMARY TASKS

1 Identify five different strategies you could use to illustrate creativity in your projects.

2 Justify the use of PMI as a cognitive organiser.

3 Describe the process involved in a brainstorming session in which you have participated. Do you think the brainstorming helped?

4 Describe the role of sketching in the communication of design ideas. When have you used sketching to communicate design ideas? How have computer software and applications changed the way we communicate design ideas?

5 Explain why idea development is so important in the development of a project.

6 Discuss how a concept board can assist in the development of a project.

7 Identify a movie you have seen recently. List all the roles of the team involved in the production of that movie.

8 What makes an app useful? Develop a list of criteria. Use your list of criteria to evaluate five apps for organising ideas.

9 Outline the advantages and disadvantages of working in a design team.

10 Justify the communication techniques used in effective team design situations.

EXTENSION TASKS

1 Think about other uses for the technology used in the Ceres Tag. Document your suggestions for future developments. Describe the design team you would need to develop one of these ideas.

2 You have been nominated to organise a fundraising event in your school to raise money for World Vision. Think about the problem-solving techniques discussed in this chapter and list the steps you would follow to complete this task.

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5 Using design processes

This chapter explores design processes used in the development and production of design solutions to meet identified needs and opportunities. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P4.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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5.1 Formulating and analysing design briefs

Formulating a design brief is a process that may not necessarily be evident straight away. When a designer is solving a problem, they will need to make a careful analysis. This may involve interviewing those who are experiencing that problem or conducting other forms of research in order to ensure that the designer knows all the relevant information.

Similarly, when the designer is responding to a need, that need will have to be analysed carefully to determine all the issues involved. Comprehensive research will be necessary to ensure that the designer has all the necessary facts before beginning work.

If responding to an opportunity, the designer must first examine all the **parameters**. Then, through market research, they should consider the **target market** they're looking for and what opportunities exist.

Before a designer can identify a potential market to target, they must first analyse the competition. This process involves examining what is on offer from potential competitors and assessing what needs the competitors may not be fulfilling. Through this market research they might identify a gap in the market, which will help to formulate a design brief to solve that particular problem.

As a designer, one of the best ways for you to conduct initial market research is to look at existing designs and ask consumers whether they would be interested in the solution you are considering. You need to establish whether there is a genuine need for the project you have in mind.

Some people use specific terminology such as asking whether the project has a point of difference to the existing item; that is, whether there is sufficient reason for the project to be pursued. To put this in a negative way, what you are really doing is examining what need your potential competition does not satisfy, identifying the weaknesses in their products and looking at addressing those weaknesses by value-adding and improving on the current model.

parameter a limit or boundary that defines work
target market the sector of a market that a product is being produced for and marketed to

By formulating a design brief, you are working out what you need to focus on to make your project a success. Once you have been through this formulation or decision process, you can begin to analyse in detail what you are really trying to do.

5.2 Identifying the parameters and criteria of design

Every design project has parameters (guidelines, specifications) that it must comply with. For designs to be considered successful, all parameters need to be addressed. Other criteria may be incorporated into the must-haves of the design. The criteria, though not inherited, are still essential if the design is to be considered a success. Sometimes the parameters are established around standard sizes, available heights or spaces, or environmental issues which help you to shape your design in a certain way.

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If your teacher asked you to design and develop a bedside table lamp, the list of parameters they might give you could include:

- the lamp's height
- the diameter of the base
- the voltage that it would run off (e.g. 240 volts)
- the socket type for the light globe.

The brief could also specify criteria that the project must include to satisfy the client's needs, such as:

- the use of a particular type of switching mechanism (e.g. a touch lamp)
- the style of the lamp (e.g. a contemporary look)
- the materials to be used (e.g. recycled materials).

These parameters or boundaries are the obligations you inherit with a particular project; they are factors outside your control that you need to embrace and include in your design.

When designers start working on a design brief for a solution to a particular problem, they also need to consider the materials to be used and the processes that may be required. These are not separate: they must be considered together. For example, cutting metal may not use the same tools as cutting fabric. Consideration of what technologies are available to use and what expertise may be needed to meet the design criteria is another part of this process.

Consider the work of an architect who designs residential housing. Their client arrives for a first meeting to discuss how they will work together for a common goal – to build a home. One of the first things the architect needs to know before talking about the prospective house is the size and shape of the building block. Is the block big or small? Is it sloping or level? Another environmental factor is the orientation of the block – does it face north-east or west? Does it have a view?

These are design parameters the architect inherits; that is, guidelines outside their control that they must work with. On top of these physical parameters are the building requirements of the client. If the client has a large family but a small block, perhaps they need to consider a double-storey home to accommodate everyone. Do they want solar power? Is security an issue?

There is a long list of practical parameters the architect needs to consider before they can begin their design. The challenge is to meet all of these parameters well, and design a home that they and their client are happy with. After the parameters have been ascertained, the architect meets with the client to draft other criteria that will ensure the success of the design and satisfy the needs of the client. Examples of criteria could include:

- The outdoor entertaining area needs to be protected from the weather yet filled with light.
- The kitchen should have access to both the living area and the bathroom.
- Wheelchair access is needed.

These parameters are crucial, as they assist in the development of the initial design concepts.

A classic example of architects being directed by a set of parameters is the competition for the design of the extension of the Art Gallery of New South Wales. In this case it was a priority to ensure that the design melded with the environment, and did not impact on the surrounding infrastructure and natural landscape.

Video

ISBN 9781108869300

Cambridge University Press

ACTIVITY 5.1

Assume the role of a designer. You have been employed by a council to design a children's playground. The council wants seating for parents, sustainable materials and a bright creative setting. Child safety is a priority. Draft a set of functional and aesthetic criteria that you can present to the client before progressing with your designs.

ACTIVITY 5.2

Consider the structures in your local area. Can you find examples where the building is in harmony with the landscape? Describe how the structure fits with the environment. For example, the structure might follow the contour of the coastline or it might be a pole house built among the trees, and the building material may be a colour or texture that fits with the natural surrounding environment. Meet with your classmates and share your findings.

Figure 5.1 Cabins at Wolgan Valley Resort near Lithgow are built into the natural hillside to avoid clashing with the environment.

ISBN 9781108869300 Cambridge University Press

CASE STUDY 5.1

Sydney Modern Project – Expansion of the Art Gallery of New South Wales

The Sydney Modern Project was launched to transform and expand the existing Art Gallery of New South Wales. A competition was held to choose an architect, and submissions were lodged with the NSW Department of Planning and Environment following review and consideration of all submissions from community consultations.

Since 2015 the Art Gallery has been working closely with the chosen architects SANAA to develop the final design for the new building in consultation with project stakeholders and the wider community. The design brief requires that it be sensitive to the parkland setting of the gallery. Thus the design responds with a series of interlocked pavilions that step down the landscape towards Woolloomooloo and Sydney Harbour. Sitting low on the site, these pavilions follow the natural topography of the land.

The chosen architectural team is a Tokyo based firm that has completed many prominent cultural and educational projects across the world. In 2010 they won the Pritzker Architecture Prize. An excerpt from the prize citation reads:

> The buildings by Sejima and Nishizawa seem deceptively simple. The architects hold a vision of a building as a seamless whole, where the physical presence retreats and forms a sensuous background for people, objects, activities and landscapes.

Source: https://cambridge.edu.au/redirect/8937

Environmental considerations have been high on the agenda, and the gallery design has achieved a Green Building Council of Australia 6-star Green Star rating. While providing the needed gallery space, the design shows consideration of the surrounding landscape, retaining significant trees and improving accessibility to the precinct. An Art Garden, new civic plaza, accessible 'roof terraces' and courtyards are included. Two new lifts link the surrounding areas. This improved cultural precinct provides 24/7 access, landscaping and civic amenities for all visitors, and an improved universal pathway linking Wooloomooloo with the Sydney CBD.

SANAA made the following statement:

> We have been working very closely with the Gallery to refine our initial concept design for the Sydney Modern Project. We have come to know the project site very well. We continue to learn more and more about its history, especially about the traditional owners of the land and the site's importance today for them, and for all visitors. Preservation and harmony with the landscape is a design priority. It is a challenging site including a land bridge over a road and a concrete roof over disused oil tanks. Our intention is that the site will be of greater benefit to the people of Sydney and Australia, and visitors from around the world than it is currently.

Source: https://cambridge.edu.au/redirect/8938

Figure 5.2 Image of the Sydney Modern Project as produced by Kazuyo Sejima + Ryue Nishizawa / SANAA © Art Gallery of New South Wales, 2018
Featuring artworks from left to right: Reko Rennie *Murri totems* 2013 © Reko Rennie, courtesy of the artist and Blackartprojects; Clement Meadmore *Flippant fury* 1977–78 © Clement Meadmore/ARS. Licensed by Copyright Agency; Guan Wei *Revisionary* 1998 © Guan Wei; Kimsooja *Archive of mind* 2017 © Kimsooja; Rosalie Gascoigne *Metropolis* 1999 © Rosalie Gascoigne. Licensed by Copyright Agency; Richard Long *Southern gravity* 2011 © Richard Long; Imants Tillers *Counting: one, two, three* 1988 © Imants Tillers.

5.3 Producing functionally and aesthetically appropriate design projects

You have come up with an idea, and you have spent time formulating the concept and analysing what is currently available. You have identified the shortfalls of other products, and your project aims to deal with and correct those shortfalls or add an additional element to an otherwise sound product – to value-add.

How do you ensure that the project you are designing successfully achieves your goals? You need to identify the criteria for success of your design; you need to decide and then outline what the project must do to be considered a winner.

Design criteria are a useful thinking and communication tool. Essentially, they list all the things that the product, system or environment needs to feature to satisfy the user.

When considering design, we will often consider function and aesthetics as elements that impact on the final design. These two elements are closely associated.

How will the new public space function? How will people move around? How will it be lit at night? What atmosphere do we want to create? Are there natural features that can be utilised? Will we add aesthetic features?

Consider an umbrella. Its **primary function** is to keep your body (particularly your upper body) dry when it is raining. What functional criteria are essential to ensure this occurs? The umbrella must be made from waterproof material that deflects the rainwater and keeps you dry. In this case, the materials you select are directly related to the umbrella's function.

Gallery

While being waterproof is an obvious functional criterion, other criteria may require further consideration, depending on who is to use the product. Compare a golf umbrella to the pop-up variety that expands in length before opening out. The golf umbrella is intentionally large so that it covers the player and equipment, such as the golf bag, while the pop-up variety of umbrella is a convenient, easy-to-carry item that fits into a bag. Both items are umbrellas, but their functional criteria are different, and their size and construction reflect this.

Now let's consider aesthetics. The umbrella may be a fashion statement, and fabric design may be a priority if it needs to match other accessories. If the umbrella is made to appeal to a child, it might be decorated with a cartoon character or elements that children identify with as being fun. The umbrella handle is a functional aspect of the design, but it may also be an aesthetic consideration. What shape, colour and material will it be?

primary function the main purpose for which a product is selected by a customer

ACTIVITY 5.3

Qantas commissioned the famous Australian industrial designer Marc Newson to design a business-class seat that folds down flat into a bed. It became known as the Skybed. Research the Skybed and come up with three functional criteria and three aesthetic criteria for the success of the Skybed.

ISBN 9781108869300 Cambridge University Press

5.4 Identifying needs and opportunities with market research

Finding out what the marketplace wants, and indeed whether the community's needs reflect your own ideas, is one of the most interesting kinds of research you can conduct. The results may surprise you.

Like other research or fields of study, market research can be broken down into **primary research** and **secondary research**.

There are different ways to conduct primary market research to identify needs and opportunities including telemarketing, interviews and surveys. What method you choose often depends on what is possible and what is cost-effective for an individual to achieve.

primary research research conducted by going directly to the source, such as interviewing, experimenting, and collecting and analysing statistics

secondary research facts or data obtained from sources other than the original source, such as books, other people's reports or the internet

demographic a section of the population grouped according to common characteristics such as age, income or gender

In terms of secondary research – that is, research that has been completed by another person, group or even a government agency – there are many ways to access the kind of feedback needed for a design project. Useful sources for secondary research include the Australian Bureau of Statistics (ABS), the CSIRO, Choice magazine and chambers of commerce. Even newspapers may prove useful for finding out what similar businesses there are on a local level.

Always remember to correctly source any secondary research used in your documentation. You may also need to obtain permission to use data and information.

Segmenting the market is essential when identifying the **demographic** your product is aimed at. Examples of the different categories that might be relevant in defining the market include:

- age
- income
- profession
- geographic location
- gender.

Once you have identified your target market, you can focus on other aspects of research into that market. Designers or people commissioned by the designer look at the existing designs: the competition. If you don't do your research thoroughly, and the product you design is inferior, does not address the consumer's needs or is too expensive, chances are that the product will not succeed in the marketplace.

MARKET RESEARCH USING THE FIVE PS

Areas to look at when it comes to existing designs or competitors are:

- product
- price
- promotion
- place
- packaging.

Product

Market research into products looks at the type of product the competition is offering. A successful new design could have more features or use better materials. The construction methods could be superior or more environmentally friendly. A more expensive product may be more successful if customers feel they are getting more value for their money. If the competition provides a better product that suits consumers' needs, you may need to re-evaluate what you are doing.

Price

The price of your competitors' products is significant because it is important to be able to produce an item for a competitive price. If your product is more expensive than those of your competitors, you need to be able to justify this to the customer. It is critical to research whether the intended price of a product seems reasonable to the target market, or if they would see it as too expensive.

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Promotion

Promotion or marketing is an area where careful planning is needed. Competitors can gain additional market share if their advertising strategy is superior to yours. If your competitors are using television advertisements only, there's an opportunity to focus on online advertising. What about Facebook or Instagram? Could you consider pop-up or pop-under ads? Have you identified your target market? Will they relate to your product? For example, would you find a young adult promoting pensioners' insurance believable?

Place

How the competition's products are distributed from place to place is an important study in your market research. If your competition can only deliver in five working days, there may be a gap in the marketplace for a product that can be delivered more quickly. Have you considered where you will be displaying your product? Is it easy to find? Will it be only shown online? These are some of the important questions that need to be answered.

Packaging

Does your product require packaging? The main function of packaging is to protect the product during transportation from the manufacturer, but it may also be considered a factor that can play a role in whether or not the product sells in a new market or to new customers. If you are considering the promotion of your product, you may include packaging as part of your MDP. Good packaging should be convenient, attractive, economical, protective, communicative and environmentally friendly.

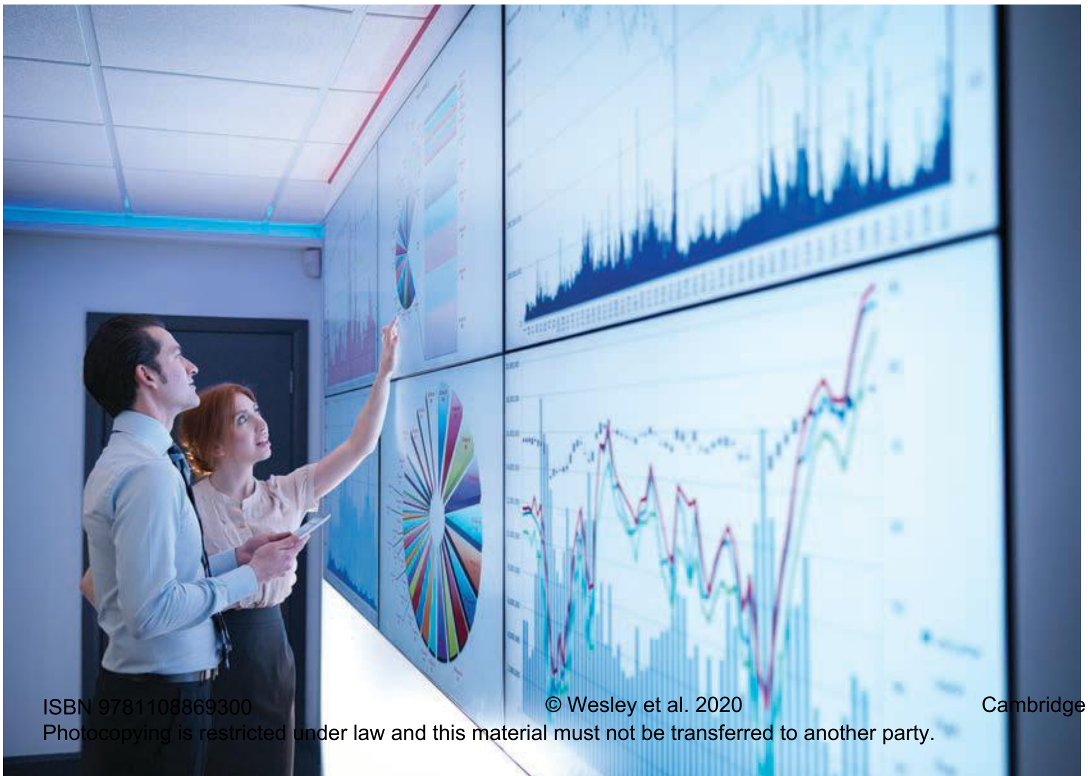
Video

Responding to the market research

Once you have the data you require, you will be in a better position to identify the needs and opportunities. Your initial criteria for success may be added to or modified along the way if a more appropriate idea presents itself.

When it comes to sharing market research data as part of a folio, presenting the results in graphs and charts can be a very effective way of displaying information.

Figure 5.3 Analysing graphs



ISBN 9781108869300

ACTIVITY 5.4

You are a game designer looking at marketing your game to the public. Identify your target market and appropriate ways you can promote and place your product.

MARKETING ENVIRONMENTS

The marketing environment to which a product is exposed will have a direct impact on the success of that product. In marketing, there are two different types of environmental influences: the micro-environment and the macro-environment.

Micro-environment

In a micro-environment, forces that can impact on the performance of a product in the marketplace can be controlled internally by the company. Better management processes, such as decisions about suppliers or customers that a company can implement, could influence, lessen or reverse a negative impact of a product in the marketplace.

Macro-environment

Six macro-environmental forces that affect organisations can be identified. The impact of these forces may not necessarily be negative. A clever marketer will read, interpret and use these forces (or trends) to their advantage.

Here are six macro-environmental forces:

1 **Demographic trends** consider the human population in terms of size, density, location, age, sex, race, occupation and many other statistics that can be obtained from the ABS through census information.

2 **Economic trends** are factors that affect consumers' buying power and spending patterns. These figures are often published by government departments and include trends such as changes in real income per capita, the changing income distribution between socio-economic classes, and changes in other economic figures, for example interest rates and the cost of living.

3 **Natural environment trends** include natural resources that are included in production or that are affected by marketing activities. Natural environment trends include shortages of raw materials, the increased cost of energy used in production and transport of goods, increased levels of pollution, and government intervention in natural resource management.

4 **Technological trends** consist of forces that affect new technology, hence creating new product opportunities and market opportunities. The faster pace of technological change causes shorter product life cycles, higher research and development budgets, concentration on minor improvements, and increased regulation.

5 **Marketing decisions** are strongly affected by laws, government agencies and pressure groups in society. Trends in the legal and political environment include changes in legislation regulating business, changing government agency enforcement, and the growth of public-interest groups.

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6 **Cultural trends** are forces that affect society's basic values, perceptions, preferences and behaviours. Designers need to consider the impact that cultural values may have on the sales success of a product. A fashion designer may find that certain styles of clothing may be too revealing for certain cultures, whereas other cultures would find the same style acceptable.

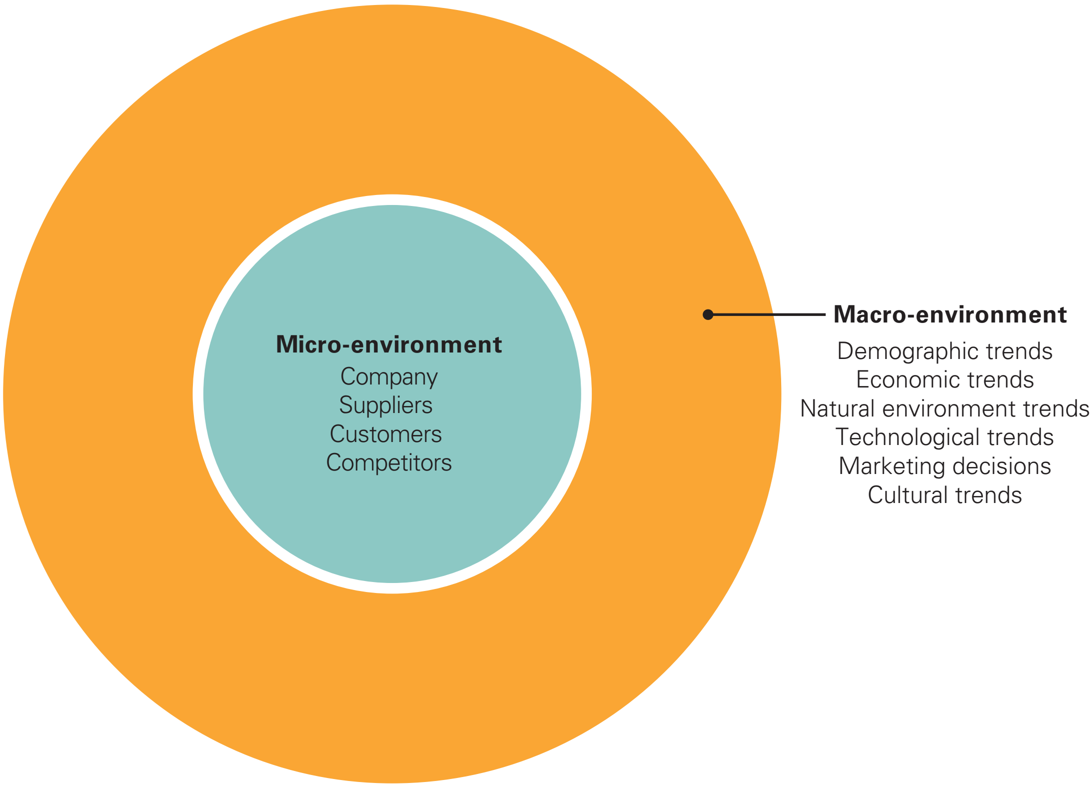

Figure 5.4 Macro-environment and micro-environment

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CHAPTER SUMMARY

- When formulating and analysing design briefs, it is important to consider all the parameters and look at any initial opportunities that may exist. Conduct thorough market research to find a gap in the market, with the ultimate aim of identifying a target market.
- Market research assists in identifying that gap in the market or degree of difference needed to formulate a design brief.
- Parameters are the list of specifications that a design must possess in order for it to be considered successful.
- Primary research is done by the person working on the project. Some collection methods are surveys, interviews and observations.
- Secondary research uses data already collected by others. Sources of secondary research include books, the internet and the Australian Bureau of Statistics.
- When researching existing competition, consider using the five Ps: product, price, promotion, place and packaging.
- There are two different types of environmental forces that may impact on the success of a product: micro-environmental and macro-environmental forces.

CHAPTER SUMMARY TASKS

1. What are the differences between parameters and functional criteria?
2. Name two parameters that an architect may have to address when designing a beach house.
3. Where can you access secondary research information?
4. What are the five Ps? Describe the impact of each on a new product.
5. How would you obtain information on the price of a competitor's products?
6. If you were going to open a new surf shop, how could you use information about demographic trends? What decisions could it help you make?
7. If you were going to market a luxury item, how could economic trends affect the success of the product?
8. How could an electrical appliance manufacturer be influenced by natural environment trends in the marketing environment?
9. Write a list of strategies you could use to conduct market research.
10. 'Know your market.' How important is this statement to the designer?

EXTENSION TASKS

1. Your company has developed a new energy drink. Create a marketing plan. Write a report to the board of directors of your company, describing and justifying this plan.
2. Have you ever bought an item that you did not really need? Why do you think you made the purchase? How was it sold to you?
3. Describe the marketing techniques used to promote a product that you believe is well marketed.
4. Create a marketing strategy to sell the idea of buying a trip to the moon in 2050.

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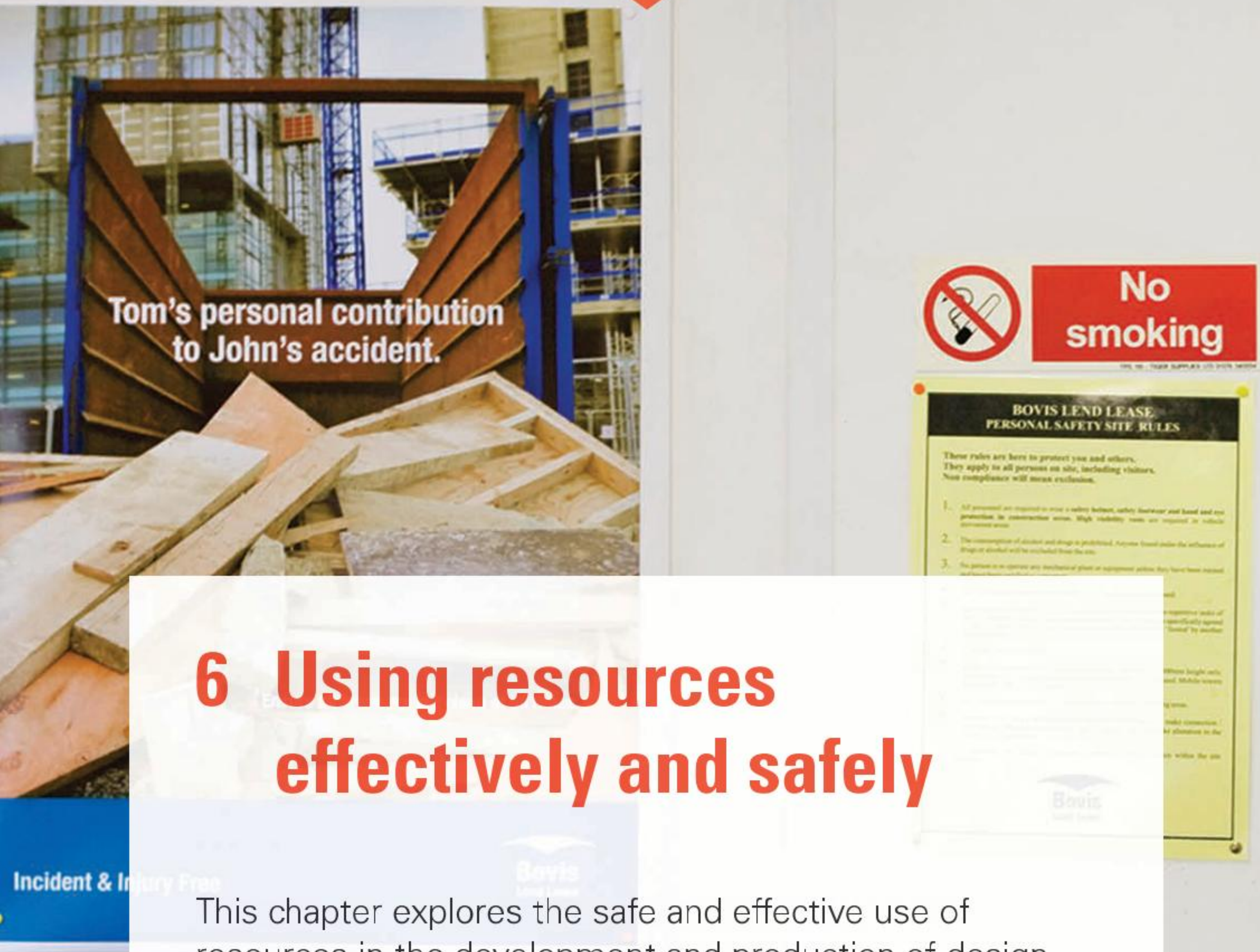

6 Using resources effectively and safely

This chapter explores the safe and effective use of resources in the development and production of design solutions. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P4.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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6.1 Selection of appropriate resources

It is important to look at appropriate materials; that is, the most suitable materials for the task. There is no point in just picking a material or process without justifying why it is the most suitable. Designers will spend time on researching possible materials and processes in order to fulfil the design brief's parameters (needs and wants) in order to be successful. The identification of resources now needs to be taken to the next stage in order to select appropriate resources. Find out what is appropriate through research into the properties of a material, its characteristics and its **environmental sustainability**, as well as the techniques and tools needed to work with that material. This can take time as each material, process, tool and item of equipment needs to be selected and justified. If you are using electronic devices to create your design, you will need to research the different software and hardware available to make the best decision. When researching, ensure that you use **credible** sources.

environmental sustainability the practice of making responsible decisions that will reduce negative impact on the environment

credible valid and reliable

durability the ability of a product to repeatedly perform its designed function for an acceptable period of time without failure; to be long-lasting

Video

Research methods could include:

- studying existing designs
- asking experts
- experimenting
- accessing secondary research
- studying characteristics and properties
- manipulating materials and practising techniques.

Selecting the most appropriate resources early in the project can dramatically reduce the time taken to complete a design because it will assist in the elimination of mistakes. Resources that are proven to be appropriate will be more reliable in the testing phase of the design or manufacturing stages. Using tables, annotated pictures, graphs and data to support your selection of resources can be useful when comparing and selecting. Many designers will undertake models or prototypes as part of the design phase to prove and refine the concept using a range of different resources before settling on a final version for the design. This can take a significant amount of time, as production of the final design needs to be as effective as possible if the design brief parameters are to be met, and in order to achieve success in the market and commercial profitability if your design is taken further.

Some criteria you may consider when making your choices about materials are:

- cost – materials to be used and the processes undertaken
- availability – impact on timing for you if the supplier is out of stock
- equipment and expertise needed – access may have constraints such as time, distance and cost (see supply chain issues below for additional considerations)
- appearance – colour, texture and so on
- characteristics – strength, **durability**, workability and so on
- environmental issues – energy use, waste, production process, recyclability and so on
- ethical supply of resources – issues such as blood diamonds for jewellery designers, black market, child labour
- supply chain issues other than availability – country of origin, distance from source and the relationship between environmental consideration and transport logistics, financial, political, geographical, reliability of supply. These may be interconnected and relate to the timing of other events.

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When selecting your materials, you may conduct some simple tests to determine suitability. The tests need to be valid for the specific material. If it is important that your materials can resist corrosion, you may test the different choices by submerging them in water for a period of time. If your project will be outdoors, you may test the effects of sunlight on the materials you are considering by leaving them outside for a set period. There is no doubt that having the most suitable materials for your project will lead to the most suitable solution.

CONDUCTING AN ANALYSIS TO SELECT APPROPRIATE RESOURCES

To consider the process of selecting appropriate resources, we will use a scenario of designing a bike.

If your project is to design a bicycle, you need to consider the functional aspect of the design. You need to determine what type of bike is required. A mountain bike has different requisites to a racing bike. Spotting the differences between a BMX bike and a road bike might be easy, but it can be quite challenging to detect the differences between different models of bicycles built for the same type of surface such as road, dirt or even a velodrome. The type of person that the bike is to be designed for is also significant: a bike for a child versus a bike for someone touring Australia.

Other considerations would also include looking at a variety of metal finishes for the frame and components and the various materials associated with the development of the seat.

Your research helps you refine this further. Perhaps you have checked out the local bike store and talked to the staff there about which bikes are the most popular. Why do they think particular bikes are good sellers and what can you learn from this?

Brakes and the choices of wheels are also important. Regardless of the mechanism used, all brakes share this common feature: they increase the amount of friction on the wheel to slow down or stop the bicycle. While handlebars have evolved, the fundamentals of steering and controlling a bicycle have not changed.

A good bike – like all well-designed products – conveys simplicity by carefully tuning and balancing many systems.

It is important to try to anticipate what you can change from the basic concept of a bike, although sometimes you will encounter setbacks. Ultimately these things are all just part of the learning cycle of design and production. 'Fail fast' is a term used in some industries, and it is certainly one that is used in design. It basically means that as soon as you learn that something in your design is not going to work, you need to move on, learn from it and try again.

Figure 6.1 Functional aspect – what is the product that you are designing going to be used for?

Bicycle frames have to be built to handle a variety of loads. First, the frame needs to support itself and other components of the bicycle. Other areas of a frame that should be considered are the ones that handle stress over time. These areas are common near the chain line. The continual pedalling action exerts forces on the frame. The appearance of the bike may be important also, depending on the type of bike and what its function will be.

Selection of resources also includes tools and techniques. If you are designing a bike you will need tools such as screwdrivers, Allen keys, pumps, Torx keys and a chain checker, and skills such as welding.

ACTIVITY 6.1

You have been commissioned to design a small child's cubby house for use in a domestic backyard. What should you consider before embarking on this project? Do you need council permission when building a structure? Do you build the floor first or last? What materials do you need and what tools should you choose? Can you use hand tools or electric machinery? What safety considerations are paramount? What costs are associated and finishes, for example paint, furnishings? Is there a time frame that needs to be considered? For example, is it a birthday present that would disappoint if not completed on time? Establish criteria for each of these and consider what might be suitable materials. What testing might be needed?

Figure 6.2 A backyard cubby house

OTHER CONSIDERATIONS WHEN SELECTING APPROPRIATE RESOURCES

Safety

In industry, safe working procedures are developed to ensure that specific tasks can be completed safely and efficiently; but safety and efficiency do not always work together. Careless workers could compromise their own safety in the pursuit of efficiency. Trying to work faster could result in mistakes or injury.

Safety should be the number one priority in design production procedures. If a designer takes on the additional role of manufacturer, they need to research the safest operating procedure for every step of the project's construction. Designers under current laws have a legal responsibility for safety in the design, manufacture, use and disposal of their designs. Assessing this is part of the designer's responsibility.

Whole of life cycle

In the past five years, there has been greater emphasis on the designer being accountable for 'whole of life cycle' for products, including end user, disposal and recycling. This is done through product instructions including Material Safety Data Sheets, which are developed at the same time by the designers. Technology has changed the way in which this information is disseminated. As well as official website content, social media has often become an important source of information about products past and present. Opinions on forums can be a source of accurate and not so accurate information, that may or may not be supported by the original designers, so check the validity of these sources. Designers also need to take into consideration the most suitable technologies available and to predict to some degree the 'what's next?' idea.

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Personal skills

In your project work, you will need to consider your own skills when deciding the types of techniques you can safely use. There are a number of questions you should ask yourself. What is my level of experience? Can I get training? Do I have time to develop the skills needed? Is the equipment available to me? Do I have access to an expert for advice? Talk to your teacher in relation to this, as they can assist in helping you to develop the skills you may need.

Access to specialists

Your production processes will be determined by the available technologies. In industry this may influence the design and production of a design, as designers do not have unlimited resources at their disposal. Research is an important stage in the selection of tools and techniques. Establishing what is available to you and feasible in the time frame should be part of your discussion with your teacher early in the designing stages, and throughout the design and production of your project. The ability to ask questions and collaborate with experts is part of the modern world of designing and can save time and reduce costs. The use of experts is considered best practice among businesses, and specialists in specific fields are often part of design teams. For example, doctors, biological researchers and scientists would be involved in medical procedural changes with engineers to produce specialist equipment, techniques and products. Accessing specialists has been easier with society expecting increased access to specialists for information: this is a vital challenge for commercially successful products to be credible.

Think about the research into the bionic ear design. Consider materials and techniques involved in its development, and which experts would be consulted.

Intellectual property

You will need to explore the different production tools and techniques available, and speak to those who have the expertise in their use. The time taken to confer with the experts and do your own testing may be both cost and time saving in the long term. Other appropriate resources you might select could be people such as your teacher or a design engineer. They may be able to suggest a particular computer program or a website that provides information appropriate to your project. Keep a record of who you have consulted, as this helps to validate your work and respect their **intellectual property** (IP). This is important in your role as an ethical designer.

intellectual property recognises ownership of a product of the intellect that has commercial value including copyrighted property such as literary or artistic works, patents, business methods and industrial processes

Some cases of IP being recognised as belonging to another party have been very public in the music industry, with the term ‘sampling’ being used. There have been cases where musicians have failed to acknowledge the influence of another person’s song, or even the use of sections of the song to create a new song. Another example of the recognition of IP on the global stage is related to disputes over packaging colours for chocolates. It is appropriate for a designer to be ethical in acknowledging sources of information and inspiration, and it is better to be up front with this rather than have someone make a claim later on intellectual property.

Based on research, selecting appropriate materials, tools, techniques and other resources will help you achieve a successful result. Thus, the formulation of a plan detailing how you are going to accomplish your goals using the best possible resources available to you is vital.

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6.2 Justifying and explaining the selection and use of resources

The next step after selecting appropriate resources is justifying and explaining the reasons for your choices. Documenting this is vital, as most designers do not work in isolation but as part of a team to solve complex problems in a design brief, or they will project-manage a brief and bring in experts for specific aspects. Justification through research, data and calculation is important. Design solutions can be expensive if you make errors. If a designer cannot justify why they have chosen particular resources, then their fellow team members may have difficulty understanding the choice of resources. Often the target market for your design and online media will be the final evaluator of success. Sometimes people produce documentaries about their processes and choices in order to sell the ethics and merits of a design in the business world, and this can influence commercialisation. As a student, you have to justify your selections to your teacher and the examiners by documenting your ideas and decisions. These should be summarised, but the supporting information must be kept as evidence. What you have chosen and why is an essential part of any design process.

ACTIVITY 6.2

Personal protective equipment (PPE) refers to anything used or worn to minimise risk to workers' health and safety. This may include, but is not limited to:

- boots
- ear plugs
- face masks
- gloves
- goggles
- hard hats
- high visibility clothing
- respirators
- safety harnesses
- safety shoes
- sunscreen.

Do a PMI (plus, minus, interesting) on the choice of PPE that a retail company may require for their warehouse staff. PPE works best when you use it to supplement higher-level control measures or when no other safety measures are available. Before relying on PPE you need to do a risk assessment to see what other controls can and should be used. What types of risks would need to be kept in mind when considering warehouse staff in a retail company?

Figure 6.3 Workers fulfill orders in an Amazon warehouse in Castel San Giovanni, Italy.

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Documenting the reasons for your choices provides evidence and explanations to enable someone who is reading your plan or folio to understand your decisions. When you are justifying your choices, pretend you are arguing with someone who has made a different choice. Explain the reasons for each of your decisions and describe what the consequences would be if a different choice were made. You should be able to support your decision with reference to your testing, research and any expert supporting information you have referenced. Be specific in this information with details of who, when and where and what was undertaken.

Justifying and explaining are processes that continue through the design, construction and evaluation phases. Throughout the course of a project, you will make choices, and each of these decisions needs to be validated with evidence so that you fully tell the story of your design project. Keeping a project journal can be useful in this process.

6.3 Developing and demonstrating proficiency in using resources

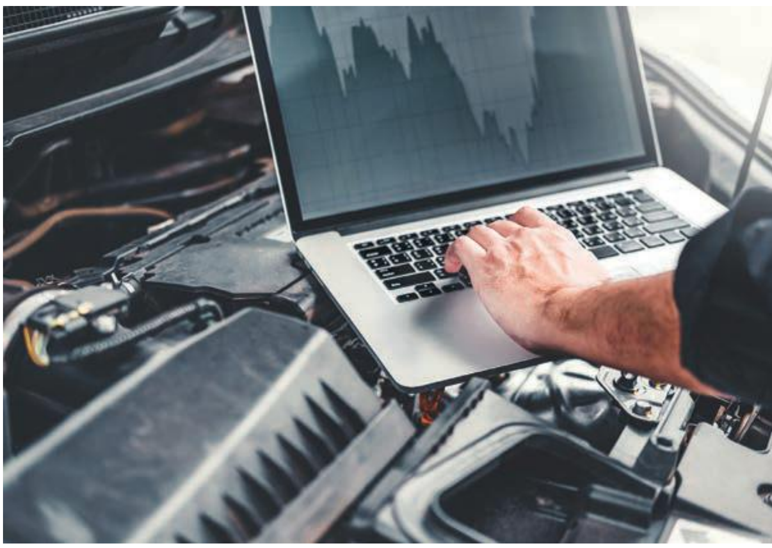
The skills of a designer are often not the same as those of the people who make the item. There is a need to understand that the manufacturing processes will be feasible. Professional designers do not necessarily need to be able to produce the design. However, as a student of Design and Technology you do need to be able to do this, and there are two major issues relating to this area of the design process. The first one concerns safety; the second is your ability to construct a quality item. Both are important if you are to impress the target audience of your design. You are also the manufacturer of your design.

As the designer/manufacturer, you will need to develop and demonstrate **proficiency** in using a range of tools, machinery and other resources deemed appropriate for your particular project. In some cases, there may be techniques and tools required that you have never used before. Doing the manufacturing will require you to develop the necessary skills. You may need to learn new skills and do so safely. Your teacher should be able to assist with many of the processes; however, you will need to assess the risks involved in all activities. Developing proficiency is not an automatic process, and some practice will be required. Testing, practice and experimentation with techniques is invaluable. So don't expect to get it right the first time!

Proficiency in a process or the use of a tool means the person can manipulate its function safely and to a specified standard to produce a quality outcome. Proficiency begins with understanding the risks associated with particular resources, and continues with steadily building and developing expertise to achieve a desired outcome or level of quality. Teachers, instructional videos and tool manufacturer user manuals are useful resources. Proficiency in the design and manufacturing stages is part of a quality design project.

proficiency a high degree of skill or expertise

Figure 6.4 As technologies advance, so to do the skills and tools required to perform necessary tasks.



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It is important to remember that developing and demonstrating proficiency in each aspect of the project are expected parts of the course, and that you are bound to encounter some materials, tools and techniques for the first time. Practising a technique that you might use on your actual project will help eliminate any possible mistakes or unwanted surprises. Samples of practice pieces should be recorded and evaluated. Many successful designers have found new ways to do things by experimenting and accidently coming across a new solution. Take time to practise before settling on a process.

It is a great achievement to know that when your project is finished you will have greatly expanded your skills and areas of expertise. Hopefully, you will have many chances to use your new skills and expertise in the future. It is expected that you will need to research, apply and develop techniques as you go.

Figure 6.5 The Paul-Henri Spaak building is part of a complex of parliament buildings in Brussels housing the European Parliament, the legislative chamber of the European Union. The building was designed by Atelier Espace Léopold & Michel Boucquillon. Michel Boucquillon is an award-winning architect and product designer.

Designers expect that their work will be manufactured to the quality standards specified. Your project is effectively a prototype of your design and a reference point for potential further manufacturing or reproduction. Before your design is taken to the market, its quality needs to reflect your expectations. Your reputation as a designer depends on it, and your design project depends on you developing proficiency.

Developing and demonstrating proficiency in using an appropriate range of materials, tools, techniques and other resources ensures that you have a thorough understanding of the project. So much can be learned as you begin building a prototype and it gives you the opportunity to change elements, for example tools or materials, if the prototype does not fit the requirements. This requirement of demonstrating proficiency is not limited to your project at school. A recent excerpt from Seek describes the role of a building designer.

> Similar to a draftsperson or an architect, building designers have the unique benefit of not requiring qualifications to be able to undertake their work in Australia. However, in order to be proficient in their role they would have to demonstrate efficiency in, for example, the following tasks and duties:
>
> - Meeting with clients to take and understand the brief in detail.
> - Designing and interpreting plans.
> - Undertaking feasibility studies.
> - Researching and analysing council codes, codes of practice and industry regulations.
> - Coordinating submissions to council.
> - Drawing up contracts and ensuring terms are adhered to.
> - Building site supervision.
> - Liaising with clients to discuss progress, impediments and project milestones.
> - Project managing suppliers, contractors and resources.

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6.4 Safety and the use of materials, tools and workmanship

After developing ideas on paper, you will understandably be keen to get to work. That enthusiasm is a positive attribute. But there is nothing more important than your safety. The processes and safety codes that are in place are there for your protection and have been devised for a reason. Sadly, some of them may have been developed as a result of injuries that could perhaps have been avoided. Working in a school does not mean that safety is just the teacher's responsibility. You must comply with the safety directions of the school. Documenting the safe use of materials and tools is important and should be included in your design processes, as it may impact your selection of tools or processes.

The ***Work Health and Safety Act 2011*** was created to protect the health, safety and welfare of all employees, employers and self-employed people in the workplace. It aims to address the increasing rates of injuries and illnesses that have affected people over the years. Parliament made the legislation so that it could create regulations (compulsory guidelines) for Australian places of work.

All designers must implement (put into practice) a safe working environment, and guidelines or rules that need to be followed when designing and producing. Each industry generally develops its own safe operating procedures. (Codes of practice may be relevant.) In schools, safe operating procedures are determined by the teachers and made into school policy. These are based on recommendations and legislated work health and safety (WHS) requirements.

Mandatory rules specific to each workplace help protect the people who work there, help maintain a safe working environment and also provide safety for the end-user of the product being designed or constructed there. There are specific activities that have legal constraints and you need to do your research.

In New South Wales, SafeWork NSW is a **statutory authority** whose primary objective is to work in partnership with the New South Wales community to achieve safe workplaces, effective return to work and security for injured workers. It promotes a safer and healthier workplace for workers. SafeWork NSW enforces the work health and safety legislation through education, undertakes inspections and investigations into incidents and complaints and, when necessary, applies penalties and prosecutes organisations that do not comply. It also has a regulatory role in licensing and certification of certain activities and hazardous equipment.

Work Health and Safety Act 2011 an Act relating to health and safety within the workplace; the Act sets the framework for duties designed to promote health and safety, and workplaces must comply with these duties

statutory authority an organisation established under an Act for a public purpose

As a responsible designer, you are required to implement safe work practices when designing and producing, to protect both yourself and your consumer – the person who will use your product. You must adhere to guidelines when operating machinery and you must also adhere to any guidelines that ensure the safety of the user of your design. The use of materials that are safe for both the manufacturer and the consumer is also important for designers to consider.

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control measures a set of guidelines or rules to maintain certain standards and consistency

The Australian Standards are safety-related guidelines to which products must adhere before being sold to consumers. You can purchase a copy of the relevant Australian Standard online (search the internet for 'Standards Australia catalogue').

Employers and government authorities try to maintain safe working environments by implementing a number of safe work practices. Training (developing proficiency) is one technique. Another technique is conducting what is known as a risk assessment, where an individual or group will analyse a task and assess various risks, analyse the likelihood of the risk occurring, and then develop **control measures**, which become best practice for workers to follow. The ultimate aim is the elimination of accidents in the workplace. Risk assessments come in a range of different forms and fall under different headings. The risk assessment conducted for people operating heavy machinery on a building site will obviously vary widely from the risk assessment carried out in a beauty salon. Businesses will develop operating procedures, job statements, work method statements and so on in order to manage workplace activities. The use of visual signs to encourage safety is common.

It is important to remember to respect the safety guidelines and operating instructions of the workplace you are in. Keep in mind that some of those have been implemented as a result of serious injuries. Something that may not appear harmful to you could have an unforeseen result if inappropriately used.

ACTIVITY 6.3

Choose a project you have completed. Identify the risks you are aware of and conduct a risk assessment on each of the activities. List the control measures that were needed to minimise the risks.

Figure 6.6 Signage in the workplace helps protect businesses and their employees.

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CHAPTER SUMMARY

- Tools, materials and techniques should be thoroughly investigated through a range of sources. The information collected from this research will assist in the selection of what are deemed the most appropriate techniques and materials. This can help avoid many issues later in the design and manufacturing stages of a project.
- Adequate documentation and justification will enable others to understand the selection of the resources used. This is important if designers are working in teams or specialist activities are to be coordinated.
- Intellectual property is the respect of another's work. It needs to be acknowledged, documented and permission sought if necessary. With the ability to search online for other people's work, many disputes and legal cases have occurred when money was involved.
- When manufacturing, there are two main considerations in developing proficiency. The first and most important is safety. The second is the production of a quality product. Developing proficiency is not a simple act; it will require practice and refinement until the standard of workmanship is satisfactory.
- Risk assessments assist manufacturers to ensure safe working environments by providing an analysis of the processes that are to be undertaken and resources used. The processes are assessed for potential hazards, the severity of the risk taken and the likelihood of it occurring. After analysing these processes, manufacturers can introduce controls to minimise these risks or change the activities.
- Legislation requires the implementation of safe working conditions.

CHAPTER SUMMARY TASKS

1. Describe two ways you could research the properties of a material.
2. Now more than ever before, designers are responsible for the creation, use and disposal of products. Discuss how the increased access to technology has made this responsibility for designers more important.
3. Investigate what materials are commonly used for boardshorts or swimsuits.
4. Where would you find information on correct sewing techniques to make the swimsuit seen in Figure 6.7? How would the sewing techniques be different from those needed to make boardshorts?

Figure 6.7 Does a high-technology swimsuit make you swim faster?

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5 List reasons why it is important for a designer working in a team to document their decisions. Use an example product to explain specific details.

6 Explain the term 'appropriate' in relation to machining techniques. Be specific for three different materials.

7 Why is colouring a design factor when developing safety equipment? Justify your answer.

8 How can we develop proficiency in the realisation of design projects?

9 Draw a flow chart of the steps undertaken before using a specific piece of equipment or machine in your school. From this flow chart, add the steps required to demonstrate proficiency before you would use it on a design project final piece.

10 What is the difference between an Australian Standard and a code of practice?

EXTENSION TASKS

1 Using another person's work as part of research can be full of rewards and risks. Acknowledgement of sources and asking permission is better. Discuss some of the issues involved in this when commercialisation takes place and how profits and royalties work with the designers. Examples of this in the media are good starting points for discussion.

2 Explain the health and safety issues that need to be considered when using one of your school workshops. Provide examples to show the cause and effect relationship between the issues discussed. Compare these issues with work and safety issues to be considered in an industrial setting.

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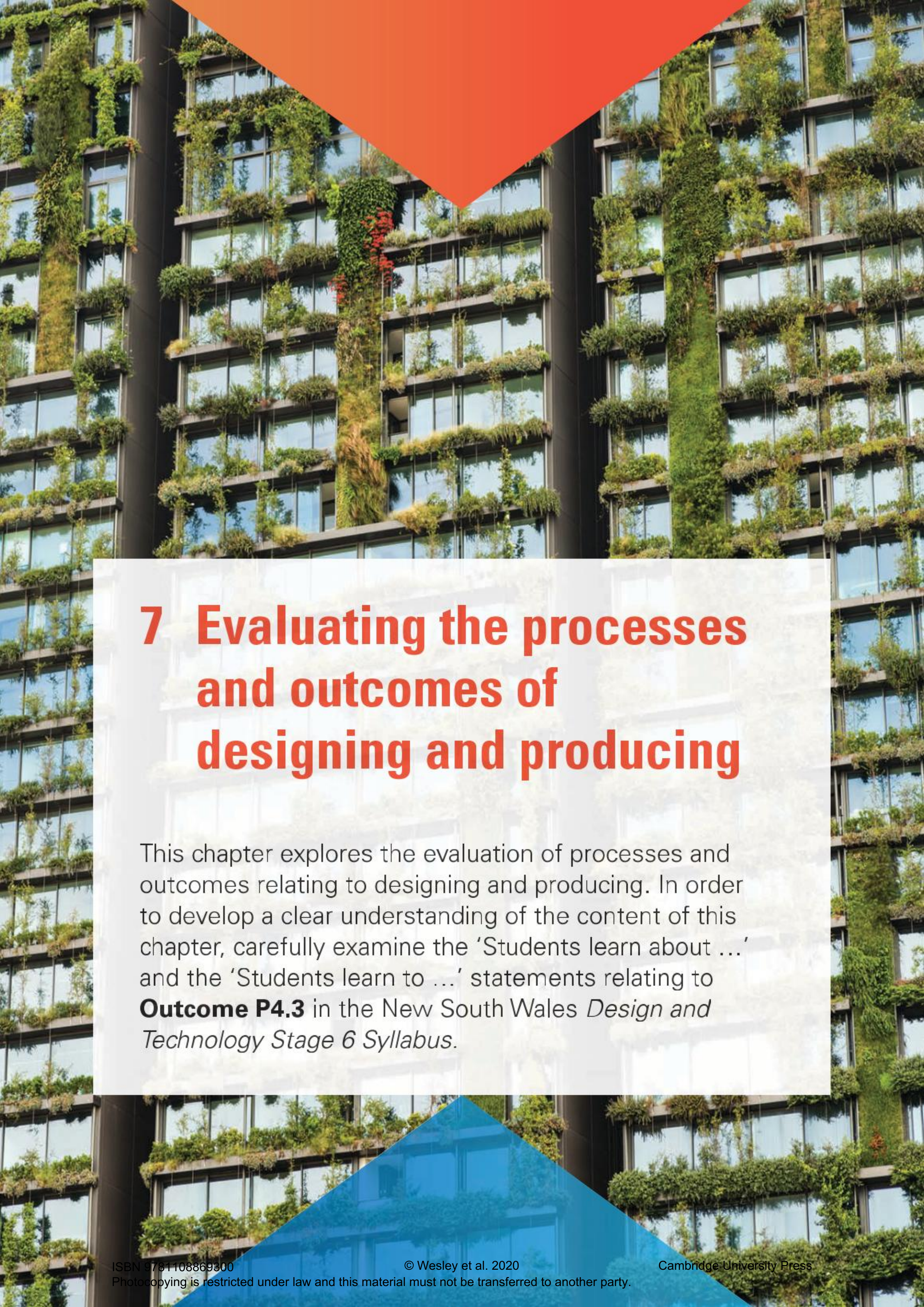

7 Evaluating the processes and outcomes of designing and producing

This chapter explores the evaluation of processes and outcomes relating to designing and producing. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P4.3** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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7.1 Establishing design parameters and identifying evaluation criteria

We have learned to identify design parameters and recognise that designers often inherit these boundaries in the design of projects. People may consider limitations to be negative – factors that inhibit the creativity of design. However, constraints may also be seen as welcome rules for compliance. As an architect, it is reassuring to know that if you design a handrail according to the regulations set by Australian Standards, you would be less likely to carry the blame in the case of an accident involving the handrail.

Do not be afraid of constraints; they often guide us. Many good designs have resulted from having to comply with regulations or other inherited constraints in designs. In today's environmentally aware world, many designers evaluate the selection of materials for their designs to ensure they address issues of health and safety and sustainability. For example, car designers and manufacturers have to work within parameters to ensure their vehicles comply with the reduction of exhaust emissions.

If a furniture designer wanted to produce furniture that had less of an impact on the environment than the products of some of their competitors, they could consider some additional parameters such as:

- must only use recycled timbers
- manufactured timber products must not be used
- furniture must be finished with non-toxic, naturally occurring materials only.

These specific parameters assist the designer to create targets of performance that they must aim to meet in order for the project to be successful. The process of determining how successfully these targets are met is the criterion for evaluating success.

As you have learned, criteria can be identified and assessed under two main headings: functional (how it operates) and aesthetic (how it looks). In some designs function may be more important than aesthetics. In other designs, aesthetics may carry greater weight. A simple way to decide what criteria your project must attain or live up to on completion is to write the parameters as well as the functional and aesthetic criteria in the left-hand column of a table, and how you are going to measure this success in the right-hand column. By identifying the criteria for the evaluation of a design project, you give yourself a set of rules, together with the parameters you have established, that will guide you to successful completion.

You will refer back to the parameters and criteria often and make necessary adjustments to ensure your project stays on track. Your project should mirror your specifications and you should be able to tick off your criteria checklist during project development.

Keep your eye on the basic criteria that fulfil the need – the reasons behind the project. If your criteria state that your project must be waterproof, make sure it is. Do not be disheartened if your first prototype leaks. Keep your eye on your goal and amend the materials or methods as required. Always make sure to keep documentary and physical evidence of the changes you make; this supports your fulfilment of the criteria. If it takes three attempts with three different types of material for your project to be waterproof, say so – and keep samples of the failed test runs as proof.

Professional designers also have to evaluate their success against the criteria they have added. Sometimes this involves testing the product, checking against the legal requirements or standards, getting feedback from the client or surveying the consumers.

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ACTIVITY 7.1

Your client has asked you to design packaging for a smartphone about to be released onto the market. List some possible parameters that you, as the designer, should develop to ensure the success of the packaging. Do not forget to consider environmental issues. Then describe how you will evaluate how successfully these parameters and the functional and aesthetic criteria have been met. See Table 7.1 for assistance.

Table 7.1 An example of assessment for the design of a sustainable piece of furniture like a coffee table

DESIGN PARAMETERS	HOW IS THIS GOING TO BE EVALUATED?
Must use recycled or recyclable material.	Visual check of the material to determine whether it has been used before or research methods of recycling.
FUNCTIONAL CRITERIA	
The table must be stable so that it sits flat on the floor and does not rock.	Ensure all final measurements are accurate and check for any inconsistencies in the floor surface.
AESTHETIC CRITERIA	
The table must fit with the art deco decor of the home where it is to be placed.	Research art deco style. Compare the table to other furniture in the house and ensure it has the same style.

ACTIVITY 7.2

You have been asked to design a new sports bag. Establish some parameters for the project. Then identify your own design criteria that will assist you to evaluate the success of the design.

7.2 Examining processes

Every day we use processes to undertake projects or tasks, from simple things like making our beds and keeping our room clean to particular problem-solving tasks. Processes are the steps required to achieve an objective, the order of tasks you follow to accomplish a task.

Some processes can be done without thinking. When we were young, we all learned how to dress ourselves and brush our teeth. We now complete these processes without any difficulty because they are common, often-repeated events in our lives – things with which we are familiar. But not all processes are well known to us. When you embark on a design project, you may know what you want to construct, but not necessarily the steps or processes that will be required to accomplish the task – that is where experience becomes valuable.

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By consulting people with industry experience gained over many years, you can learn some handy tips from the processes they follow and the decisions they make.

There may be a new material or a technique an artist has developed that is yet to be documented. Perhaps there is an unusual material they use and are willing to tell you about. Experience counts for a lot when it comes to design. Do not be afraid to pick the brains of people you think could be helpful. They probably did the same thing when they started out.

ACTIVITY 7.3

Examine and list the processes you would need to use to make stir-fried chicken for dinner.

7.3 Continual evaluation

Design, like life in general, is a constant process of critical evaluation, seeing how things work and modifying the bits that do not turn out the way we had planned. Conducting this continual evaluation throughout the design and production of your project is normal and expected. It is an intrinsic part of the course. How you respond, adjust and then document your findings will shape how your project functions and what it looks like when finished.

Constant evaluation is neither a failure on your part nor should it be viewed as such. Perhaps your model-size prototype worked well, but your full-size project was too big or too fragile to fulfil its function. These are factors that could have been extremely hard to tell prior to the final test, even if you undertook extensive testing of materials at the earlier stages. Even if the project is going well, conducting critical evaluation remains crucial, especially for fine-tuning.

milestone a significant developmental stage or point determined by the designer and allocated a specific date for completion

Imagine you decided to use one material because of its flexibility, but an industry professional has just told you that there's a new material on the market that gives a much better result. You now have to conduct an assessment. Do you stay with your original plans or change to the new option? Is the new material more expensive? Is it more flexible but harder to work with? Do you have time to become proficient in its use? Will the new material provide a better result? How will it look? This must be documented in your ongoing evaluation. It will be helpful if you get into the habit of writing a reflection on your progress after every practical lesson or at least once a week.

Activity 7.4 helps to explain that quite often we see the end product of a design; however, we underestimate the amount of ongoing evaluation (decision-making) that occurs during the design process.

Keep an open mind to change, particularly as you reach certain **milestones** in your project. Be prepared and enthusiastic to change as necessary or desired, and always remember to record those changes in your documentation.

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ACTIVITY 7.4

Scott and Janan are two friends who are going to the movies. Afterwards, Janan will message his dad to pick both of them up and drive them home.

Briefly describe all the decisions the boys had to make for this excursion. For example, they had to decide what film they wanted to see, at what time, the cost of the movie and whether to take cash or use a card. As they make each decision, Janan and Scott would be evaluating. Can you imagine the conversation as they decide which movie to watch? They would be evaluating the different movies based on criteria they had been thinking about – particular actors, genre, director, length and so on. Beside each decision, list the criteria that may be considered when evaluating that decision.

Figure 7.1 Friends discussing their plans for the day

ACTIVITY 7.5

1 Look at the historical development of Spotify, a music, podcast and streaming service that was first introduced in 2006 on an invitation-only basis. Consider why the idea for this service first took hold.
2 Construct a timeline showing all the changes and growth to the present day including the impact of other media companies and musicians.
3 Discuss what developments you anticipate in such a service, and how you think it will impact on the music lovers of the future.

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7.4 Impact of design on society and the environment

Everything in design has an impact on the society in which we live and on our physical environment. Sometimes those impacts can be negative and sometimes they can be positive. Sometimes the same item can be viewed in both a positive and negative light at the same time.

Electronic devices, despite their usefulness, are one example of mainly negative impacts. For the individual, the workplace expectation that you will be always available, the constant screen time young children are exposed to, the loss of privacy and so on, can be seen as negative impacts. Society has questioned the long-term effects of use when it comes to obesity and antisocial behaviours. The ever-increasing amount of landfill that discarded devices create, causes problems.

Designers need to look at incorporating recyclable plastics into these products and manufacturers need to develop effective recycling programs. As designers, we also need to consider ethical issues in our evaluation. Can you make a tiny difference to the complex problems confronting the global community? Exploitative practices may be occurring in an environment a world away from where we are working. Consider the role design and designers should play in the move to meaningful solutions, rather than short-sighted fixes that support the move to greater consumerism.

As responsible designers, we need to evaluate the processes that impact on our designs. Are there any questionable practices involved in the production of materials we are using? Is there any evidence of slave labour in the collection of raw materials? Have allowances been made for recyclability?

To assess the impact of designing and design projects on society and the environment, it helps to weigh up both the positive and negative factors of the design. You can do this with your own design ideas and even devise modifications as a result. Perhaps you were thinking of a design using a

ACTIVITY 7.6

As a class, think of positive ways that smartphones have impacted on the environment. How many can you list? List all the positive ways social media has made an impact on society.

Figure 7.2 Biodegradable alternatives have less impact on the environment.

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product that is not **biodegradable**. Could you substitute this product with a recycled material or one that will break down over time? Keep in mind that many biodegradable products often require specific conditions for breakdown such as high temperatures. Is your product likely to be subjected to these conditions in a natural environment? You need to consider the advantages and disadvantages of the materials you use and the impact of your final solution.

When assessing the impact of your designs on society and the environment, you should try to ensure that the items in your positive column outweigh those in your negative one and amend the negatives as much as you can. Keep an open mind, but do not hunt for negatives if you cannot find them.

biodegradable able to decay naturally and harmlessly

ACTIVITY 7.7

Select a couple of common household items and write down the impacts of each on society and the environment. Try to list both positive and negative impacts for each item.

CASE STUDY 7.1

Mobile apps

Today's technology is being used to assist the millions of people around the world with varying disabilities. Using developing technologies to improve health and wellbeing is to be commended. This is a positive impact on society.

For example, if you are blind or visually impaired, the mobile app 'Be My Eyes' could be used to connect to volunteer helpers around the world via a live chat. You may need help navigating in new surroundings or want to check the expiry date on your milk or help to choose a tie that matches your shirt. Another app called 'Voice Dream Reader' allows you to read with your ears. It is considered an excellent text-to-speech app that offers a high-quality listening experience – a perfect solution for those with visual impairments.

'uSound' is an app created to optimise hearing for those with hearing loss or impairment, with similar features to a high-end hearing aid. This app allows the user to add a personalised filter which offers different sound quality and volume in certain environments. Using a sign language dictionary like 'Spread the Sign' increases valuable communication with those who are deaf.

Another example of an app with positive impacts on those with disability is 'Wheelmap'. It offers a simple way to search for wheelchair-accessible places around the globe. 'Wheelmate' is dedicated to locating toilet facilities and parking spaces for those who are wheelchair bound.

The design of products to assist those with disabilities is open to innovation and new uses of technologies. Mobile apps are only one technology that is being utilised in this way.

Video

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7.5 Testing and evaluating

Designers hope that after their hard work is over, their project meets its goals – the goals set out as criteria to make the project a success. But by testing and evaluating the appropriateness of your project you are not simply ticking off whether it fulfilled its criteria, you are also looking at whether the solution you have created is appropriate or suitable.

An appropriate solution could address factors such as:

- cost
- safety
- functionality
- aesthetics
- material characteristics
- environmental impact.

How is the appropriateness of the design determined? This can be checked against the functional and aesthetic criteria that you formulated beforehand. In this case, you are not necessarily evaluating whether it achieves its goals, but how it achieves them – or how it does not – and whether there are other options that are more appropriate. If you have designed a new innovation that is based on a modification of an existing product, is the new product better than the original? This is the section where you need to look at your project and examine it closely.

The best way to evaluate is to test things out. If you designed an item to contain water, pour in water and see whether it does. A designer who develops an underwater camera housing to take video footage in the surf would include waterproofing in the functional criteria of their design. They may test the design in a kitchen sink or bucket before taking the expensive video camera out to the ocean for a test run. Always keep your listed criteria handy and address each point separately to ensure your analysis is complete.

ACTIVITY 7.8

You are a landscape designer. Your client who lives in an arid area has asked you to suggest some design solutions for beautifying their front yard after renovations to their house. Develop general and specific criteria and offer two design solutions. Justify the designs according to your criteria.

Figure 7.3 Some plants need less water.

CASE STUDY 7.2

Michael Mobbs

Michael Mobbs specialises in the design, construction and project management of sustainable projects. He began his crusade when renovating his own home in Sydney's Inner West. With some ingenuity and much perseverance, he and his wife developed what is known as the sustainable house. Drinking water was collected from the roof, electricity was generated from solar power and all wastewater was processed on site. This private investment became an example for others to be more sustainable.

Michael has moved on from his personal endeavours to encouraging whole communities to consider sustainable living. He has promoted kerbside gardens and also designed a system where people can apply for assistance in making their community more ecologically sustainable.

A number of Michael's initiatives have been supported by individuals and councils to make communities more sustainable.

- Cradle to Cradle or C2C is a concept developed by those wanting to create a certification system for building products that are healthy for people and the planet – where the manufacturing system and final products are able to be reproduced in an everlasting circle. Michael has used carpet tiles that meet this criteria.
- Michael describes how to irrigate your garden with water from the roof. 'Water at height, such as on your roof or in your down pipe, has energy in it. The higher the water the more energy it has to drain to your garden. To divert the roof water to the garden there are several products which can be inserted in the rainwater downpipe. They divert the water to a hose to irrigate your garden. They can also divert the rainwater to a pond, pool, or tank.'

Figure 7.4 Michael Mobbs in his sustainably watered back garden

- Composting breaks down organic matter, like certain foods and plants, into rich soil. By mixing these organic items, they naturally work together to break down into usable fertiliser. Composting takes care of food waste in a healthy, environmentally friendly manner while producing nutrient-rich soil that can be used for gardens and more. Overall, it eliminates the need for food waste to go to a landfill. Michael supports a new composting device we can sit on, that emits no odour, and becomes part of our garden furniture, called the Subpod®. This odourless mechanism can be placed in almost any outdoor area. It has a flat surface that allows for various seating or table uses. Its smart design and ample air flow promotes plant growth and composting.

For many years Michael Mobbs has been promoting a way of sustainable living, supporting individuals and communities to live more cost effectively and reduce their carbon footprint.

For more information, search for Michael Mobbs' blog on the internet.

Video

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CHAPTER SUMMARY

- Parameters are boundaries or design constraints to which a design must adhere in order to be considered successful.
- You can set your own design parameters. They do not all have to be inherited.
- Functional criteria are statements detailing how the project must operate.
- Aesthetic criteria are statements detailing how the project must look, including choice of materials, style, texture and colours.
- Before undertaking the design and construction of any design project, consider existing designs of similar products. Research books, magazines and the internet, and talk to experts to determine which processes are the most appropriate and which features are the most important.
- Design projects can impact on individuals, society and the environment in both positive and negative ways.
- Refer to your criteria to evaluate success continually as you work through your project.
- Evaluate on a continual basis. Remember, you have to justify every decision you have made.

CHAPTER SUMMARY TASKS

1. What are design parameters? Give an example where a designer would inherit them.
2. What is the difference between functional and aesthetic criteria?
3. Why could having too detailed criteria to evaluate success be a problem?
4. How would you evaluate Michael Mobbs' *The Plan*? Write your criteria and conduct the evaluation.
5. Why is it considered important to live more sustainably? Describe how you might contribute to a more sustainable community.
6. What is the purpose of evaluation? How do you evaluate?
7. How has electronic communication impacted on society? Provide examples to support your discussion.
8. Explain how electronic devices have a negative impact on the environment.
9. Explain the term 'appropriateness' as it applies to design projects.
10. Study the design of the bag you bring to school. Evaluate its function and aesthetics.

EXTENSION TASKS

1. In relation to a project that you have previously completed, list the different steps of the design process. For each of these steps, give specific examples of the ongoing evaluation that occurred.
2. Critically evaluate the impact that the motor vehicle has had on society and the environment.

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8 Management techniques and tools

This chapter explores management techniques and tools. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P5.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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8.1 Management techniques and tools

Management is the activity of getting people and resources together to accomplish desired goals. It involves planning, communicating, providing support to workers, resourcing, coordinating, controlling finances, motivating, leading and facilitating in order to reach the set goals. The person who performs the role of manager has the power and responsibility to make decisions that will manipulate the organisation or situation and direct resources to achieve the stated objectives. Things do not just happen, they are managed. From planning and organising our daily lives to completing a design project, how we manage our projects directly affects the success of the final outcome. Many skills are needed to successfully manage a project: communication, meetings, action plans, journals, **Gantt charts** (or other project management tools) and **finance plans**. As a designer, you will need to incorporate all these factors into your design projects.

Gantt chart a detailed grid that displays the tasks to be undertaken and time allocated, and maps these on a specified timeline

finance plan a detailed report of the resources used in a project with costs applied

Managing tasks is something we all do – getting out of bed and getting ready for school, managing our homework schedule, assessment task deadlines, part-time jobs, family activities, planning social activities with friends and managing our design projects at school. We develop skills in management that are an important factor in making a planned activity successful. According to *Collins Concise English Dictionary*, one definition of managing is 'the skilful or resourceful use of materials, time and so on in order to complete a task in a given time frame'.

When we embark on a project that involves combining tasks, resources, skills and a timeline, we need to develop skills to oversee the whole project so that each task is completed at the right time and in the right sequence. In the manufacturing industry, many employees work on the management of a particular project to ensure everything runs smoothly and is completed on time. Project managers use project management tools such as:

- communication – discussion between parties involved
- meetings – formal gatherings to help communication between all parties involved
- Gantt charts – to list and schedule each task
- journals and diaries – to record all meetings and track problems faced and decisions taken
- finance plans – addressing all the costs involved
- management plans – describing all the components of the project and how the team will stay informed about developments.

ACTIVITY 8.1

1 Make a list of all the activities or tasks you do each day in order to get to school.
2 List these in the correct **sequential** order and assign times next to each task (e.g. wake at 7 a.m., shower by 7.15 a.m.).
3 Explain why it is important to complete one task before moving on to the next task.
4 Are there any tasks you do simultaneously (e.g. checking the bus timetable while eating breakfast)?
5 Explain what the consequences would be if you were to change the order of some of the tasks.

sequential happening in a logical order or sequence

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CASE STUDY 8.1

A camping holiday

A group of year 12 students have decided to go on a camping holiday after their HSC examinations. The five students met to organise the event. This meeting took place early in the year so that most of the organisation could be done well before the HSC examinations.

The first discussion involved making a decision about where to go. All agreed that they wanted to go to an area where they could enjoy immersing themselves in nature as they were all keen bushwalkers. It was decided that each student would do some research and return with one suggestion. Then the group would take a vote. A list of factors that needed to be considered was made. The venue needed to be easily accessible. Two students had drivers licences and access to a car. Travel by train was considered easiest. Cost was also a prime factor.

Each student presented their findings to the group when they next met. Transport and cost proved to be a limiting factor. One student had a relative who owned a property outside Mudgee and had agreed that the group could camp there for five nights. The group decided this was a better option than a camping ground. However, transport had to be considered. A train and bus could take them to Mudgee so one member was set the task of estimating the cost of a taxi to the site. It was hoped that the owner of the property would provide transport from the bus station, but they could not rely on that and wanted to show their independence. Eventually they decided to drive as the car provided access to transport in case of emergency and to explore the wider area, which was important. The student who owned the car was given the task of estimating the cost of petrol.

Each of the students had access to a two-person tent and so accommodation was settled. However, there were other issues to consider: sleeping gear, clothing, food, water, cooking facilities and utensils, swimming in the creek, local walking trails and so on. Two students visited a camping store where the assistant provided worthwhile information. The others gathered further information on camping from websites like Tripsavvy and Love The Outdoors. When they next met, they realised that they had too much information and needed to consolidate it.

They decided to seek advice from one of the teachers, whom they knew did a lot of camping. With the teacher's guidance, the students wrote a checklist and transferred that into a Gantt chart to ensure that all tasks were completed in time. Each student then volunteered to complete particular tasks and this was recorded. Those that needed to be done close to departure were left to the students who finished the HSC earlier than others.

It was important to have an idea about cost, so two members of the group created a spreadsheet and itemised the estimated costs. Now a student who felt they could not afford it could pull out. Fortunately, the parents were so impressed with the planning they were willing to provide some financial support. The parents were put in contact with the owner of the property and could clarify his support for the event.

This attention to detail and planning meant that the project was well organised and should run smoothly.

Figure 8.1 Organising a camping trip

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Video

ACTION PLAN

The action plan is an important first step in the management of a project. It usually starts with a brainstorming session to determine the actual tasks needed to complete the project. A brainstorming chart or mind map should be created as a visual guide to all the tasks. An action plan is a useful tool because seeing all the tasks written down acts as a reminder. When completed at a meeting with a group, an action plan can often cover all the required tasks.

JOURNALS AND DIARIES

A journal contains the ideas, notes, diagrams, informal thoughts and plans of the designer as they embark on a new project. It may contain minutes from meetings or sudden flashes of inspiration that come to mind when attempting to solve a problem. Rough sketches are an important visual tool used by the designer and are also included in the journal. Recording all aspects of the design project can also be important when problems occur during the project so the designer can look back at the notes and sketches to recall how tasks were completed. In your project work, you may use a journal for your ongoing evaluation.

GANTT CHART

A Gantt chart is used in the management of tasks or projects. It lists the expected start and completion dates of all tasks and activities, as well as the resources used in the project. Estimated start and completion times for each task are determined, based on their expected duration. Commercial software applications (such as Microsoft Project) can be used to create these charts. The user enters the required dates or durations of each task and the software displays times on a horizontal axis. Figure 8.3 shows a Gantt chart created by a student to assist in the management of her project.

FINANCE PLAN

If a project is mismanaged and the costs exceed the budget, the success of the project will be compromised. Thus a finance plan is a vital project-management tool that ensures costs are managed and realistic and the whole project stays within the budget set. A finance plan uses much of the information gathered in the action plan, the journals and diaries as well as the Gantt chart.

Figure 8.2 Rough sketches in a journal

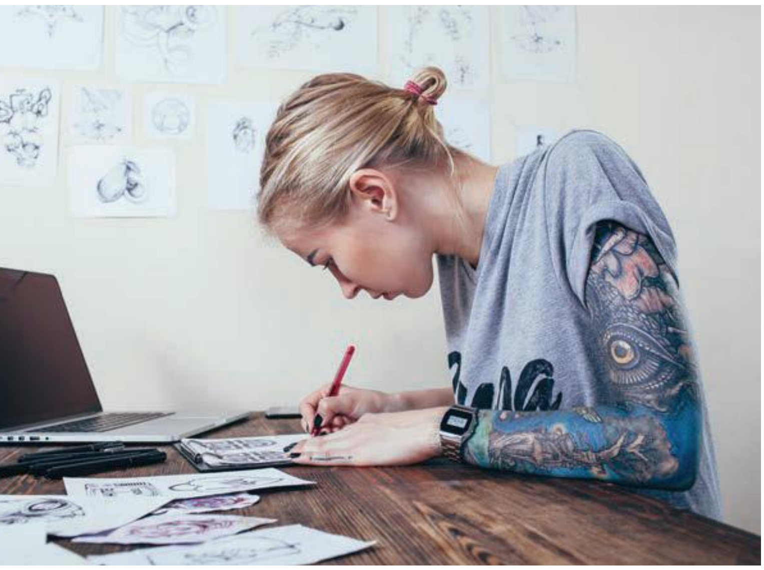

Figure 8.3 A student's Gantt chart

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A designer must be accurate with all costings throughout in order to obtain correct financial details for the project.

Costs could include:

- materials
- resources – tools and equipment needed
- labour – time and rates of pay
- overheads.

A project manager would also research the best sources for materials and resources so that costs are minimised and savings are made. Often design projects are given a set budget and it is up to the designer to creatively select the materials and resources needed to complete the design.

Figure 8.4 Consulting on the finance plan

ACTIVITY 8.2

Using project-management software or a spreadsheet, create a Gantt chart for a project. Set up the vertical task column on the left and assign a timeline in days or weeks horizontally along the top. Shade each task according to the times allocated and allow for adjustments.

ACTIVITY 8.3

1. Set up a spreadsheet to complete a finance plan for a holiday you or a friend are planning at the end of school.
2. Collect accurate information from various sources in order to make the task as realistic as possible. Costs would include:
   - travel
   - accommodation
   - spending money
   - pre-holiday purchases, such as luggage, sleeping bag, waterproof jacket.
3. If you have 12 months to save for your or your friend's holiday, use the spreadsheet facilities to calculate how much you or your friend will need to save each month.
4. Print out a copy of the completed spreadsheet.

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8.2 Planning, implementing and evaluating a sequence of operations

The world of design is an exciting one. From a first idea, a concept or just the need to solve a problem, humans have been honing their ability to plan, implement and evaluate projects since the Stone Age. A staggering series of technological innovations has led the way to how we live our lives today.

The stages of your design process and their sequence will differ from project to project, but at all times you need to have a plan, and that plan must be documented to ensure that you do not miss anything. There is much to remember when you are designing and producing, and you should utilise all the tools and techniques discussed in the previous pages to assist you in your management.

Thorough evaluation is crucial to the success of your project. You will continually evaluate the effectiveness of your resources, costs, decisions, processes and so on. It is important to be prepared to make changes to your management plans in light of ongoing evaluation. Designers also need to consider ethical issues as they evaluate. Sometimes decisions need to be made about processes that occur a long way from the actual design and production of a product or system – on the other side of the world. Responsible designers consider the possibility of questionable practices in foreign factories (e.g. sweatshops) or in the collection of natural resources (e.g. child labour). There are often far-reaching ethical implications of what we actually do and use in the development of our projects.

Remember: plan, implement and evaluate.

ACTIVITY 8.4

You will find that a 'plan, implement and evaluate' process is followed in most situations. Read Case Study 8.2, create a table and place the steps involved in the process described under the headings 'Plan', 'Implement' and 'Evaluate'.

Video

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CASE STUDY 8.2

Elecdata Australia

Elecdata Australia is an electrical and communication contracting company specialising in transport infrastructure. Elecdata Australia values sustainable development and designs all fitouts with energy efficiency in mind, aiming to reduce the occupant's carbon footprint. Some of the technologies it uses are motion sensors, electronic timers, intelligent lighting control systems, and effective lighting design to reduce energy consumption. Elecdata Australia designs and implements solutions for electrical installations; data, voice and communications systems; lighting and building **automation**; and audio-visual installations. Careful, considered planning and implementation is a crucial aspect of the operation.

One client of Elecdata Australia was a rail operator who decided to provide disability access to all their train platforms. This major project was conducted by a number of builders who engaged electrical contractors with rail experience to do the electrical, lighting and communication cabling works. Elecdata Australia management spent time with these builders to ensure that they understood their requirements before offering a price for an effective solution by way of a select tender process. Consultation between the client, the builder, the engineers and Elecdata Australia occurred regularly throughout the project development, using face-to-face meetings, email and telephone conversations. Electronic copies of drawings and resource specifications were sent to the client, builder or engineer for approval.

The project manager had the task of organising all the people and resources to complete the job on time and to the highest quality. Plans were drawn up by an electrical engineer, using CAD.

automation mechanical controlling of machinery for speed and accuracy

It was important that these plans would meet criteria for disability access to all areas of the rail network. Conditions for the visually impaired, the hearing-impaired, and wheelchair access were considered. To achieve this, the upgrades would include ramps, lifts, hearing loops, tactile surfaces and wayfinding.

All the required resources had to be organised by the project manager, ensuring that all products were of high quality with warranties, and that manufacturers' specifications were clear to the electricians building the systems. The project manager

Figure 8.5 An engineer using CAD

Figure 8.6 An electrical engineer at work

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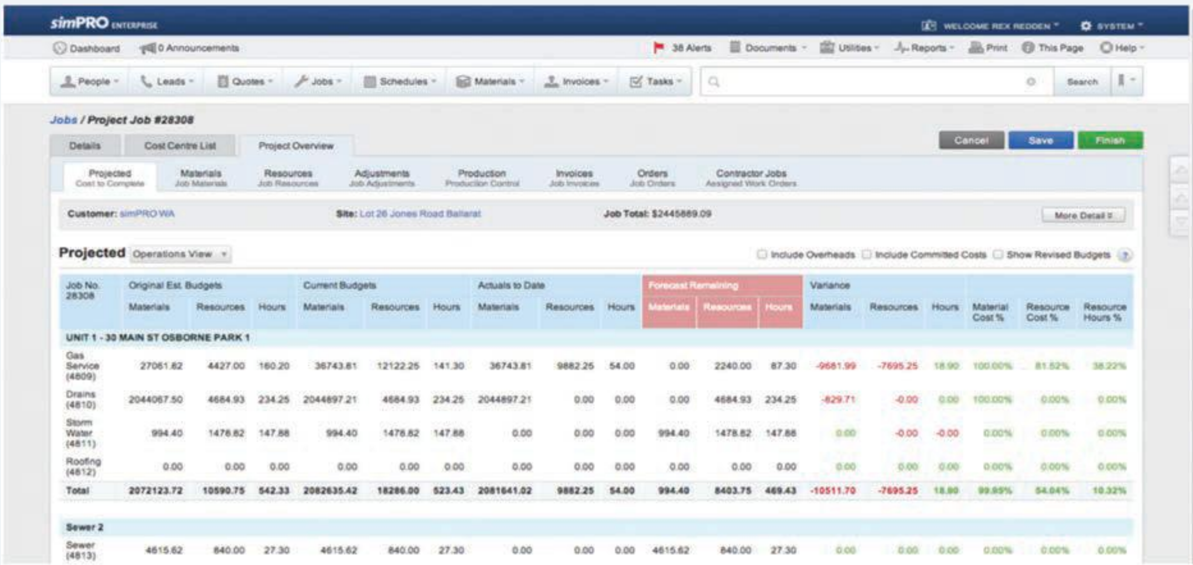

Figure 8.7 The progress of a job can be tracked using software like simPRO.

also had to ensure that all legislative requirements were followed in accordance with Australian Standards and the engineer's designs.

All decisions were documented in the notes section of the online management system and correspondence was filed physically and on the Elecdata Australia server. As the job progressed, it was tracked through the use of simPRO software that enables the project manager to oversee all steps of the process. Through the use of this management software, other Elecdata Australia employees can also view the progress of projects. Any changes to the original plan can be monitored and evaluated by the management team.

The project manager organised the electricians working on site to fit around the needs of the builder and the engineer. Communication and accurate scheduling were important to ensure that the right person was available at the right time. It was also important that the resources needed (such as data cable, power cable, lighting and sensors) were on site in the correct quantities when needed. Any errors in the provision of workers and resources would be very costly to the company.

The projects were completed on time and to the satisfaction of the client, but this would not have occurred without comprehensive and capable project management.

Figure 8.8 Ensuring designs are inclusive of people with disabilities

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CHAPTER SUMMARY

- Good project management is essential in any design project.
- Designers need to be aware of the techniques and tools available to assist in project management.
- It is important to meet with the client to clarify values and set goals.
- Documentation of plans, tasks and finances assists the process of design.
- Evaluation occurs throughout a project as decisions are made about design, materials, costs and so on.

CHAPTER SUMMARY TASKS

1 Choose a design project you have completed and analyse the design process by answering the following questions.

- **a** What was the initial design brief?
- **b** List the criteria to evaluate the success of the product.
- **c** What action planning was carried out?
- **d** What research was carried out in the initial planning?
- **e** How many tasks were listed on the Gantt chart?
- **f** What information did you present in your journal?
- **g** What materials did you use in the construction of your project?
- **h** What resources, machines and tools did you use in the completion of the project?
- **i** List the computer technology you used throughout the design project.
- **j** How did you evaluate the project?

2 Create a graphic to represent the management of the design project described in Question 1.

3 Compare and contrast the role of a finance plan and an action plan in project development.

4 Use the internet to search for management software. List all the tasks addressed by three different software tools in their packages.

5 Explain what you think is meant by 'plan, implement and evaluate'.

EXTENSION TASKS

1 Research the concept of quality control as it is used in the manufacturing industry. Discuss how you implement the concept of quality control in your project work.

2 Interview a manager from any profession and ask about the types of tools they use in their work. If possible, look at the management software they use. Your teacher may be able to show you the software used to manage the school timetable, classes, students and teachers, or at least explain how it works.

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9 Communicating ideas and solutions

This chapter explores a range of techniques used in communicating ideas and solutions. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P5.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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9.1 Communication and designers

Communication is at the core of a good design project. The ability of a designer to effectively communicate their ideas, thoughts, plans and intentions cannot be underestimated.

Designers have an array of tools and resources at their disposal to assist them in communicating these ideas when attempting to solve a given design problem. These have been developed over centuries, particularly with the introduction of new technologies, but many simple tools remain important, such as the use of a pencil or drawing tool to convey ideas.

9.2 Using appropriate design and technology terminology

Humans have an extraordinary array of communication devices at their disposal to interact with one another. But we have had to develop these communication methods and skills over many centuries, and they will continue to develop. We have developed forms of communication such as speech, writing and graphics. These now enable us to communicate at a much higher and more complex level than any other species on Earth.

Whichever method of communication we use, we should always ask the question: ‘Has my message been received and understood?’

Humans usually use a range of communication methods (verbal, written, visual, audio and various combinations of these). Designers must be skilled in the full range to be able to convey their solutions to design problems. The use of electronic communication and multimedia has enabled designers to communicate in different ways.

Becoming a designer is similar to learning a new language, as we must become familiar with technical terminology or jargon. Thousands of new words make up the design dictionary – from the strange names given to tools and equipment and the materials we use (which could be exotic timbers or complex plastics) to those we use in explaining our thoughts and ideas about a project.

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9.3 Visualising and communicating ideas and solutions with a range of techniques

Designers have a wonderful array of communication tools at their disposal, none more useful than the pencil. Being able to describe something to someone is one thing but making marks on a piece of paper and being able to sketch your thoughts and make them come to life is something very special. Designers need to constantly practise, develop and improve their drawing techniques. Whether it is sketching rough drawings, adding colour to render a drawing or completing a formal **orthographic** drawing, these are skills that need to be developed.

orthographic the drawing technique of representing lines, surfaces or solids in one or more imaginary planes that are at right angles to one another

Designers have always had a range of tools and resources available to assist them in the communication of ideas to any given design problem. In early times, parchment was used (in the way paper is today), along with a range of drawing implements, and designers were extremely skilled in their use. They used a range of charcoals and pencils to make their marks, as well as quills made from bird feathers sharpened to a point and dipped in ink. Designers had to be very neat, as mistakes were often costly. With the development of lead and graphite pencils, designers were able to draw finer lines, enabling them to create very complex drawings and designs.

Over the past 100 years, there have been improvements in the art resources available to designers such as the quality of paper, pencils made from graphite and coloured media, such as acrylic paints.

In the past 25 years, there has been a revolution in the way designers present their ideas. Electronic devices have become powerful tools and their use is now widespread. Software packages have been developed that allow the designer to draw complex designs more easily and very accurately. A whole range of shapes can be drawn using the computer and mistakes are easily corrected.

Designers have developed new skills to use these new technologies. Computers have provided designers with the tools to produce quality drawings and the ability to visualise designs by creating virtual models. Also, computers can be used to produce very high-quality 2D and 3D printouts that can then be passed on to the manufacturing team for production. The whole drawing and revising process is now speeded up significantly, and designers are able to send files around the world to specialist companies for manufacture. These developments also encourage collaboration on a global basis. A designer can now send design concepts to specialist designers (engineers, industrial designers, medical technicians etc.) located anywhere, and the specialist can send feedback immediately.

Here are some tips that will help when you are presenting ideas through drawing:

- Think about the best way to present the image; for example, perspective drawings for three-dimensional images.
- Incorporate correct conventions for line styles.
- Include a scale.
- Show all dimensions needed to produce the object.
- Place dimensions outside the product where possible.
- Include projection lines that extend 2 mm past the dimension line and are to be drawn parallel to the measurement.
- Include a 1 mm gap between projection lines and object outline.

There are many drawing tutorials available on YouTube. Search for 'Mark's Drawing Tutorials' for a range of different techniques.

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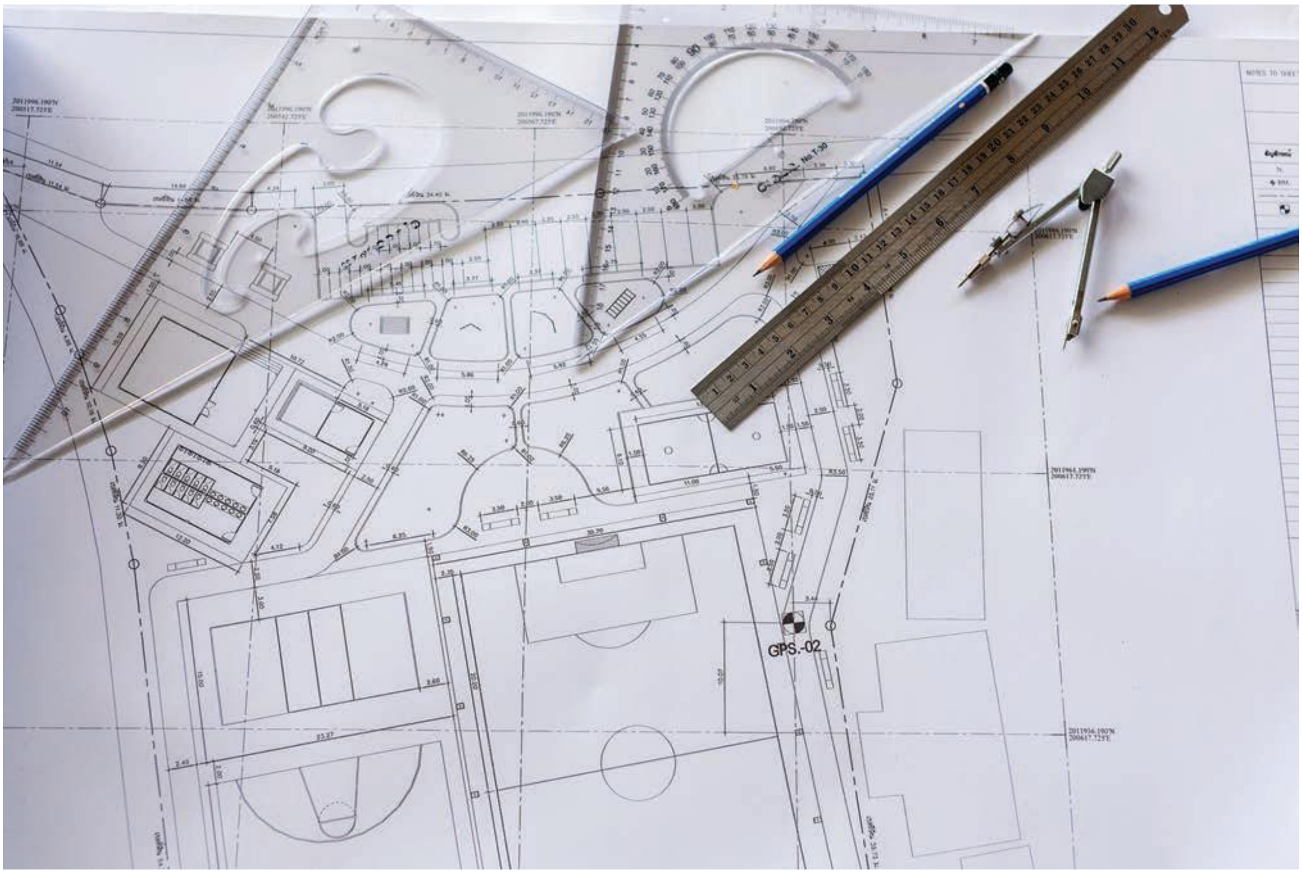

Figure 9.1 A close-up of architectural plans

9.4 Drawing standards and conventions

Working drawings must convey the information needed to make the article you have designed. They need to show the dimensions, the construction methods and the assembly techniques. They may be produced manually or using a computer.

With so much technological development occurring in almost every city around the world, manufacturers and designers realised there was a need to standardise the way in which design ideas were drawn. A standard way of drawing meant that a designer or engineer could draw their design and send it to almost any manufacturer, who would be able to interpret the drawings and make the article.

Drawing standards are a set of rules providing specifications and procedures that will ensure that the drawing is suitable for its purpose and will be

ACTIVITY 9.1

Define or provide a sketch to illustrate each of the following drawing techniques:

- orthogonal projection
- exploded drawing
- circuit diagram
- architectural drawing
- data flow diagram
- cut-away illustration
- assembly drawing.

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Figure 9.2 Automated manufacturing stations reduce the need for human workers.

understood by the user. This is an important method of communication within the design industry. The Australian Standard AS 1100 for technical drawing can be found on the Standards Australia website.

In early years, manufacturing companies employed large numbers of draughtspeople who would work on large drawing boards, creating the drawings that would be used by the engineers to make the products. The computer has revolutionised the whole manufacturing process. Computers are not only used for drawing products, but the data provided from the drawings can be sent to computer-controlled machines, which then make the product or item. Computer-aided design (CAD) and computer-aided manufacturing (CAM) involve the use of computers in the design and manufacture of components used to build items such as automobiles and jet engines. CAD is software for creating precise engineering drawings in two and three dimensions. It uses computer software to facilitate the generation, modification, and optimisation of a part or a compilation of parts. This allows for higher precision, simpler and more accurate design iterations, and comprehensive documentation. CAM links a computer to a machine tool such as a drill or a **lathe**. Software controls machine tools and related tools in the manufacturing process. The primary purpose is to create a faster production process and components and tooling with more precise dimensions and material consistency, minimising waste and reducing energy. CAM engineers use computer modelling to determine the best overall manufacturing procedures for use in an industrial plant, including the testing and handling of finished products.

Engineers use CAD and CAM together, creating the design in 2D and 3D CAD on one computer, then transmitting the design to a second computer which creates the part using CAM. CAM uses a computer to control the manufacture of objects such as parts, which are most often made of metal, plastic or wood. The manufacturing operations may include milling, drilling, lathing and polishing.

When we consider the future of CAD and CAM, the possibilities seem endless as industrial manufacturing enters the next generation. It is often said that we are now in the digital age, where computers control almost everything. The industrial world has had to embrace this technology in order to meet the demands of a consumer-driven society as the public demand new and better designed and made products.

The future is exciting as **mass production** is extended, with entire factories now being operated by robots and computers controlling the whole design and manufacturing process. The **standardisation** of drawing and manufacturing processes has enabled companies to use manufacturers' expertise from many different countries and to achieve cost savings by using cheaper labour in less-developed countries.

lathe a machine used for cutting and working wood or metal that spins the material against a cutting tool

mass production the manufacture of goods on a large scale, usually on an assembly line

standardisation the process of establishing a technical standard to ensure compatibility of production assemblies

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ACTIVITY 9.2

Computer graphics technology has impacted on the communication of design ideas in many ways. Research three different technologies and explain how they have impacted on communication for designers.

Figure 9.3 Computer-aided design


Video

9.5 Selection and use of communication techniques

As a designer, it is important that you become familiar with the range of communication techniques at your disposal. When embarking on a design project, you need to select the most appropriate tool for the task. When first given a design brief, your sketching ability will be tested considerably, as this is where the creative process begins. At this stage of the design process, it is important simply to get ideas down on paper as fast as you can. Rough sketches are a good record of your thought processes and how you attempt to solve the design problem you have been given. The more ideas you generate, the better the chance for success of your design, as you can often evolve a concept through a range of ideas that improve the design with each version. Alternatively, your final design solution may be a combination of some of the best features from a range of your ideas. The creative process of generating ideas must be seen as ongoing, with each stage or idea being evaluated against the original design brief. Some ideas may seem crazy and impractical, but it is important to keep all these rough sketch ideas as they tell the story of your approach to the design project.

These initial ideas should be displayed in the design portfolio as evidence of early research and experimentation with possible solutions. By displaying them, the designer clearly shows the depth of understanding of the design brief and how the realisation will take place. Many sketches in 3D, sectional views, render drawings and some CAD drawings will be produced and should be all kept as a record.

Once a final design solution has been achieved, the designer is required to produce a working drawing, which is one that shows various views of the product with dimensions added. These dimensions will give the designer valuable information about the size of the finished parts of the product. These drawings are often drawn to an exact scale in order to accurately show this information. Certain standards, such as British and American Standards, are used to ensure drawings can be correctly interpreted globally.

With a number of rough sketches, initial design ideas, and rendered and orthographic drawings completed, the designer is equipped with sufficient

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information to make a prototype model of the design project. A prototype or model is a vital part of the design process and will give the designer valuable information about their intended solution. More importantly, the designer and client are able to see a 3D form of the intended design.

Seeing an idea on a piece of paper or a computer screen is one thing, but being able to see and touch a concept model of the idea gives far more information than an image. Prototypes are made from inexpensive materials or on a smaller scale, but they are intended to give the designer a real sense of scale of the final design. If the prototype is not successful, the designer should go back over the initial sketches and ideas in order to solve the design problem. Industrial designers use prototypes to assist them in creating the right design solution to a given problem.

Video

In the field of car design, a designer would even make a full-size working prototype of a car that could actually be driven. In fashion design, a designer would probably make a range of prototypes from calico or cheaper materials, which give information about the cut and fit of the garment. An architect would produce 3D drawings and/or models to explain concepts and communicate ideas. The models may also be used to communicate with other designers, such as interior, landscape and lighting designers.

Designers present their client with a mock-up or a layout of the design work before proceeding with the final stage of production. The client then gives feedback to the designer, and any adjustments and refinements are made at this stage. Depending on the nature of the design requirements, the designer might present mock-ups or layouts to the client several times. When the client has approved the final mock-ups or layouts, the production of the design work can take place. The design process is completed when the client has received what they requested in the brief and is satisfied with the results.

Advances in technology have enabled designers to utilise the power of virtual reality. Manufacturers can now use powerful head mounted displays to give designers and clients a truly immersive and interactive 3D experience. Computer software makes it relatively simple for architects and engineers to convert building information modelling data into a virtual reality experience. This enhances the design experience, providing new insights into design ideas. It is invaluable as a presentation or communication tool.

Figure 9.4 A prototype for the design of a windfarm

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Communication is crucial to the work of designers. As a designer, you need to develop criteria to evaluate the elements of your communication methodologies. You will ask yourself:

- What message am I conveying? Is it being received clearly?
- Have I used the most effective method to communicate design development?
- Are appropriate standards and conventions employed?
- Can I justify the selection and use of communication techniques?
- Is my solution clearly visualised?

Figure 9.5 Using VR to communicate with the client

CASE STUDY 9.1

Web design

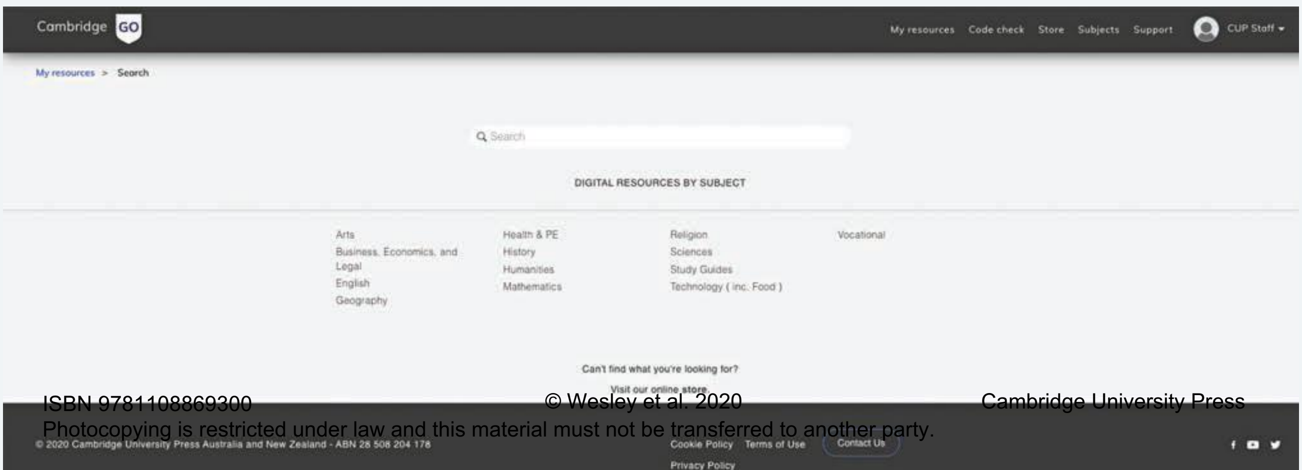
Much of the communication between designers, products and clients occurs via the world wide web. It is the prominent marketing tool in today's world of electronic communication. Web designers are responsible for designing and building the interface, navigation and aesthetic of websites.

Successful web design teams depend on clear communication between developers and their clients – and between members of the development team. Thus real-time collaboration is crucial to the success of web design. Design diagrams such as wireframes, site maps and flow charts establish a common language among the designers and project team. It is important to present and capture ideas, track progress and keep all stakeholders informed.

The web designer has responsibility for a range of processes, needing both technical and creative skills. They design engaging and responsive landing pages for the site, ensuring the user has a positive experience immediately, as well as attending to technical issues such as integrating management systems and data feeds. They optimise sites for maximum speed and scalability ensuring website function and stability across devices. Another responsibility is to communicate with marketing and research teams to incorporate brand elements and relevant market research findings into the website.

Thus good communication is essential to a well-designed website, but additionally the site itself must communicate effectively with the users.

Figure 9.6 Good web design anticipates the user's needs.



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ACTIVITY 9.3

Interior designers present their ideas in different ways. Study the images below and describe the different methods used to present the design ideas. Do a PMI (plus, minus, interesting) on each one.

Figure 9.7 A model of a floor plan

Figure 9.8 A computer-generated image of a house interior

Figure 9.9 Draft plan of a house

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CASE STUDY 9.2

Bruce Munro

Artist Bruce Munro is known for impressive large scale, light-based installation artworks. He uses light and colour to share his response to stimuli such as music, literature, science and the world around him, producing temporary experiential artwork as well as intimate story pieces. He conceived the idea for *Field of Light* while visiting Uluru in 1992. Struck by the incongruity that deserts seem like infertile, unproductive places until it rains, he literally dreamt of a field of light that would bloom at night like dormant desert seeds responding to the rain. The idea stayed with him until he had the opportunity to make a large version in 2004 in a field behind his house. The installation was first exhibited by London's Victoria and Albert Museum, and since in various incarnations in the UK, the USA, Asia and Mexico.

Figure 9.10 *Field of Light*

Now on show in Central Australia, it is named Tili Wiru Tjuta Nyakutjaku or 'looking at lots of beautiful lights' in local Pitjantjatjara language. As darkness falls and Uluru is thrown into silhouette, *Field of Light* illuminates: as far as the eye can see gentle rhythms of colour light up the desert. It is overwhelming in size with some 50 000 solar lights atop slender stems – a fantasy garden of glowing buds appearing as blooms swaying in the darkness. Pathways invite the visitor into the artwork.

In this way Bruce Munro communicates his message of vitality in the desert of Australia's spiritual heartland, with a spectrum of ochre, deep violet, blue and gentle white. The installation has been accorded critical and popular acclaim, standing beside the majestic Uluru and joining the star-studded skyline of Uluru-Kata Tjuta National Park.

Bruce comments: 'the installation seems to inspire many thoughts and ideas; it brings people together and most importantly makes people smile, a worthy epitaph for a moment of inspiration in life's journey'.

In a similar vein, Bruce's new exhibition of illuminated sculptures, *Tropical Light*, in Darwin, aims to switch the way people perceive the wet season, encouraging them to be more appreciative of the tropical summer.

Figure 9.11 *Tropical Light*

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CHAPTER SUMMARY

- Designers need to develop clarity in all forms of communication and fully understand the different forms of communication, including verbal, non-verbal, written, graphical, digital, visual and audio.
- As a designer, you need to be aware of the elements of communication, in particular the roles of senders and receivers. Criteria to evaluate communication are important.
- Designers need to develop a range of graphical techniques, including freehand sketching, 3D drawing, shading and rendering and the visualisation of ideas in both digital and analogue formats.
- As a designer, you will be required to understand and use the relevant industry terminology, such as the names of materials, processes and techniques.
- Drawing standards, such as the British and American Standards, are rules that govern the way technical drawings are drawn. The symbols and conventions used are applied across the world.
- Prototypes or concept models are often produced as part of the design process to give the designer and the client valuable information about the intended design.
- Emerging technologies impact on communication methodologies.
- Design portfolios – electronic or hard copy – are vital for documentation of the process and presentation of the final design.

CHAPTER SUMMARY TASKS

1. Describe three different communication resources available to designers to assist in the management of a design project.
2. Identify the various communication techniques that you have noticed in your environment.
3. List the general criteria you think should be used when evaluating the effectiveness of communication.
4. List five media that a designer could use to create graphics and visualisations for a design project.
5. Explain how you visualise ideas in the initial stages of a project.
6. Explain why it is important to evaluate the methods of visualising ideas.
7. Explain how computer technologies have impacted on the way designers work today.
8. What is the importance of standardisation?
9. Create an orthographic drawing for a common product found in your home.
10. Explain why a portfolio is important for documenting the design process.

EXTENSION TASKS

1. Create a multimedia presentation to show the development of your current design project and present it to your class.
2. Select a product with which you are familiar. Create a sketch, an orthographic drawing and a CAD drawing.

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10 Research methods in the development and modification of design ideas

This chapter explores a variety of research methods used to inform the development and modification of design ideas. In order to develop a clear understanding of the content of this chapter, carefully examine the ‘Students learn about …’ and the ‘Students learn to …’ statements relating to **Outcome P5.3** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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10.1 Research methods

Research is a major part of the design process. We all want to get straight into our projects and make a start but making a false start can be more time-consuming than making a well-planned and researched start. Our research cannot be confined to just one type; it must encompass a variety of methods and sources and be as wide-ranging as possible. The research needs to be appropriate for the information required. Investigation about the target market's needs will be different from looking at specific tools and materials or alternative designs that are already in the market. This research and understanding of what we want to do can produce a light-bulb moment that makes our project special and shapes its realisation.

Research is a complex subject with many different methodologies employed and a language of its own. You will need to understand the methodologies and terminology of researching, as it will underpin your design process and, ultimately, successful designs. Collecting quality information will shape your thinking and influence the final product.

COLLECTING INFORMATION

Before starting research, you will need to establish what it is you want to know. Is it an opinion or subjective view on whether one colour or shape is better (qualitative)? Or is it based on data and performance (quantitative)? Collecting appropriate information forms part of the justification of designing, as the information can be used to prove that a design needs to be changed or to establish a need for a design. (This can be from the design brief.)

There is a need for a number of research methods to be used to inform the development and modification of design ideas. So when is research needed? The timing will determine the types of research needed. Some suggestions are:

- **Start of the design process:** to establish the need and what is already out there, to investigate existing ideas, to determine the needs of the target market, to establish any changes in technology and so on
- **Investigation of production techniques and resources:** to ensure the viability of design ideas and the capacity to complete the design
- **Design of possible solutions:** to investigate aspects of designs and alternatives. This is where experts and team members bring the ideas in.
- **Testing alternatives before final design is completed:** to ensure changes are made prior to the design being released to the market
- **Completion of the design:** to determine the success of the design and the potential for improvement. This can be time sensitive if commercialisation or health and safety is a priority.

CONDUCTING A SURVEY FOR RESEARCH

To provide a foundation for research processes, we will work through a scenario. In this scenario, you have identified a local primary school which currently does not have a school crossing and you wish to design a solution to the problem.

You have visited the local council's website and downloaded data from a survey that the council conducted last year, you have listened to an interview with a roads and traffic expert on the radio, and you have collated a number of newspaper articles written about the issue. These three research strategies are known as secondary research, because someone else conducted the actual research.

You have also researched the criteria for a school crossing. Some of this included the requirements of:

- the site must be located within a 40 km/h school zone
- in the morning or afternoon, the crossing must register counts of either:
  - 50 or more unaccompanied infant and/or primary school children, or

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– 300 or more passenger car units (heavy vehicles over three tonnes unladen are counted as two passenger car units).

Next you will conduct some primary research; that is, you will gather the data yourself and analyse the results. Although you obtained data from conducting your secondary research, you now have the opportunity to confirm the data by observing the site yourself and counting the vehicles at specific times of the day over a period of three weeks. You are going to interview the people who live around the site. The drivers who pass through will complete a survey and local councillors will receive a questionnaire. In your interview you will use some open-ended questions such as 'Could you list reasons why the local primary school would need a crossing? How can we solve the traffic problem?'

You will probably receive a different response from each participant. This is known as qualitative research, as your findings cannot be counted or quantified. Qualitative data are based on feelings, beliefs, attitudes or opinions. The results of qualitative research will usually be presented in text format. Good use of qualitative research questions draws out valid opinions but does not provide statistical data. Validation of a design, or an aspect of one, will require more than just this type of data, as often it is woven into a story by the designer to give an opinion.

In this scenario, you will move on to the collection of quantitative data. In your survey, you will ask questions that require a box to be ticked or a yes or no answer, as shown in Table 10.1.

Table 10.1 Examples of quantitative data questions

HOW OFTEN DO YOU DRIVE PAST THIS SITE?	YES	NO
MORNING		
AFTERNOON		
AT LEAST THREE TIMES A WEEK		
WEEKLY		
SELDOM		

Figure 10.1 It is important for schools to ensure that young students have access to a school crossing.

You will be able to count the results for each of these choices. For example:

- morning – 312
- afternoon – 516
- at least three times a week – 746
- weekly – 438
- seldom – 118.

The answers are numbers, so they can be quantified. This is known as quantitative research. Quantitative data can be counted and statistically analysed. The results of quantitative research will usually be presented in a graph or chart.

When you are designing your research tools (questionnaire, survey, interview questions, tally sheet and so on), you will need to carefully consider how you will present your data in order to analyse your findings.

- Will you make lists?
- Will you make a graph or chart?
- Will you make a table or diagram?
- How will you sort your data?
- Will you put the raw data into a spreadsheet?

Your findings will be used to help you make decisions. In order to justify those decisions, you need to refer to the research data. It will need to be presented in a logical manner so that others can also read your findings.

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ACTIVITY 10.1

You have developed a beverage marketed at young sportspeople. You plan to conduct a taste test at your school. Devise a survey you will use when conducting the taste test.

RESEARCH METHODOLOGIES

Some research instruments are described below to help you decide how you will collect relevant data to assist in your decision making.

- **Survey:** This is used to collect quantitative data, which provide a systematic examination of the issue or situation. A survey can be conducted on paper, online (direct or indirect collection of information online can be done on social media or even by counting 'likes', etc.) or via telephone. It may involve a combination of other research techniques.
- **Questionnaire:** A series of questions or prompts is used to gather information. The questionnaire can use open or closed questions. Questionnaires are usually designed for a high number of participants, so they often require shorter responses.
- **Interview:** This is a conversation between two or more people in which the interviewer asks questions to gather opinions or thoughts on a particular subject or a range of subjects. Some interviews will be formal, with a set of questions to be answered, and some will be informal, where a topic is given to the participants. Interviews can be conducted face to face or via telephone, email or video link. The interviewee, or interviewees, can be from the target market or an expert on the subject in question. An interview has the advantage of allowing for in-depth questioning with less chance of misinterpreting the responses. An interview can be more expensive to conduct than a questionnaire.
- **Observation:** This is simply the act of looking and noting specific elements such as behaviour. These elements are sometimes recorded on a tally sheet to produce data on a subject. Observation has the specific purpose of gathering information. Observational research can be conducted in a structured setting, such as a clinic, or a natural environment, such as a busy street.
- **Experimentation:** This is a set of actions, or controlled tests, which verifies a **hypothesis** or allows further investigation of an idea. Experimentation is an excellent way to conduct research on materials. The method of experimentation should be scientific with the aim, method, results and conclusion documented clearly. The conclusion should also indicate how the findings have impacted on the project.
- **Statistical analysis:** Data gained from any form of research can be analysed using statistical analysis to draw conclusions on a subject.
- **Information research:** A range of information resources, such as paper and electronic media, is used to gather information.
- **Social media and targeted online communication analysis:** Using 'likes', 'view counts', and 'reward cards' to track spending or viewing habits. This online behind-the-scenes 'data' is big business in the IT world and its commercial value has grown with increased access to technology. The success of a product is often based not just on its performance, but its target market's acceptance. (Think of how mobile phone brands use brand loyalty as an example of how they listen to their users before developing the next version.)
- **Metadata collection:** 'E-commerce' is driven by 'behind the scenes' analysis of metadata by IT specialists. Often this is not very public but can be instrumental in identifying and understanding target market behaviours.

hypothesis a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation

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ACTIVITY 10.2

You are designing a new game that will appeal to young adults. List the characteristics and the materials you need to have for this new game. Devise a test that you could use to research one of the materials you are investigating. State the aim of the test and the method, describing the procedures involved. If you can actually conduct the test on a material, you will then be able to document the results or data collected. In the conclusion you should interpret the results in relation to the aim of the experiment and your design solution.

Video

The internet is an easily accessible source of information. When conducting research using the web, it is important to check the validity of the information. Ensure that the author of the material you plan to use is an authority on the topic and that the data are current. Document the URL and the date of access. (Screen shots, view counts, likes etc. are all valid sources of data.)

Figure 10.2 Research can be as simple as sourcing information from experts in a newspaper.

ACTIVITY 10.3

You have been employed to design a new education site aimed at the secondary school market. You plan to conduct some market research with teenagers to find out their views on education sites. List 10 questions you could use in the research. Ensure that five of your questions are closed questions and five are open-ended questions.

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CASE STUDY 10.1

Researching to inform design

Being overweight or obese increases a person's risk of developing long-term health conditions such as cardiovascular disease, high blood pressure and Type 2 diabetes, while being underweight can also be a health risk factor for some people.

Obesity is an issue that concerns Jack as he has noticed a number of overweight adults and children in his area and on the school bus. This is based on his own observations and is known as anecdotal research, as it has no proven data from formal research to back it up. That does not mean that his thoughts are wrong, but he should not make such assumptions without support from research.

Jack did some secondary research by visiting the Australian Institute of Health and Welfare website and looking at Australian Bureau of Statistics (ABS) survey data. Here he found some statistics about obesity. This is known as secondary research, as it is not his own work. The following statistics agree with Jack's thoughts on the subject.

In 2017–18, two thirds (67.0%) of Australians 18 years and over were overweight or obese. Slightly more than a third (35.6%) were overweight and slightly less than a third were obese (31.3%). Just under one third (31.7%) were within the healthy weight range and one per cent (1.3%) were underweight.

Since 2014–15, the proportion of adults aged 18 years and over who were overweight or obese increased from 63.4% to 67.0%. This change was driven by the increase in the proportion of adults categorised as obese, which increased from 27.9% to 31.3%. Since 1995, the proportion of adults aged 18 years and over who were overweight or obese increased from 56.2% to 67.0%, which was also associated with an increase in the proportion of people who were obese, which increased from 18.7% in 1995 to 31.3% in 2017–18.

In 2017–18, the proportion of adults aged 18 years and over who were overweight or obese in general increased with age. Less than half of those aged 18–24 years (46.0%) were overweight or obese. By age 35–44 years, this had increased to 68.7% and by the age of 65–74 years, the proportion had increased to almost four out of five (78.2%). However, there was a large increase for those aged 18–24 years, with 38.9% overweight or obese in 2014–15 compared with 46.0% in 2017–18.

Further investigation by Jack, using the Australian Bureau of Statistics website, found that one quarter (25.7%) of children in NSW were overweight or obese, with the rates similar for boys and girls and remaining similar since 2014–2015. More children were overweight (17.6%) than obese (7.9%).

As a result of this and other research, Jack has decided to design a fitness program with a particular focus on young people. It is necessary for him to understand the sporting activities in which children participate, so he looks for some more research data. He visits the Australian Bureau of Statistics website, which presents data on a number of topics in text, in tables and in charts and graphs.

In the section on children's participation in sport, the ABS present research results in text format. It makes the following statement:

> In the 12 months to April 2012, of the 2.8 million children aged 5 to 14 years, 1.7 million (60%) participated in at least one organised sport outside of school hours.
>
> Approximately two thirds (66%) of all children aged between 9 and 11 years participated in organised sport, higher than the participation rates of those aged 5 to 8 years and 12 to 14 years (56% and 60% respectively). More males (949 000) participated than females (727 000).
>
> On average, children spent five hours in the last school fortnight playing and training in organised sport outside of school hours.

Results of ABS research into children's participation in selected physical recreation activities are presented in table format (see Table 10.2).

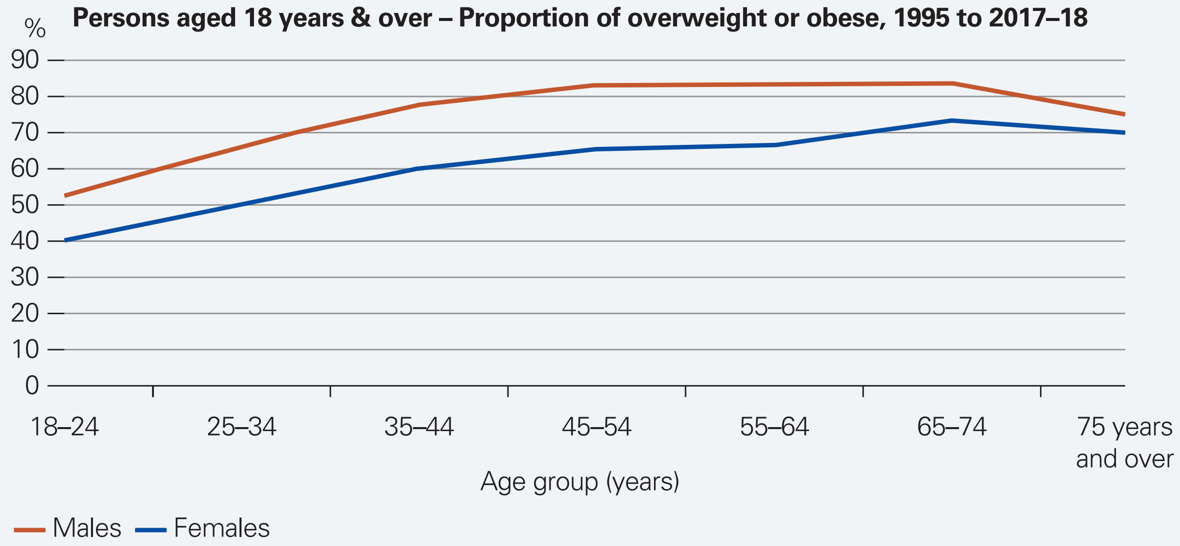

Figure 10.3 Persons aged 18 years & over – Proportion of overweight or obese, 1995 to 2017–18

Table 10.2 Children's participation in selected physical activities, 2012

		NUMBER	PARTICIPATION RATE (%)
MALES	Rugby League	107.4	7.5
	Soccer (Outdoor)	309.7	21.7
	Netball	2.4	0.2
FEMALES	Rugby League	2.5	0.2
	Soccer (Outdoor)	87.8	6.5
	Netball	220.4	16.2

These data tell Jack that soccer (outdoor) was the most popular activity for both genders in this selection of activities.

Now that he has looked at some secondary research on physical activity, he decides to do some primary research. Jack plans to conduct both quantitative and qualitative research. He has permission from the principal and parents to visit the local primary school to conduct a survey with 100 students aged 10–12 years. He will interview 10 students of the same age group for a case study about physical activity.

He plans to record the interviews so that he can study the responses later. He will seek permission from the participants' parents to do this.

This is Jack's list of questions:

- Do you enjoy sport at school? Why or why not?
- What do you do in your spare time on the weekends?
- How do you spend your time after school?
- What types of activities do you like best?
- If you were offered the holiday of your dreams, where would you go? Why?

As you can imagine, he will receive many different answers and that is why it is called qualitative research. Jack will carefully analyse the responses later and look for commonalities and themes to assist him to analyse and organise the results. He will write up the findings in a case study format and may use tables to collate similar responses so as to draw conclusions with some numerical data.

The survey will provide students with an image and a word to indicate an activity, such as a picture of a soccer ball and the word 'soccer', a picture of a netballer and the word 'netball'. The students will be asked to draw a ring around the activities in which they would like to participate more than once a week. This is quantitative research, as it will give Jack numerical data that he can present in a table or graph. Jack can then analyse the results and determine his findings. The more surveys Jack completes, the more likely his results will be to provide valid data (provided he does not have too many people in his survey who are too similar in demographics). That data could be extrapolated to represent the whole target for his design brief.

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10.2 Analysing, interpreting and applying data

It is a vital part of the design process and the production of your design portfolio to document and present your findings; not just your major findings, but also those that took you along the path to the finished project. The presentation of these results can take many forms. Tables, graphs, charts, diagrams and the written word are all ideal ways of presenting and interpreting the data you collect.

Figure 10.4 Pie charts can be used as an effective means of showing majority and minority sections versus the whole.

The process of examining data to draw conclusions or identify patterns is known as statistical analysis. This mathematical science has a language of its own. Some terms that you may meet when you are researching are:

- **Population:** The whole group that is under study. A set of entities from which inferences or conclusions are to be drawn.
- **Sample:** A subset of the population under study. Items are selected at random from a set population and used to test hypotheses about that population.
- **Mean or norm:** An average approximating the statistical norm.
- **Median:** The middle value of an ordered set of values.
- **Standard deviation:** A statistical measurement of dispersion around an average or mean.

Surveys are a useful tool to collect a great amount of data quickly and easily. Table 10.3 shows a survey used by a designer who was planning to design an overnight bag for women and another one for men.

From the table results, you could then produce a pie chart to determine what requirements are important.

Table 10.3 Overnight bag design survey

INVESTIGATING NEEDS OF A BAG WHEN STAYING OVERNIGHT		
Please note that your responses will remain anonymous and confidential.		
WHAT ITEMS WOULD YOU TAKE WITH YOU FOR AN OVERNIGHT TRIP? (PLEASE TICK)	MALE	FEMALE
Nightwear		
Toothbrush		
Phone		
Clothes for next day		
Hairbrush		
Moisturiser		
Wallet		
Jacket		
Water bottle		
Other (Please list)		
Thank you for taking the time to complete this survey.		

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ACTIVITY 10.4

Select a project you have done in the past or one you are working on now. Consider the research that you have done and what you found out from your research. Collate the data into a table, then present your findings in a graphical format.

10.3 Ethics in research

Video

Many different institutions and professions promote ethics that reflect their aims and goals and influence accepted behaviour. These norms help members to coordinate their behaviour and develop public trust. Medical practitioners, for example, support the Hippocratic oath of 'First of all, do no harm'. In research it is also important to adhere to ethical norms. Many research institutions and government bodies develop their own code of conduct for research. These codes of conduct will usually incorporate the following:

- honesty in the communication of all data, methodology and findings
- objectivity to remove bias in the design of the research
- integrity to keep to all agreements and strive for consistency
- care in ensuring there are no errors in the findings
- respect for intellectual property, and to honour all **patents** and **copyrights**
- confidentiality to protect the privacy of those who are involved in your research
- ownership of information and potential to share information is transparent.

Like any set of rules or policies, this list does not cover every aspect of ethical research. As the researcher you must always be conscious of behaving in an ethical way and ensuring you will maintain the respect of the reader. Always advise the participants of the purpose of your research and develop a process to ensure the confidentiality of your findings.

When you are developing your research tools (questionnaires, surveys, experimentations and so on), you should always consider the validity of those methods. Qualitative research can sometimes contain personal bias. Quantitative research is considered more objective, though the way in which you collect that data may be biased.

When you are conducting your research to help you develop your ideas, learn from the work of others. However, it is illegal to copy someone else's work and claim it as your own. This is known as plagiarism or academic dishonesty and must be avoided by any ethical researcher. Always acknowledge the sources of information and, if needed, get permission.

patent a legal document granted by the government that gives an inventor exclusive rights to make, use and sell an invention (for a specified period)

copyright legal rights of artistic ownership and integrity, represented by the symbol ©

ACTIVITY 10.5

Mirabella plans to design a range of nightwear that is suitable for people who reside in aged care. Many of them suffer from arthritis and have difficulty in manipulating buttons and zips. In her research plan, she has stated that she will interview 10 people. This research is due to be presented to the teacher and she has only interviewed seven people so far. She decides to make up the final three interviews. Discuss this situation from an ethical perspective. What would you have done in a similar situation?

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CHAPTER SUMMARY

- It is important that a designer is able to use a variety of research methods, which may include questionnaires, interviews, observations and experiments.
- Qualitative research does not provide numerical results, while quantitative research will provide numerical results.
- All research results should be carefully analysed, and clearly communicated.
- Texts and experiments are useful research tools when determining the most appropriate material for your project.
- Authenticity and currency should be considered when obtaining research material from the internet.
- As a researcher, you should behave ethically towards your participants and readers.

CHAPTER SUMMARY TASKS

1. Provide an example from your own research of qualitative research.
2. What is meant by the term ‘quantitative research’? Give an example from your own research.
3. Explain the difference between primary and secondary research.
4. List and describe a range of research methods a designer could use to develop design ideas.
5. Explain why surveys are used by market researchers. How has this changed with technology?
6. Research the many different types of graphs and provide examples to present data.
7. Define the term ‘statistical analysis’.
8. Provide an example to illustrate how to behave ethically.
9. Explain the terms ‘copyright’ and ‘patent’.
10. Define the term ‘plagiarism’ and make reference to intellectual property and how it might impact on research.

EXTENSION TASKS

1. Write a set of guidelines that will promote ethical research and are suitable to be used by Design and Technology students.
2. Explore the Australian Bureau of Statistics (ABS) website. Can you identify a demographic profile of people who may be your target market for a project you have designed? What are some of the characteristics?

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11 Investigating manufacturing and production processes

This chapter explores manufacturing and production processes. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about ...' and the 'Students learn to ...' statements relating to **Outcome P6.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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11.1 Manufacturing and production processes

Understanding the fundamentals of manufacturing and production processes is important to a designer. It is of no value to come up with a concept that has no capacity to be produced or commercially viable. Therefore, it is important to have an understanding of what is feasible within the world of current manufacturing and what requires some technological creative thinking. A designer may need to be involved in developing a new system or technology or using resources in a different way.

Engineers, fashion designers, microbiological researchers, doctors, tradespeople, toolmakers, fitters, scientists, athletes, labourers or machinists may at some stage have important input into certain processes of manufacturing. Making changes or alterations to the processes in which they are involved requires specific understanding of the manipulation of tools and equipment. There may be a crossover between manufacturing processes; for example, where a portable electric saw, once seen as a woodcutting tool only, is modified to perform tasks on multiple materials by changing a blade or changing the action to cut metal, bone or synthetics depending on the user's needs. Manufacturers of tools will work with specialists to refine the equipment and processes.

Designers are part of this process as well. But often the 'designer' is also an engineer, doctor, tradesperson or scientist, and as part of their employment they are required to perform design processes. Smart businesses recognise the value of having qualified specialists who understand design principles.

Fundamentally there are three main categories of manufacturing processes, regardless of material:

1 **Subtractive processes:** This is where processes are applied to the raw material, whereby materials are removed from it in order to achieve its final shape.
2 **Additive processes:** This is where processes are applied to the raw material, whereby materials are added to it in order to achieve its final shape.
3 **Formation and deformation processes:** This is where no material is added or taken away, but the shape is changed by force into a new final shape. This may result in changes to the physical properties of the material.

Figure 11.1 Large gantry structure being assembled for Sydney Roads

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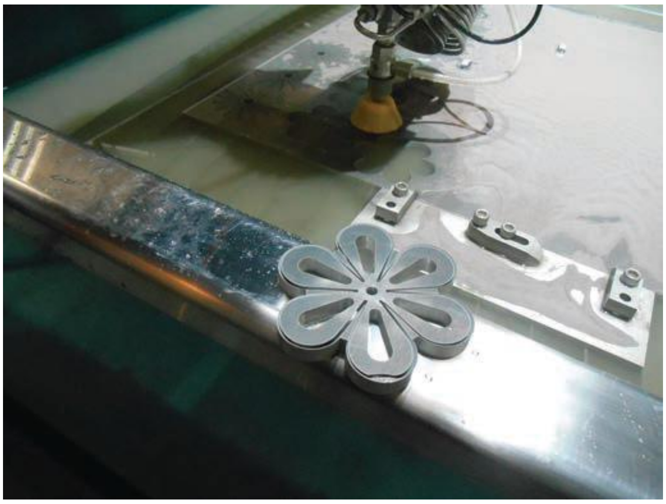

Figure 11.2 Water cutter

Figure 11.3 3D printed examples

Combinations of the processes are used in order to build up complex systems. Very few items are made from one material only and have no movable components. Adding pieces together from the same or differing materials allows a collective function to occur, combining the properties of each of the base materials in order to perform a new higher-order function.

New technologies in the last decade have become increasingly accessible and allowed greater creativity at a lower cost: think 3D printing and how the cost of these machines has reduced significantly. Other examples of technology becoming more common include high-powered water cutting of metals, and laser and ultrasonics used for material removal or cutting. Many of these new technologies are used or supplied by specialised small enterprises. Not so long ago, these were the preserve of universities, research hubs, medical equipment manufacturers, government departments and/or defence contractors. The scaling down (cost and size) of new manufacturing technologies has allowed designers to become more creative in many fields around the globe with new industrial and commercial opportunities. Contract and subcontracting of aspects of a design has become commonplace at all levels of manufacturing, and communications technologies are at the hub of this revolution.

Video

Consider the examples of wheels of differing complexities and manufacturing technologies shown in the gallery on the next page. The technology to produce each wheel was designed and developed together with the design itself, often by a design team, along with the other parts required to work together.

ACTIVITY 11.1

From the pictures of wheels in the gallery on the next page, can you identify the types of processes that might be involved in the manufacturing of these complex shapes? List the processes for each, and categorise the processes as subtractive, additive or deformative. How do the expected value and quality of the finished product affect the types of processes that may be involved or chosen? As designers, we need to be on the lookout for what is possible and feasible. Can you identify the processes you have undertaken on a design project you have completed? Was viability an issue when selecting the processes?

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Figure 11.4 The primitive stone wheel, shaped from solid material

Figure 11.5 Metal wire wheel created from wire welded onto a rolled steel wheel and chrome plated

Figure 11.6 Cast aluminium alloy wheel created with additional parts bent, welded and machined to produce a complex shape

Figure 11.7 This wheel uses a specialised alloy and has the processes of forging, machining, casting and bolting together to be part of a complex machine. Note the degree of machining versus roughcasting. This would be significantly more expensive to produce.

11.2 Manufacturing and production processes in industrial and commercial settings

Video

To be a successful designer, you need to be aware of the limitations and strengths of the technologies you could be using. The properties of those technologies and the way in which materials can be shaped, formed or joined are of vital importance to create a new object using existing materials and technology.

Understanding what these processes are can assist in identifying the most appropriate process for each specific task. Often there is more than one way to undertake a process and there may be a combination of procedures that is required to achieve the finished product.

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COMMON MANUFACTURING PROCESSES

Tables 11.1–11.3 outline many of the common processes found in industrial and commercial settings. The specific details of how each process works can be looked up on the internet or in specific books or reference manuals.

Table 11.1 Additive processes

PROCESS	TOOLS OR EQUIPMENT	MATERIALS MOST COMMONLY APPLIED TO	EXAMPLES OF PROCESS OR PRODUCT
CASTING AND MIXING, DIE-CASTING, SAND CASTING, LOST WAX CASTING	Furnace – heating equipment; moulds for castings; specialist hot work equipment	Polyceramics, concrete, alloys, steel/iron carbon alloys, glass, polymers, composites	Bronze statues, complex shapes requiring machining (e.g. toy cars)
PLATING – ELECTROPLATING, CHROMING, GALVANISING	Chemical tanks/baths for dipping, electrical current equipment; specialist equipment as per equipment manufacturer	Metals, some polymers and ceramics	Cutlery, vehicle headlight reflectors
PAINTING – SPRAY, BRUSH, ROLLER, ELECTROSTATIC	Spray, pneumatic compressors, brushes, rollers; specialist equipment as per equipment manufacturer	Most materials can be painted, depending on the type of finish or effect required	Furniture, toys, cars, bikes
IMPREGNATING, DOPING (SEE HYDROGEN GAS BALLOON FOR HISTORICAL CONTEXT); CAN BE DONE WITH HEAT OR PRESSURE	Specialist equipment as per equipment manufacturer	Impregnating a chemical to another material to create new properties – usually a liquid into a solid, or melting a solid to become liquid; wax paper, fabrics, timbers	Canvas, fabric (e.g. ship sails); now common with electrical components such as LEDs
SEWING, STITCHING	Sewing machines, overlockers	Textiles, leather, polymers that can be threaded	Clothing, sails, curtains, furniture, shoes
KNITTING, WEAVING, SPINNING, FELTING, MATTING	Specialist machines built to undertake tasks include looms and mechanical spinning equipment	Textiles, polymers, natural or synthetic fibres; any material that is flexible enough	Clothing, towels, linen, upholstery
GLUING OR ADHESIVE, USING CHEMICAL OR MECHANICAL BONDING	Chemical bonding agents; clamping devices. Can use heat or microwave radiation as part of curing process. Other specialist equipment can be found as developer of product will design specific equipment to match process.	Most materials can be joined with an adhesive; permanency and durability are limitations	Household items, mobile phones, garden tools
WELDING AND BRAZING – MIG, TIG, SILVER SOLDER, SOLDERING	Welding equipment, MIG/TIG/electrical current devices can be general purpose or specialised. Heating equipment can use a variety of fuels including LPG/NG/acetylene/coal seam gas. Storage and supply of these is specific.	Any material that can be bonded with heat and a filler material added	Machinery, ships, bridges, factories
CHEMICAL BONDING	Chemical storage and application equipment may require ventilation and risk minimisation equipment such as PPE.	Most materials	Fuel tanks, TVs, circuit boards
3D PRINTING	Specialist 3D printers; software. Specific equipment can be dependent on material to be printed. May include laser or frequency-based technology.	Originally just polymers, now a range of metal and non-metal techniques have been developed	Small plastic parts, prototypes. Building up of specialist shapes that could not be done in any other way or location.
NANOTECHNOLOGY	Laboratory and manufacturing technology will be specific and often developed and owned by the designer's companies or developed with specialist research facilities.	Microtechnology; changing the way items are made or function	Engineering, medical

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Table 11.1 (*Continued*)

PROCESS	TOOLS OR EQUIPMENT	MATERIALS MOST COMMONLY APPLIED TO	EXAMPLES OF PROCESS OR PRODUCT
SYNTHETIC GROWING	Laboratory and manufacturing technology will be specific and often developed and owned by the designer's companies or developed with specialist research facilities.	Chemical growth of synthetic items	Engineering, medical
BIOTECHNOLOGY, BIOENGINEERING	Laboratory and manufacturing technology will be specific and often developed and owned by the designer's companies or developed with specialist research facilities.	Growing organic materials with synthetic engineered components	Medical – spray-on skin tissue
FRENCH POLISH	Hand process – cloth, shellac, methylated spirits, etc.	Most hard materials	Painted surfaces to retain shine
SINTERING – HEAT AND PRESSURE TO CHANGE PROPERTIES	Heat and pressure tools. Material often needs to be ground into powder first, specific to materials.	Metals, ceramics	Brake pads, abrasives
GENETIC MODIFICATION	Laboratory and manufacturing technology will be specific and often developed and owned by the designer's companies or developed with specialist research facilities.	Organic and chemical processes to change properties of a living organism	Crops, livestock
DYEING	Fabric and chemicals. Specific dyes used, dependent upon material.	Fabric, fibre, leather, timber, synthetics	Most fabrics, clothing
LAMINATING, PRESSING – EMBOSSING	Presses, specialist equipment dependent upon materials	Hard or soft materials – timber, leather, vinyl	Paper, sheet manufacturers, furniture, kitchens
FIBREGLASS, CARBON FIBRE, RESIN – TWO-PACK CHEMICAL REACTION	Chemical process requiring PPE and ventilation equipment. Brushes, sprays often used to hand lay to matt and apply resin in complex shapes.	Glass/carbon fibre strand/matt – chopped or weave; built-up with layers	Boats, motorcycles, swimming pools
MECHANICAL FASTENING – SCREWS, RIVETS, BOLTS, NAILS, ZIPPERS, CLIPS, ETC.	Hand or machine tools used to press, screw or force fasten together. Think of hand screwdrivers and hammers that may be applied in a machine as well.	Most materials, dependent on specific fastening device	Clothing, wood/metal items; any complex machine

Table 11.2 Subtractive processes

PROCESS	TOOLS OR EQUIPMENT	MATERIALS MOST COMMONLY APPLIED TO	EXAMPLES OF PROCESS OR PRODUCT
MECHANICAL CUTTING – HAND OR MACHINE	Blade tools such as knives, shears, scissors, guillotine, saws, planes, chisels, scrapers, peelers	Textiles, materials – wood, metals, plastics, composites; tool is dependent on thickness of material	Clothing making, fabrics, timber furniture, sheet materials
MECHANICAL MACHINING – MILLING, DRILLING, BORING, PLANING, ROUTING, GRINDING, CHIPPING, ENGRAVING	Lathes, milling machines, 5-axis machines, boring, bridgeporting, slotting machines, grinders	Wood, metals, plastics, composites; any material hard enough to be cut with blade or abrasive device	Most machines with moving parts – cars, bikes, trucks, engines
HIGH ENERGY, CUTTING, SHAPING, MANIPULATION, HEAT/ COOLING-PROPERTY STRUCTURE CHANGING	Laser, ultrasound, electrical conduction heating, water jets, sonic cutting, microwave	Metals, stainless steel, titanium, stainless	Stainless steel signs, bullbars, surgical instruments, engine crankshafts in high performance applications – F1 racing cars

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Table 11.3 Formation/deformation processes

PROCESS	TOOLS OR EQUIPMENT	MATERIALS MOST COMMONLY APPLIED TO	EXAMPLES OF PROCESS OR PRODUCT
FORGING OR DROP FORGING BY PRESSING, COMPRESSION OR SHOCK; CAN BE WITH HEAT, DEPENDING ON MATERIAL. METAL SPINNING WITH PRESSURE IS A FORM OF FORGING WHILE ROTATING METAL TO SPREAD THE PRESSURE	Specialist equipment as per equipment manufacturer. Hammers – hand and mechanical. Anvils and dies may be used.	Metals, manufactured materials	Automotive suspension parts, spanners, sockets. Metal spinning of disc shapes from sheet materials.
BENDING AND NECKING – PRESSURE APPLIED WITH OR WITHOUT USING HEAT	Specialist equipment as per equipment manufacturer. Pan brake, magna bend, bending bars.	Metals, polymers, timbers, synthetics	Push-bike frames, prams, garden furniture
ROLLING – HOT OR COLD; MATERIAL DEPENDENT ON PROPERTIES REQUIRED	Specialist equipment as per equipment manufacturer. Rollers and presses.	Metals, polymers, timbers, synthetics	Engineered parts of machines
BLOW MOULDING, VACUUM FORMING, CENTRIFUGAL MOULDING	Specialist equipment as per equipment manufacturer. Vacuum equipment and moulds. Varies upon material.	Polymers – thermo softening	Curved signs and windows
INJECTION MOULDING	Specialist equipment as per equipment manufacturer. Varies upon specific material. Often used with heating polymer to liquid state first.	Polymers	Bumper bars of cars, motorcycle fairings
EXTRUSION	Specialist equipment as per equipment manufacturer. Heating equipment often required. Often used with heating metals/polymer to pliable state first.	Metals, plastics	Shower screen aluminium frames
FOLDING	Specialist equipment as per equipment manufacturer. Bending bars, magna bend, pan brake, etc. Dependent upon material.	Paper, textiles, metals, synthetics, any thin material	Paper, thin sheet materials
HEATING, COOLING, MELTING, BURNING – CHANGING THE PROPERTIES OF THE MATERIAL BASED ON TEMPERATURE; CAN INVOLVE OTHER MATERIAL TO HARDEN OR TEMPER	Hot working equipment relying on fuel or electrical current. These can vary in size from small furnaces to massive specialist workshops.	Metals, textiles, polymers, synthetics, engineered products that may require changes to properties or state (solid, liquid, gas); can change crystalline structure of material	Metal tools, hammers, axes, spades
APPLYING EXTERNAL FORCES – PRESSING, STRETCHING, COMPRESSION OR TENSION TO CHANGE SHAPE	Specialist tools used often with mechanical assistance (e.g. hydraulic rams).	Metals, polymers, textiles	Tubing used in furniture
BURNISH – RUBBING ONE MATERIAL AGAINST ANOTHER TO CHANGE THE SURFACE PROPERTIES	Hand process applying a material with pressure to moving surface or by moving the material fast (buffing) onto product. PPE required.	Textiles, wood, leather	Leather belts, handbags

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ACTIVITY 11.2

Using Tables 11.1–11.3, conduct an audit of the production resources available in your school. Create a table to identify what the processes are and what tools and equipment might be available. Describe how these resources could be used to benefit a design project you have completed.

COMMERCIAL PRODUCTION

Commercial production covers the full range of production strategies from **custom products** produced manually (with highly skilled, often qualified and experienced labour) to mass-produced objects that are manufactured by the thousands (which may be done with low-skilled labour through to high-tech automated machinery). Whether a producer is a large or a small organisation, they need to determine the scale of the production suitable for their needs and the market. The scale of the production is one that allows efficient use of technology to produce the number of products in volume required at a cost that is competitive. Unit cost per item is often referred to when making comparisons between methods and products. In the 2014 and 2019 case studies at HSV, this was a consideration for many parts as the cost of tooling and batch production needed to be balanced with the quantities to be made and the quality of parts. The balance in labour versus tooling for processing specialised parts needed to make economic sense.

custom product product produced manually by an experienced, highly skilled and qualified labourer

3D printing the building of physical models directly from computer-aided design (CAD) data

automation mechanical controlling of machinery for speed and accuracy

A designer who uses recycled materials may find it difficult to create identical items due to variations in the materials being supplied and the recycling aspects. That would mean that the raw materials going into the design would need to be of consistent quality. A designer of one-off pieces would find this easier than one who wanted to replicate each piece.

One-off or custom production: This is where a special order is placed, and the production processes are specifically tailored to meet the individual needs of the client. Usually this type of manufacturing produces individual, unique products. This can often be seen as prototyping. This is where the designers spend time developing the first one to get it right before proceeding to further manufacturing. **3D printing** is good for this process for small items. With large, complex, expensive designs, you may have heard the term 'commissioned to design' a building, structure or major project, where engineering, building and architectural companies compete for the design and are required to tender for its development.

Small-scale production, batch production and job lot production, with limited quantities and small variations in each product: These types of manufacturing may require jigs and templates that allow the reproduction of tasks without the expense of new tools and moulds. This enables more specialised use of labour, increased **automation** and lower costs. Complex parts may be sub-assembled or pre-assembled using existing parts that are already available (using standard nuts, bolts, fittings from other designs and so on is common) and there may be some automation or mechanisation and/or skilled labour.

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Figure 11.8 Methods of production such as a potter's wheel may produce unique work; but prove ineffective in mass production.

Mass production: This refers to the production of large quantities of similar goods with minor variations. The concept and processes of mass production, such as mechanisation and specialisation, were mainly developed in England during the **Industrial Revolution**. The final step in the development of modern mass production was standardisation, where all parts for a particular function are made identical, allowing them to be interchangeable. Mass production can require expensive tooling up if large quantities are to be produced. This costs money and time and the more items produced from the same production line often bring economies of scale in bringing the cost per unit price down.

Industrial Revolution the transition to new large-scale manufacturing; paved the way for mass production

The scale of production and the techniques used must be considered by the designer and often are developed while designing.

Figures 11.9 Recycling materials for new design

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CASE STUDY 11.1

HSV new business model

In February 2020, General Motors announced that the Holden brand would be retired in Australia by the end of 2020. Case studies featuring HSV relate to the manufacturer's practices prior to this.

Holden Special Vehicle (HSV) is a premium Australian car manufacturer, specialising in performance vehicles that automotive enthusiasts want to own and drive. HSV has been designing and producing performance cars since 1988 to meet a specific market in Australia. This target market saw the company grow from small beginnings to being exported around the world.

Prior to 2017, HSV used a strategic relationship with General Motors Holden as a key part of their production process. The core HSV vehicle was built by the Holden vehicle assembly plant (VAP) in Elizabeth, South Australia and supplied as a complete running car to the HSV manufacturing facility in Clayton, Victoria. It then went through a 13-station process to transform it into a HSV. The reason for this split production was that many of the additions HSV carried out could not be packaged into the initial Holden VAP build.

This process is discussed in detail in the additional case study, which can be found in the interactive textbook.

On 20 October 2017, Holden ceased operations in Australia and closed their factory. Rather than closing their business, HSV evolved from a value-added producer of cars to a company that converts products not available in Australia into products that fill a gap in the market. HSV's business model was based on an Australian designed and made platform that was made by Holden. Post 2017, this option was not available. The details of HSV's pre-2017 operation is available in the interactive textbook.

HSV has over 300 staff and four product lines of manufacturing. Operations include:

- cosmetic and minor performance upgrades to the Holden Colorado to become the SportsCat
- full left-hand drive to right-hand drive conversions of the Silverado and Camaro
- contract conversions for the Dodge RAM and Golf Clubs under the Walkinshaw brand produced by the parent company Walkinshaw.

The diversity of talent within the organisation proved adaptable to the changing market conditions and the ceasing of productions of the Commodore in Australia. As the partnership with Holden Australia ceased, the company became a full importer of global vehicles.

Figure 11.10 The 'remanufacturing' process requires a full strip-down of the Silverado to allow a fully integrated factory conversion from left- to right-hand drive, with over 300 parts either custom designed and/or remanufactured in Australia by HSV.

Figure 11.11 The finished product: Silverado after full conversion from left- to right-hand drive in Australia by HSV

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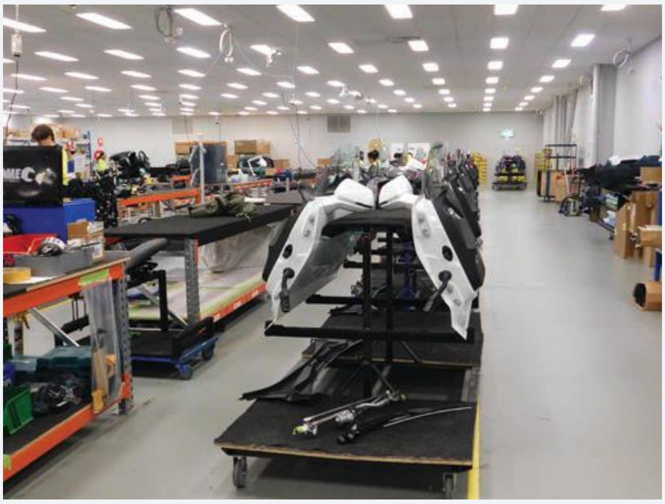
Accessing global product lines from the parent company General Motors allowed HSV to look at the market opportunities in Australia and develop a business case for the business to be successful. It took a significant amount of work by engineers and designers to develop systems and processes to convert these vehicles from left-hand drive to right-hand drive to meet the current legislative requirements for a vehicle to be sold in this country, and as such HSV has gained manufacturer status.

This required engineers to design over 300 parts for each vehicle and in most cases reusing significant numbers of small components inside larger ones, which are stripped down and remade to suit. Examples include the seat fabric and shells that need to be stripped so that the controls and sensors are on the correct side.

Lots of little things need to be changed for full conversion from left- to right-hand drive. Many of these processes require a mix of manual labour and mechanised work. Each process is carefully developed with the cost versus consistency of end product quality, which is developed to suit the production quantities required. Developing specialised tooling costs money but can be offset by longer production quantities. Every step of the remanufacturing process and each part needs to be considered by the design teams.




Figures 11.12 and **11.13** The Camaro door trim needs to be stripped and remanufactured with controls on the correct side of the finished product.


Figures 11.14 and **11.15** Dash assembly before and after the whole unit is inserted into the car. The small parts are removed from the original dashboard and relocated to the new one, which is manufactured in Australia using parts from suppliers who were part of the supply chain for the Australian car industry prior to the plants being shut in 2017. By using quality suppliers, HSV is able to ensure their final product matches global standards. Left- to right-hand drive in Australia by HSV is more than just the steering wheel.

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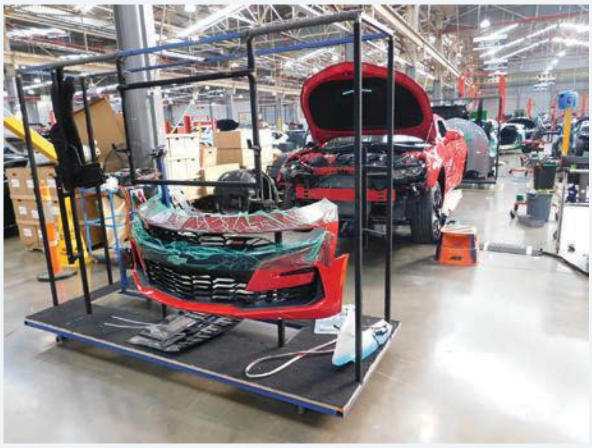

Figures 11.16 and **11.17** The disassembly and assembly process for the Camaro requires each part, and the jigs to hold each part, to be designed by the designers and engineers. Often these production tools are developed with the production teams and can be modified for more efficient processes when systems change. It is important for designers to not just consider the parts being designed, but how they are going to ensure the manufacturing occurs.

The steering units need to be housed in new casing designed by HSV to fit on the correct side. In each case, the vehicles are stripped down and the remanufacturing and re-assembly takes place to factory standards. Many of the suppliers of new parts are Australian and this contributes to employment. Each of these parts and processes needs to be designed and the systems to undertake the tasks developed. Lots of testing and prototypes of each operation are undertaken. Many tasks are a combination of human-controlled activities along with mechanisation and clever thinking, not to mention the calibration, testing and integration into the computer systems of the car.

The redesign and manufacture of so many significant components in the Camaro and Silverado has resulted in full HSV warranty of the vehicle.

In 2019, author Michael McLean (MM) interviewed Andrew Purcell (AP), Manager Customer Care Technical Liaison HSV:

MM: When talking about the design of the components for the conversion process is each part assigned an engineer to develop or are teams involved in the development of each system within the vehicle, for example, the steering parts? How is this process organised?

Figures 11.18 and **11.19** Each part needs to be tested and can be attached to a testing jig. Electronics are complex in a modern vehicle and testing the hardware before assembly can save effort later when the vehicle is completed. Ongoing testing at each stage of manufacturing ensures faults are not compounded and are resolved at the correct stages. Jigs such as those below can be used not just for the manufacturing, but as part of the testing processes.

AP: There are six groups (SMT's Systems Management Teams) all with lead engineers. **Powertrain**, chassis, body, interior, electrical, and aftersales. Each part is allocated to a lead engineer who then allocates it to an engineer/s within his group. Progress is then tracked at model-specific SMT meetings (weekly) where the heads of each SMT discuss where they are at within the program. Starting with long lead time parts and getting down to short lead time parts.

MM: This shift to having functionality being the emphasis in much of the current processes. Has this changed the roles in the pre-preproduction activities and in the manufacturing activities? Most of the operation is about getting the conversion right and not about changing the original performance or aesthetics. As you are aware this is largely the hidden design work that makes the current HSV activities different to the old production enhancements from Holden's base products.

AP: Yes, we used to rely on a management body named 'Product Group' to sign off on aesthetic and mechanical changes. This role would be somewhat rolled back to a 'choose a model to import' role now. There is less input from design (clay modelling etc.) and more emphasis on direct engineering.

Future designers need to be able to understand the existing products and manufacturing capabilities that are available to the market in order to plan for future design needs. Developing new products which include new technologies that build upon existing knowledge improves the chances of commercial success and can lead to ongoing growth of a business.

Note in Figure 11.17 the process of a production line with many stations undertaking specific processes. These processes include many additive and subtractive technologies such as cutting and welding of metals. Each station has specialists who are trained in each process. The team that does the cutting and welding of the floorplan of the vehicle is different to the team responsible for the dashboard insertion.

Many other activities in the production process by HSV have not changed since 2014 and the preparation for the final testing and calibration prior to sending the vehicles to the dealer and/or customers has evolved. With online brand recognition being critical to the future of vehicle sales, HSV has an active website with up-to-date information. This is the way of the future for designers and engineering businesses to ensure and explore global success.

powertrain the mechanism that transmits the drive from the engine of a vehicle to its axle

Figure 11.20 The steering box in the Silverado requires significant redesign to fit when converting to right-hand drive as the engineering to move parts from one side to the other is not simple. HSV engineers look at the housing location and design a way that the internal parts can be stripped out of the original box and re-assembled into the new one, so that no change in the performance of the vehicle takes place. This solution ensures that the engine and balance of the vehicle remains as per the original engineering. Clever design ensures full warranty support can be provided for peace of mind for the customer.

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Figures 11.21, 11.22 and **11.23** Stages of the left- to right-hand drive conversion process for a Camaro by HSV in Australia

ACTIVITY 11.3

Video

List the design projects you have undertaken to date and identify the processes you used. Describe the procedure you followed and make comparisons with the steps in a stations-based production process approach like that used by HSV (outlined in the additional case study). What are the similarities in breaking down the tasks? Did you undertake sub-assembly of minor components prior to final assembly? What changes did you make when fitting parts together? How would this change if you were to mass produce your project?

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MANUFACTURING PROCESSES

Manufacturing of products can be achieved through a variety of basic processes. Processes that use heat, for example, are forging, rolling, casting metals or extrusion, calendering or blow moulding. The materials can be physically changed in shape by cutting, machining and bending. Products can be fabricated by joining materials by melting them together or physically joining using adhesives, rivets, sewing or staples. Manufacturing can involve the final assembly of complex components with many moving parts. It is essential that when designing and manufacturing, you consider the specifications and properties of each material before undertaking the process of making.

ACTIVITY 11.4

Answer the following four questions about the manufacturing process to help you select the most appropriate process for your current design project.

1 What is the material?
2 What is the shape?
3 Will any finishing processes be used?
4 What quantities are involved?

CASE STUDY 11.2

Manufacturing technology used by TSA engineering

The laser cutter (Figure 11.24) is a high-speed machine that is 10 times faster than plasma cutting machines and far more accurate. Only one operator is required when manufacturing. The machine can be programmed to cut up to 30 mm steel plate.

The laser cutter operator is protected inside a booth (Figure 11.25). Work health and safety when using specialist processes is part of the design of the machinery as well.

Figure 11.24 A laser cutter

Figure 11.25 A protective booth for laser cutting operations

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Programming the laser cutter (Figure 11.26) requires great skill in being able to interpret the CAD drawings into machine code suitable for computer-aided manufacturing (CAM).

Machines like the drill press shown in Figure 11.27 are found in industry as well as in school workshops. They are an important part of manufacturing when small production numbers are required, or a one-off prototype is constructed (Figure 11.28).

Specialist folding machines (Figure 11.29) require the operator to set up the machine before each job. This changing of settings can take time, but is necessary to ensure accuracy of production, especially if parts are to fit together.

Figure 11.26 Coding the laser cutter

Figure 11.27 A drill press

Figure 11.28 Custom production

Figure 11.29 A folding machine being operated

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ACTIVITY 11.5

Identify some industries in your local area that undertake one-off, low-volume and mass production. Compare the work done in each organisation, their level of automation and the type of products they produce. If industry is not available in your area, consider a known industry and make enquiries via the internet.

COMPUTER-AIDED MANUFACTURING

Computer-aided manufacturing is a current technology in the automation process. It uses computers to control the machinery in the workshop. Because the computer program that drives the machinery is much easier to control and change than a mechanical device, the CAM process is much more flexible and able to produce a wider range of goods and improve efficiency. In most cases, the CAM system will work with the CAD system, made in a 3D environment, to manufacture the product the designer has developed on the computer.

FLEXIBLE MANUFACTURING SYSTEM

One of the great advantages of the CAM system is the speed with which machinery can be altered to produce different goods. Mechanical systems have usually been set up to produce a large quantity of products in a single run. The time and cost involved in changing the machinery means that producing small numbers of products to meet special demand is not economical. CAM production systems allow a quick, low-cost alternative. Often a simple change in the program controlling the equipment is all that is necessary to change from producing one article to a different one.

The application of flexible manufacturing systems has been evolving for some time and continues to do so. The huge impact of the 3D printer in this area of design and prototyping has extended to small batch productions and also to specific products being produced by individuals as well as small businesses. The global uptake of 3D printing technology in areas such as defence, medicine, science and backyard hobbies is due to the lower cost of the technology, which has stood out as the revolution in flexible manufacturing. Collaboration across the globe by sharing code for 3D printing has allowed designers to access markets and be more adaptable to specific product needs. The use of this technology is seen as a significant way of being able to solve the need of a product on site and in remote locations. This has been and is seen as crucial technology for future long-distance space travel where shipping of replacement parts is not going to be feasible. The materials being used to print in 3D have expanded from polymers to complex multi-process printing using metals and organics. This printing ranges from complex metal parts that are then sintered (heat-treated) for engineering strength to cake decorations that are edible and specific to an occasion. This technology is already available in some schools and is becoming increasingly the technology to use for flexible manufacturing for many future products. The designers of the future do not have to freight the prototype or products; they can just send the 'coding' for an item to the customer to print. This is a significant shift in not just the way we think of product ownership and quality of manufacturing, but also who owns the intellectual property for the product design.

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11.3 Developing appropriate skills and techniques

In production environments such as industry and schools a variety of methods are used to manipulate materials and change them into products. Depending on the product and the type of material being used, the selection of the forming process must be based on sound research and experimentation. There are thousands of processes to choose from. You will need to undertake research on the specific processes suitable for your design projects.

QUALITY PRODUCTION SKILLS

When working as a designer and manufacturer, you must ensure that your work is of an appropriate quality for the project. Everyone should aim to excel and produce faultless work. Factors such as time, cost, availability of resources and skill development can all hinder the pursuit of excellence. The intended use of a product can also be a factor in the level of quality required for a finished product. Using checks at specific stages of production can often prevent errors late in the manufacturing process. Developing a system of quality checks is common in manufacturing and can be useful in developing your project through to the standards you expect.

The quality of a garment produced to be worn at special functions would be very different from the quality of a garment designed for a single costume party. The quality of a prototype would be very different from the quality of a product you intend to become a family heirloom (to last several generations). The term 'quality' is a subjective one. Different people have different expectations of quality. It is important that you decide what quality will mean for your design projects, define a level of quality that will result in a functional aesthetic for your project and explain this in your folio.

When deciding on the appropriate quality for your project, always aim high – a project that is better than it needs to be is desirable over one that fails to satisfy its design parameters because of poor quality.

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CHAPTER SUMMARY

- When designing and making products at school, the processes can be limited by the availability of resources, technology and your skills. When you design products, you should endeavour to fully utilise the facilities within your school, your own skills and the time available for the project. If a process is unavailable to you within the school, you may engage with specialists to undertake specific tasks. (Remember to acknowledge their contribution.)
- Society expects manufacturing to be sustainable and environmentally appropriate; to use minimal resources and produce minimal waste products and environmental harm. Consumers also want ethical products that respect people in the production of a product.
- The process used to manufacture a product as a result of a design process must be appropriate to the needs of the designer, producer, consumer and society.
- The aim of every Design and Technology student should be to excel and produce work that meets the specifications of the design brief. Factors such as time, cost, availability of resources and skill development can all hinder the pursuit of excellence.
- Manufacturing enterprises usually employ people who are experts and qualified in a field who can also design solutions that can be manufactured and are also prepared to develop the technology required along with the actual designs.

CHAPTER SUMMARY TASKS

1. Describe how a project you have completed could have been done on a larger scale in industry. Create a table to compare and contrast the two work methods.
2. Describe the use of industrial or commercial practices you have used in design projects and justify your choice.
3. Waste minimisation is an important consideration in industry, both to reduce resource use and increase efficiency. Describe the processes that you follow in the design and production of your projects that lead to reduced waste.
4. Analyse the processes you follow in the design and production processes to ensure appropriate quality for your final product.
5. Work health and safety is an important consideration in any design project. What must be considered before introducing a new or changed technology into a production process?
6. Synthetic materials are widely used in industry today. Compare the effect of natural and synthetic materials on the individual, society and the environment.
7. Make a list of 10 common items at school or at home and research them to identify the industrial processes used to produce each one.
8. The use of computer-aided manufacturing has not only improved production efficiency, but also made many other processes more flexible and responsive to consumer demands. How is this possible?
9. The concept of quality is subjective. How do you define the quality necessary to meet the requirements of your project? How does this compare to the concept of quality in a commercial venture?

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10 High-technology and mass-production industries produce the bulk of their products at high efficiency and low cost. However, there is still a large market for one-off or low-volume production items. What attributes do these products have that make them able to compete successfully against cheaper products?

EXTENSION TASKS

1 Identify an industry in which you are interested and produce a study of how changes in the technology involved have impacted on that industry. You might like to consider issues such as:
- efficiency
- production
- design
- employment
- management.

2 How has the global economy impacted on the manufacture of goods today compared with 20 years ago, 50 years ago and 100 years ago? As Australians, what would you expect the nation could do to encourage greater design and manufacturing in this country?

3 What has changed in the last 10 years of design and manufacturing in Australia? Discuss this. An example could include the closure of significant manufacturing in the automotive industries. Ford, Holden and Toyota car production plants have closed in Australia. How has this impacted the greater economy (job losses is the easy one – discuss the knock-on effect)? How have whole communities been impacted by the globalisation and competition in designing and manufacturing in this country?

4 Discuss how HSV evolved its business model to adapt to the changing global and local market. Are there any other examples of manufacturing industries in Australia and globally you can identify?

Figure 11.30 Chess metal removal

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12 Computer-based technologies in designing and producing

This chapter explores computer-based technologies in designing and producing. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome P6.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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12.1 Computer-based technologies and design

Computer-based technologies and digital devices have influenced the way in which designers design and produce. Computer-based technologies may be used at every stage of a design process including research, experimenting, prototyping, project management, and manufacturing of the final product, system or environment. As you witness this explosion of computer-based devices, you must also be aware that gadgetry alone is of little benefit. It is the people who drive the technologies that are most important. It is the designer, not the computer, who is able to consider the impact of developments on the individual, society and the environment. Designers are often heavily reliant on computer-based technologies because they allow them to work flexibly and efficiently.

Today computer technologies may also be the final solution for a design process. The information technology explosion has made available technology with tremendous potential to enhance communications efficiency and effectiveness into all aspects of daily life. Designers are creating more and more devices or software to solve a myriad of problems and make life easier for the average person. Miniaturisation has led to the design of watches that include computerised data, monitoring of exercise, storing of health information, calling emergency services and much more. New programs have been designed to allow police to build profiles of criminals; robots are used to defuse bombs; drones are computerised and used to monitor surfers and check for sharks; and a voice activated speaker for your home allows you to control your various devices. Developments in artificial intelligence have enabled the design of smart machines capable of performing tasks that typically require human intelligence. Engineers and designers continue to develop new technologies and enhance older technologies. Computer industries are among the largest and rapidly expanding industries, and this area is continually changing. No textbook will be able to provide you with current developments, and so this is an area that as a design student you should do continual research to find the latest technology you may be able to use, or look for new developments that you can take advantage of in your project work.

We live in a digital economy and cannot escape its impact, no matter what our occupation. This digital economy can be described as the global network of economic and social activities that are enabled by information and communication technologies such as the internet, mobile and sensor networks. The technologies of infrastructure, smart technologies and digital communities impact on the development of these economic and social networks and, consequently, on the life and work of designers. While much research and development focuses on improving the physical performance of these networks, wireless technologies and home network technologies will continue to provide mobility and cost-effective solutions for improved user access. Smartphones are expected to continue to drive future growth in mobile traffic, service carriage and application developments. The concept of cloud computing, sharing computing services and storage over the internet will no doubt continue to expand and provide designers of the future greater opportunities for real-time collaboration.

Sentient tools are intelligent tools that are aware and can make sense of their surroundings. It is predicted that they will affect nearly every industry, emerging from a base of computational, sensing and communications technologies that have been advanced over the years. Within this increase in information resources, sustainability concerns drive smart application development. The applications development community in itself is a significant player in the area of communications and media.

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The level of complexity in the area of digital development makes it difficult to predict the technologies that will be available for your use in the future. There is no doubt that the rapid pace of emerging technologies and their adoption will continue to shape and inform our lives at all levels of interaction.

As a designer, you will make many decisions about which digital technologies to use in your work. Your choices may be determined by your own personal access to the myriad of digital technologies available. The challenge is to choose the most appropriate technologies that will enable you to realise your project in the most creative and effective way possible. It is not always simple to decide which computer or software is most appropriate, and at times the choice is based on what is available. Sometimes a design may be inspired by the capabilities of a particular digital technology.

Different types of computers have their own strengths. Computers and their hardware are run through a range of operating systems, such as Microsoft Windows, Mac OS and Linux, which act as an interface and host a range of software, typically performing such tasks as memory allocation, job scheduling and input/output control. Your smartphone runs an operating system too – probably Apple's iOS or Google's Android. Servers, like those that host the websites you visit or the videos you watch, typically run a specialised operating system designed and optimised to run the software required. Software ranges in function from the simplest word processing and graphics programs to presentation and voice recognition software. We can design our own apps with app development software. We can make a high-quality video or create our own website with little knowledge of coding but access to the right software.

Improved information technology has greatly expanded our capacity to integrate various media as well as the choice of delivery mediums. Today it is common to store digital data 'in the cloud', where the information is basically kept on someone else's collection of hard drives. By using an internet connection, you can connect to a service that has the architecture and software to manage any task or storage requirement. Many large companies (Google, Microsoft, Apple, Amazon) offer such storage services but these can be expensive. There are also companies that focus entirely on cloud storage – Dropbox, for example. The advantage of cloud computing is that it eliminates the difficulty and expense of maintaining, upgrading and scaling your own computer hardware and software while increasing efficiency, speed and resources.

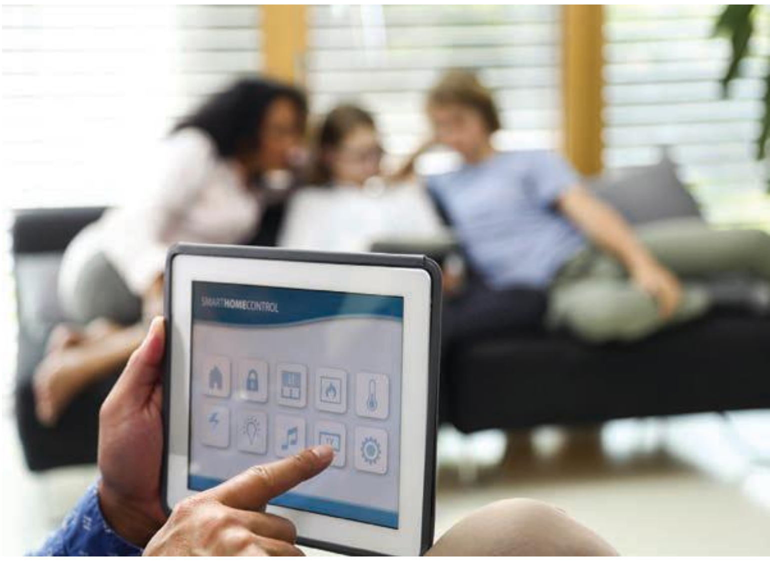

Figure 12.1 'Smart homes' continue to provide mobility and cost-effective solutions for improved user access.

Digital identity management is at the core of information processes that support communication and is an issue that you must consider in your use of information and communication technologies. Your school will control and manage identity data at the school level, but you will need to ensure that you have appropriate processes in place for your personal devices and home network. As online and web-based opportunities continue to grow, the issue of identity management will become more complex. Security in computer use will continue to pose problems at all levels of society. Malware and

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viruses have been known to viciously attack personal equipment, but international espionage security, data theft security and protection of our electrical grids, water systems and nuclear reactors pose further issues. In our increasingly internet-connected world, cyber security has become a priority and we do all we can to ensure sensitive data and networks are secure.

ACTIVITY 12.1

Outline each of the following developments in computer technology. Alternatively, you can choose five other developments that are of particular interest to you to outline.

1. Advanced artificial intelligence
2. Quantum cryptography
3. Big data
4. Augmented reality
5. Machine learning

12.2 The application of computer-based technologies

MODELLING

Mathematical modelling, using theoretical data and formulae, has long been a valuable tool for designers. Computers have now sped up that process for designers. Computer modelling is a powerful tool that has developed as rapidly as the computer hardware it uses. A computer's calculation capabilities have even progressed beyond human capabilities.

A designer may use computer modelling techniques to make predictions about costing or material changes in a project. Modelling may be used to predict the consequences of a new transport system or the environmental impact of a new development. Computer analysts are able to input a range of data to represent different scenarios and analyse the results. They design information systems solutions to enable organisations to operate more efficiently and effectively, as well as making predictions based on certain criteria. Computer modelling is used in the decision-making process.

Another form of computer modelling is the use of 3D modelling software to generate a three-dimensional graphic of a design on screen. Unlike a hand-drawn sketch, the computer model can be rotated and viewed from different angles.

Computer-aided design (CAD) software allows you to develop a design concept in one piece or a detailed model in parts that can be assembled on screen as you would the real object. It can have moving parts and reproduce the movement of the real product. It helps the designer and the client to visualise the end product in 3D form.

CAD software, such as AutoCAD, Trimble SketchUp or FreeCAD, enables you to undertake design testing without the need for time-consuming model-making. Design changes can be made and carried out very quickly and easily when problems are encountered along the way.

This technology caters for 3D printing or rapid prototyping systems. Designers can produce the 3D design on their computer and then make the design in a polymer material using computer-aided manufacturing (CAM) technologies. The solid form

ACTIVITY 12.2

Describe the benefits to the designer, producers and client of using computer-based modelling. Support your discussion with examples.

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is reproduced by laying down (printing) a series of layers of the polymer.

The process of designing an article from an initial idea to a solid, 3D reproduction originally took many months and required input from a range of skilled tradespeople. These computer technologies now mean that the process can be achieved in a few hours by a single designer. Designers can then try out a number of concepts at a 3D prototype stage before committing too many resources to a final production version. This can be a very cost-efficient and time-effective process for the designer.

Computer-aided manufacturing facilities allow a software engineer to program a computer to produce a specific part. The production process is driven completely by the computer with minimal human intervention. This allows the designer to have total control of the design of the finished product without having the skills to produce the item by hand to the required accuracy. It also allows identical multiple items, such as table legs, to be reproduced perfectly time after time.

It is predicted that 3D printing could change practical methods of mass production. If widely adopted, manufacturers would not need to maintain large inventories – they could simply print an object, such as a part for a car, whenever someone needs it. Large factories that mass produce a limited range of parts may be replaced by smaller ones that make a wider variety, thus adapting to consumers' changing needs. The 3D printing method for creating stainless steel parts, twice as strong as traditionally made ones and so much faster, means greater changes in the future.

A further development that is emerging is called 4D printing because the time dimension is added; that is, the object changes shape over time after it has been printed from a 3D printer. This technology is paving the way for smart materials that can change shape by themselves when they come in contact with stimuli such as water or heat. By using a scan of a customer's body, a dress could be designed to fit perfectly. A computer model would then compress the design into the smallest possible space to fit inside a normal 3D printer. The customer would simply download the design, print it and unfurl it! What future can you see for this technology in design and production processes?

Figure 12.2 A computer model in 3D

Video

RESEARCH

Good research is fundamental in a successful design. Electronic and online resources provide a faster, wider and more up-to-date range of references. With access to the internet you have a huge amount of information at your fingertips. You are able to:

- gather statistics about a range of topics
- examine the work of other designers
- gather data about different materials
- access databases and encyclopaedias
- read newspapers and current research articles
- communicate with designers, producers and authors
- use less traditional sources of information such as **blogs**, forums and **podcasts**
- find new and interesting information that adds to your research.

blog a regularly updated website used to cover a single subject

podcast a digital audio file available to download from the internet

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With the common use of the internet, information is being shared in real time through email, blogging and social network sites. This is an effective way for you to keep track of what others are researching and any new developments. You could use Google Docs, Google Drive, Dropbox, a **wiki** or other technology to store and share your research and receive feedback from others. There are a number of ways you can create and edit documents online while collaborating with other users in real time.

wiki a collaborative website or database that allows all users to update and edit the content

It is important to organise the information that you collect. An annotated resource list will assist you here. You must keep the details of the source of your information for your research reference list, as well as the date you accessed the website. Your school will have specific requirements for referencing web sources. You could collate all this information into a database or table. Classify your sources to assist your organisation using labels like design, products, environment, materials, tools, research and government.

SIMULATION

Simulation is the imitation of a real-world situation. First, a digital model of the situation is developed, and the simulation will represent the situation over time. Simulation is a very useful tool, because it informs decision making and improves the quality of the final product. Simulation can involve representing key characteristics or features of a design – be it a design for a physical product or an abstract system. A designer may also choose to simulate the environment in which that product or system is used.

Simulation technologies allow designers to provide a visual experience of the final design, for their clients and for their own testing purposes. Simulation is appropriate at a concept, development and manufacturing stage, and it can be used to test both the aesthetic and function of the design. Modelling may play a role in simulation.

Finally, simulation programs are themselves products of design. They have widespread applications, which include education and training, and the sciences. Video games that use simulation technologies, such as role-play and walk-through games, are among the most prevalent of these designs. An automobile simulator replicates the characteristics of real vehicles and external factors and provides the opportunity for drivers to become immersed in the experience. Simulations can be specialised for creating biomechanical models of human anatomical structures in order to study their function and assist in the design and planning of medical treatments or devices. Simulation training can be used to prepare people for disasters, replicating emergency situations, such as bushfires or terrorism attacks, and enabling responders to practice their knowledge in a safe environment. The possibilities are endless – urban infostructure, communication satellites, military, finance, marine, ergonomics etc.

Augmented reality (AR) is another way in which we interact with design. A person can use their mobile device to superimpose a new view over the real world. For example, Disney has technology that makes characters in colouring books 3D while they are being coloured in. The Smithsonian museum in Washington DC has added a new dimension to its display of skeletons. Users with the AR app can hold their phones in front of the skeletons to see an overlay of skin and muscle, and also movement, bringing the whole display to life.

ACTIVITY 12.3

Research a design process used for one of the following:

- a motorcycle
- an online role-playing game
- a new theatre complex
- a running shoe.

Account for the ways in which simulation plays, or could play, a role in that design process.

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Figure 12.3 An augmented reality app lets customers view sale prices.

Figure 12.4 Virtual reality – the ability to interact with a design

The producer of the app says it is an opportunity to share 'some of the untold stories behind one of the museum's most iconic collections'.

Video

Virtual reality (VR) gives a user the sense of existing in a 3D simulated environment. It typically uses a headset, and sometimes gloves incorporating sensors, so that the user can look in any direction in the artificial world and use their hands to interact with it. As well as audio and visual information, sometimes other types of sensory feedback is included such as haptic (touch).

GRAPHICS

Many of the images we see on a daily basis are computer-generated graphics. These graphics are the product of a design themselves, but they also have a role to play in the design process. Two-dimensional and three-dimensional graphics are indispensable to the designer who needs to simulate and present designs. Animation can also be a powerful tool.

Software to create, manipulate, animate, edit and automatically render graphics is available to designers. This software is readily used in designs for film and television, the web and paper media.

SKETCHING

As previously outlined, the process of designing an article from an initial idea to a solid, 3D reproduction previously took many months and required input from a range of skilled tradespeople. These computer technologies now mean that the process can be achieved in a few hours by a single designer. Designers can produce and develop their ideas and make modifications quickly and easily as well. Designers can use software like Illustrator, InDesign or Fusion 360 to showcase many versions of their design and make modifications of colours or shapes within minutes.

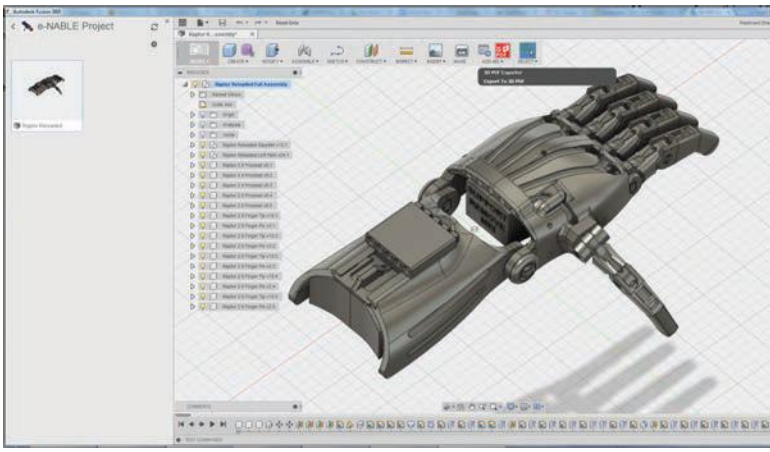

Figure 12.5 Fusion 360

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CASE STUDY 12.1

3D printing

The ubiquity of computer-based technologies enables a wide range of people to take an interest in design. Don D'costa, who is self-educated in that regard, tells us about his hobby:

> I started using the CAD software called Fusion 360 to create my designs about a year ago. My designs range from practical prints like a specialised pot for my bonsai tree, a stand for my Playstation controller and adjustable golf tees to the highly impractical (yet artsy) three-wheeled motorbike!
>
> I always consider two cornerstones before I create my design: form (proportions) and aesthetic (how cool does it look).
>
> For example, with my design for golf putters, I started by creating a rough sketch of what I wanted. I had to consider the limitations and maximum print size of my 3D printer (200 by 200 by 180 mm). Seeing as the overall size of the putter would far exceed this, I needed to break it down into components, which I later glued together (in this case I used a screw thread). I also needed to understand that certain shapes would not properly print with the type of printing method my printer uses (Fused Filament Fabrication – FFF).
>
> The next step was to create the components to scale in Fusion 360. Here I usually render a realistic 3D image to see how it looks in real life. Then, I exported the 3D objects as .stl files to my 3D printing software (Cura). This allows me to adjust certain parameters of the print, for example, to add supports to the printed object (in case print layers sit above the print bed) and choose the height of each printed layer.
>
> Once my first prototype was printed and assembled, I tested it to see what changes I would need to carry out for the next iteration of the design. So far, some of the changes have been: the shape of the putter's face and adding the provision for metal weights to the back of the putter.
>
> Not all my designs are geared towards the final product being a 3D print. With some of them, I do stop with just the rendered 3D image, as that in itself is an exercise in creating realistic renderings with lighting, camera effects, custom backgrounds and materials.

Gallery

Figure 12.6 3D printing golf putter

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COMMUNICATION

Digital technologies and information and communications technologies (ICTs) shape many of the ways in which we communicate on a daily basis. Cheaper microelectronics have allowed the diffusion of telecommunication technologies into all aspects of daily life and have encouraged a cross-fertilisation of their multiple application branches, including industry, commerce, administration, education, medicine, entertainment, and encouraging a wider design environment. Designers can make great use of these technologies, sending and receiving information that relates to their work, integrating various media through an expansion of delivery mediums to enhance communications efficiency. Technologies such as voice over internet protocol (VOIP) and videoconferencing are replacing many of the traditional forms of communication. These technologies have helped overcome many of the challenges previously presented to project development, including distance and time, and they can be relatively inexpensive to run. A scientist from Canada, an engineer from Germany and a surgeon from Australia can easily confer on the design and development of a **prosthesis**. Email, social networks, newsgroups and video transmission have connected the world in unimaginable ways. High-speed connections allow for a huge amount of data to be transferred in seconds. As communications technologies evolve, so will the way in which we use them. Televisions have evolved to allow for more interactive functionality. Digital communication technology is pushing the live music experience with its potential for real-time interactions between concertgoers and other fans. A watch is now a communication device. As a designer, you may be able to utilise these amazing communication technologies to develop an innovative idea.

ICTs are now used widely throughout schools and the design industry. ICTs allow users to interact with wirelessly connected computers. In any school, you can find identity card readers, digital whiteboards, smartphones, laptops, notebooks and a range of messaging services. The list continues to grow.

ACTIVITY 12.4

1 Create a mind map to explore the ways in which communication technologies are involved in a design process you are currently undertaking.
2 Discuss the advantages and disadvantages of using a variety of communication technologies throughout the design process.

Improvements in internet speeds, with broadband services now in wide use, mean that people are able to download large amounts of data. The ability to interact through the internet with media-rich content will lead to the design of new services and information sources for students and designers.

COMMUNICATION IN DESIGN AND TECHNOLOGY

As a Design and Technology student, you need to be able to succinctly evaluate and describe the process of design. You need to be able to communicate to the assessors of the course how well you have achieved the design challenges you have set for yourself and show that you have met the outcomes of the course. You must be able to write about your design and technology knowledge and how you have achieved your goals. In your design folio, which forms part of that assessment, you have to present large amounts of information. That information will best be communicated using text and diagrams that are clear and succinct.

Computer technologies will assist you. Well-formatted text produced on a word processor, for example, is simple to produce and easy to read and understand.

prosthesis an artificial device used to replace a missing body part

In the design project, it is often better to show as well as to tell. Well-chosen images, either moving or still, can convey a huge amount of information

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very easily. Often the most effective way of communicating your ideas, decisions or actions is through the use of graphics. Do not forget 3D examples such as test pieces or samples as these often tell a large part of your story very well.

PRESENTATIONS

You may use computer technologies to prepare presentations of design concepts and production plans, just as a designer often does.

A properly planned and well-constructed presentation or movie can make your work more exciting, effective and memorable. A poorly prepared presentation can become a liability rather than an asset. The following guidelines will help you make the most of your visual presentations.

- Simplicity is an effective way to capture and hold your audience's attention.
- Illustrate one idea at a time. Trying to cover three or four ideas in a single slide reduces the clarity of your presentation.
- Use information that supports your statements; for example, use photos and drawings to show internal parts of a design not usually visible.
- Experiment with a variety of layouts. Remember that many people retain information better after looking at a picture or a chart than after reading words.
- Proofread your work very carefully. Try to have someone else proofread it as well. Even a small error in your work can detract from the overall impression you create when it is magnified on screen.
- Fonts should be clear and easy to read. Decorative fonts are not recommended. Use only one typeface in each slide. You can add variety by using different sizes and bolding your headings.
- Coloured fonts should contrast strongly against their background. Details should be shown in clear, bright, contrasting colours. Use no more than three colours per slide.
- Avoid using shades for the background colour for titles or details.
- Test your presentation several times before submitting.
- Diagrams are good for illustrating relationships and designs. Graphics of this type show how each piece contributes to the whole. But avoid overcrowding, which will confuse the point you are trying to make.
- Good-quality photographs can make a major contribution to your presentation.
- Video used in presentations should be carefully edited to show important information quickly.
- Less is more.

Designers often present their ideas using software such as PowerPoint. Search the internet for effective PowerPoint presentations. Make a list of the tips that may help you in your presentations.

Other presentation software includes Prezi, a free online software which allows the user to include motion, zoom and spatial relationships in their designs, or Powtoon, another online software which allows the user to create their own videos and presentations easily and effectively. New developments in presentation software will provide a range of options.

The secret to success for multimedia communication is exactly the same as for any other type of communication technique: keep the message simple and clear. Do not lose your message in an attempt to make the presentation eye-catching or entertaining. There are a large number of books and websites to guide you in producing great presentations.

Visit the Mima Design website to see examples of how this company uses graphics to promote design concepts in the design, development and implementation of branded environments.

Developments in infrastructure and smart services and applications provide a platform for continued innovation in the area of digital technologies. These complex developments will create challenges for us as designers and consumers. Cloud computing, smart devices and virtualisation will offer a myriad of challenges.

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CHAPTER SUMMARY

- The technologies of infrastructure and digital communities impact on the development of the economic and social global networks, and on the work of designers.
- As in industry, students can complete their research, presentation ideas and production of plans to a higher standard by appropriately using computer technologies.
- Computer-based technology applications may be useful for modelling, researching, simulating, visualising, communicating or presenting ideas and processes.
- Designers discriminate in the choice and use of computer-based technologies.

CHAPTER SUMMARY TASKS

1 Discuss how CAD and CAM have influenced the end result of a toaster.

2 Explain how simulation and modelling can influence the development of a shopping complex.

3 Explain how simulation may be used to enhance the communication of a design.

4 Explain how storage 'in the cloud' can help a designer.

5 What are the main points to remember about good and poor communication with respect to the impact on how your design is understood?

6 Discuss the ethical concerns of using the 3D printer.

7 When sourcing items on the internet, how can you avoid infringing the intellectual property rights of the owners of work?

8 How can you ensure that the information from the internet you are using is accurate?

9 Think about the future uses of 3D printers and describe how you see them being used in 10 years' time.

10 Evaluate the use of computer-based technologies in your design and production process.

EXTENSION TASKS

1 Identify a recent product and research how the use of computer-linked collaborative design, 3D computer modelling and rapid prototyping affected its design process.

2 Choose a large search engine such as Google or Bing and find out how it collects data and allows you to quickly search its database. Does the search engine have advanced search features that are useful and if so how do you use these? Suggest any improvements.

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HSC YEAR 12

PART TWO

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13 The factors affecting design and the development and success of design projects

This chapter explores the factors affecting design and the development and success of design projects. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H1.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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13.1 Factors affecting design

There are a range of factors that may impact, either positively or negatively, on the development and success of a design. In the research of existing designs, you can learn from their success or failure to adequately address the needs of the user. For each design, the list of factors is not exhaustive and would be different for each individual design. Some factors will have greater influence on your design than others; therefore, it is important to consider their significance to the development of your major design project (MDP).

This chapter will discuss the how the eleven factors identified in the syllabus may affect a design solution. It is important to consider that these factors may make a difference to the design that could be either positive or negative, and sometimes what may appear to be a negative at first may enhance a design for the better once the project is complete.

APPROPRIATENESS OF THE DESIGN SOLUTION

The design solution should be a manageable response to an identified need or problem or opportunity. It should answer the need, fix the problem or capitalise on the opportunity. The outcome of the design process must consider the end-user and the environment in which it is to be used. It must effectively perform the task for which it was designed and be acceptable to the target market. For example, an appropriate design solution aimed at preschool-aged children would need to consider the appropriateness of the solution in terms of durability, non-toxic materials, weight, no sharp corners, and use of bright colours. Other design features that may be deemed appropriate for operation by young children may incorporate large, clearly labelled buttons or control mechanisms incorporating symbols rather than words.

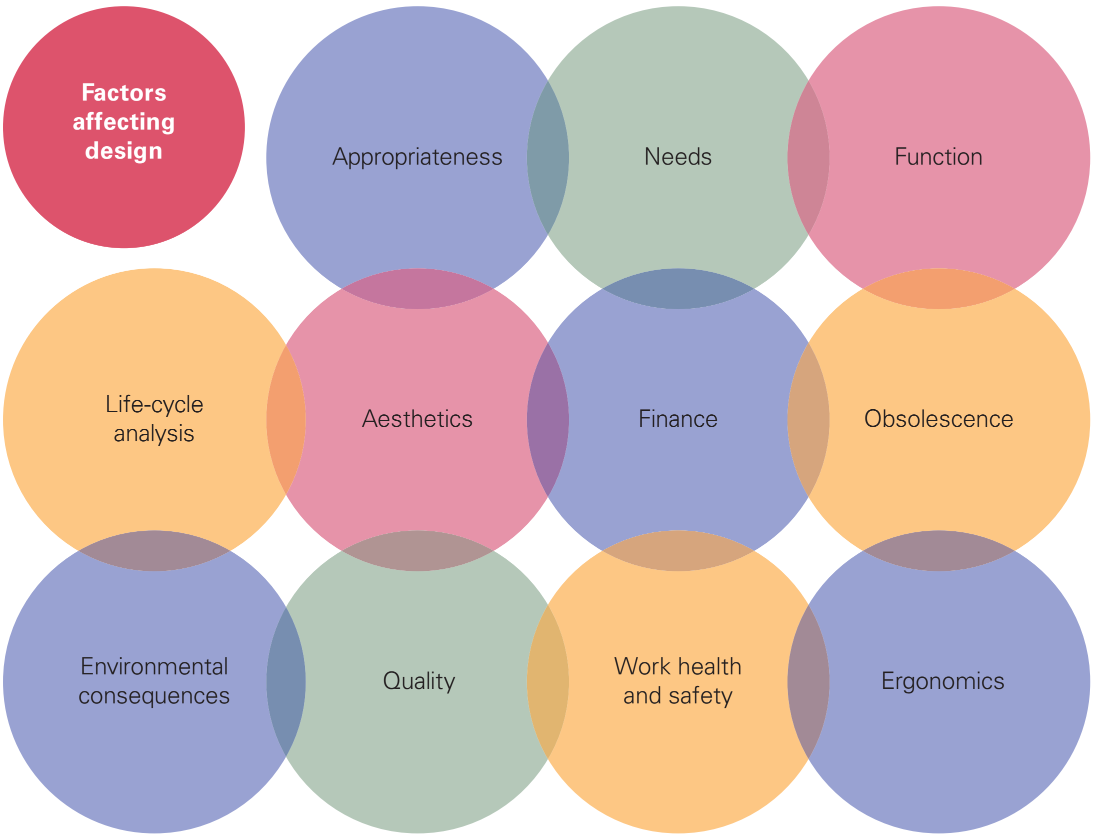

Figure 13.1 Examples of factors affecting design

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Consider what aspects may determine, or influence, whether designs are appropriate or not. Examples could be safety or fashionable expectations, or feedback from the user.

Not to be confused with Workplace Health & Safety, the Australian Competition & Consumer Commission (ACCC) is an excellent resource on some considerations regarding product safety. Visit the ACCC's website Product Safety Australia.

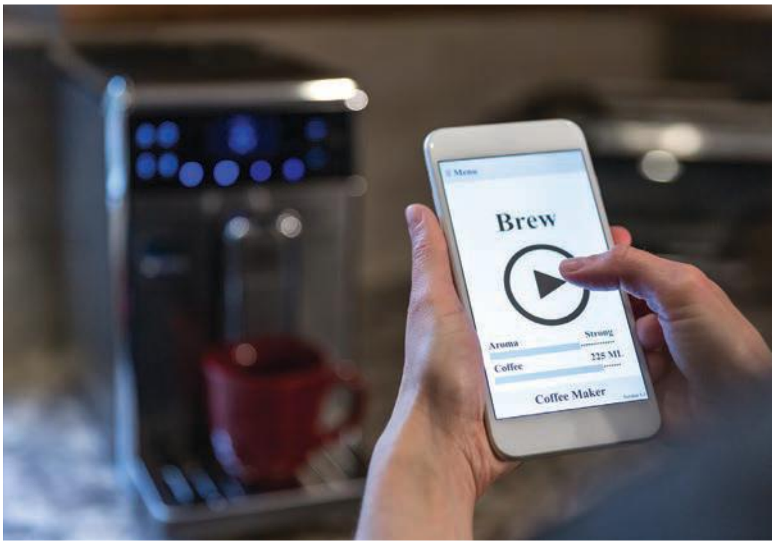

Figure 13.2 An example of the increased functionality of smart devices such as this coffee machine

NEEDS

Successful designs respond to genuine needs, so identifying a need is a good starting point in the design process. The need may present itself as a problem experienced by consumers, which may be solved by developing a new or improved product. A **needs analysis** may be conducted to explore the problem to evaluate existing solutions, examine the consumers in the target market and determine the potential for future development of a product.

FUNCTION

Function refers to the ability of a product to perform the task for which it was designed. It is what the product must be able to do in order to be successful. All products are designed to achieve a primary function; that is, the main purpose for which they are selected by the consumer. All products, however, also have **secondary functions** or additional features that differentiate them from other products on the market and encourage consumers to purchase them. This is sometimes referred to as the point of difference. From a positive perspective, is it possible that your design solution has a greater functionality than the existing designs?

For example, the primary function of a dishwasher is to wash and hygienically clean dinnerware, cutlery and kitchen utensils. However, many consumers will make their purchase choice based on secondary factors such as water and energy efficiency, quiet operation, capacity or materials and finishes that blend in with their kitchen decor.

AESTHETICS

Aesthetics refers to the physical appearance of a product and its visual appeal to the target market. What appeals to one group of consumers may not appeal to another. Age, gender, socio-economic background and current fashion trends are some factors that will determine whether a product appeals to consumers. There needs to be a balance between the consideration of function and aesthetics when designing. Not all designs have this balance, and they may either not attract users or may not function as expected. If two products perform the same function, it will often be their aesthetic qualities that determine their success. People are attracted to and like to use things that look good, are value for money and work well.

needs analysis in-depth exploration of the needs and wants of the target market; used to establish a genuine need or opportunity, and ensure that the design solution is in response to that need

secondary function additional features that make a product different and preferred to competition products

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FINANCE

Finance refers to the amount of money required to progress the development of a product through all the phases until completion. This may include research and development; procuring raw materials, plant and equipment; and establishing and maintaining manufacturing processes, product distribution and ongoing advertising and marketing costs. Developing a new product can be a very expensive and time-consuming business; however, it is important to invest in trying to get the design right before progressing to the next stage. If not, it may cost a lot more money to correct any errors in the future. Contemporary technologies like 3D printing enable designers to create and test prototypes to assess their suitability before preparing for mass production.

Video

Designers need to consider how they will fund the initial design period prior to the release of the product, whether government support or funding is available, or whether the assistance of an **entrepreneur** is advisable. In recent times crowdfunding platforms such as Kickstarter have become popular to enable innovators to access capital in exchange for products and services. Finally, the designer needs to consider any trade-offs as a consequence of accessing the capital. As an example, a venture capitalist may expect an equity stake in the success of the design. Any payback period or how long it will take before the product starts to make a profit would need to be considered in the long-term viability of progressing the design. The management of finance is crucial to the success of any project, and this may impact on the project's quality and functionality if funds are scarce. The budget established for the MDP needs to be analysed to determine whether it is affordable for the student and to ensure that it is worth proceeding with the project, or whether changes to the design need to be or can be made.

entrepreneur a person who sets up and manages new commercial enterprises to make a profit

Figure 13.3 Budget is a crucial consideration for any project. Schedule regular periods to track or update the budget.

ERGONOMICS

Ergonomics may be defined as the relationship between the human user and their physical or work environment. Ergonomics is an important consideration in products designed with the user in mind and aims to ensure that workplaces, products and systems are designed to fit the people who are intended to use them. Ergonomics uses data obtained from several disciplines, including anthropometry (body sizes and shapes), biomechanics (muscles, levers and forces) and environmental physics (noise, light, heat, cold and radiation), and using modern and emerging technologies such as 3D body scanners. Ergonomic considerations enable the designer to develop empathy for the user by looking at the different ways in which people interact with the product or system – physically, mentally or otherwise. This is referred to as the product–person interface. The aim of ergonomics is to develop a comfortable, safe (and thus productive) product or work environment. Failure to consider ergonomics could result in a project that causes discomfort, pain or physical injury to the user.

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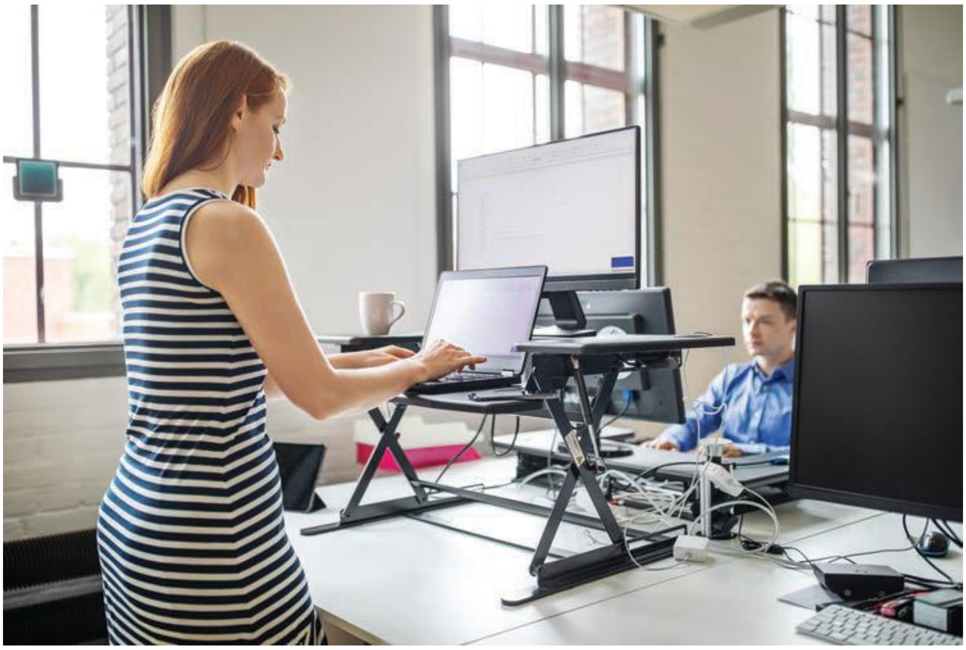

Figure 13.4 Ergonomic designs such as this standing desk can reduce physical and mental stress to improve performance.

WORK HEALTH AND SAFETY

Work health and safety (WHS) refers to both the rights and responsibilities of employers and employees in the workplace. Employees have the right to a safe and healthy work environment (provision of appropriate personal protective equipment, adequate training, well-maintained equipment and machinery, good lighting and ventilation) and the responsibility to adhere to all safety procedures put in place by the employer (wearing personal protective equipment, following evacuation procedures, not using machinery if untrained). Employers must comply with all work health and safety guidelines and legislation applicable to their state.

Figure 13.5 A 3D body scanner develops an accurate model of the scan based on the data captured.

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The *Work Health and Safety Act 2011* was introduced in New South Wales on 1 January 2012, replacing the previous *Occupational Health and Safety Act*. The new work health and safety laws were designed to provide greater consistency and make it easier to understand work health and safety duties. Safe Work Australia is the government regulatory body responsible for workplace safety policy, and this is regulated by the relevant authorities in each state or territory. For students, the classroom or workshop is your workplace, and rules relating to safe work practices are implemented to ensure your safety, and it is your responsibility to abide by these rules that are designed to protect you. Treat your tools and machines with respect. Learn to use them safely and always use them with patience and consideration.

Designers have a responsibility to ensure safety on several levels. They should consider the safety of those involved in researching the situation and the manufacture of their products, and they should ensure materials and processes used do not harm workers. They must also consider the safety of the consumer when using their product. Rigorous safety testing should always be carried out on prototypes, and modifications should be made if there is any chance of harm to the user.

QUALITY

Quality is a measure of excellence. It is difficult to define exactly what we mean by quality or what properties a quality product must possess. Quality is closely linked to value and durability. We expect a high-quality product to perform well for a long period of time, as it may incorporate superior materials and components. Regarding the concept of value, we associate quality with a higher cost for a product and consumers may be prepared to pay more if they feel the product will work more effectively and last longer. We associate brand names with quality products and often choose products based on a manufacturer who has a reputation for producing products that work well or are durable. Superior materials and finishes are another indication of quality, both of which may contribute to the final cost of the product. Finally, quality may be the result of the selected manufacturing processes and workmanship, such as short production runs, high-quality control mechanisms and bespoke (custom) production, which again make a product more expensive to the consumer.

SHORT-TERM AND LONG-TERM ENVIRONMENTAL CONSEQUENCES

As designers, we have a responsibility to consider the environmental impact of our work for both the short and the long term. The impacts of designs can be both positive as well as negative. Check out the case study in Chapter 21 on the designers who developed the Seabin.

Short-term environmental impacts, such as waste and energy use, can be minimised by making informed choices about the selection of resources and the production of wastage and pollution. To mitigate negative impacts, designers have a responsibility to actively seek sustainable alternatives to non-renewable resources or develop designs that are lean, meaning that they don't produce a lot of waste or may be produced efficiently minimising energy use.

To combat a throwaway culture of designs for single use, designers need to ensure that their design decisions focus on the preservation of our natural resources for future generations. Design considerations such as developing solutions that are more durable, that can be repaired or use less components would reduce the impact on the environment. Unfortunately, environmentally friendly choices are not always the cheapest option and incorporating sustainable materials and processes may increase the overall cost of a product for both the designer and the consumer. Ultimately this leads to competing choices of environmental versus financial values.

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The consequences of human disregard for the environment over a prolonged period of time is seemingly in the news on a daily basis. The increase in **greenhouse gases** leading to **global warming** is reportedly contributing to an increase in catastrophic weather events. Issues such as food and water insecurity, waste such as microplastics, and a loss of diversity from activities such as deforestation are just a few examples of environmental consequences that are related to long-term human activities and unsustainable resource consumption.

To ensure that future generations have access to natural resources, it is not just the consumers who need to be proactive in changing their behaviour by choosing products that have less of an impact on the environment. It is also up to policy makers, manufacturing companies and their designers who need to implement environmentally considerate policy, and design and produce products that satisfy environmental criteria.

OBSOLESCENCE

Products are considered obsolete when they are replaced by a new or more attractive product that performs the same function. Products may become obsolete when an entire technology is replaced by a new or more effective one. Some industries such as the telecommunications, computer and fashion industries rely heavily on obsolescence to maintain high sales levels, encouraging consumers to buy the latest version or style.

global warming increases in the average land and sea temperatures on Earth

greenhouse gases gases that trap and emit heat in the atmosphere causing a greenhouse effect on the planet

Planned or built-in obsolescence refers to when a product has been designed to fail, become unfashionable or limited in its function within a given period of time. Planned obsolescence is incorporated into the product at the time of design, as many companies continue to plan for the design and development of their next version. Planned obsolescence may involve creating products that cannot be repaired or have components replaced, using poor-quality finishes that will deteriorate over time or using materials with lower durability that will fail after a period of repeated use. Even though this practice is frowned upon, it ensures that new technologies are adopted and, of course, it leads to repeat sales for businesses.

Figure 13.6 Solar technologies are a viable energy source.

LIFE-CYCLE ANALYSIS

Life-cycle analysis is an evaluation of all the resources used when designing, making, using and disposing of a product. It examines all inputs (materials/resources and energy) and all outputs (pollution and wastage) from initial concept through design, manufacture, distribution, usage and disposal. It is a complete analysis of the environmental impact of the product. It considers where the original materials came from, what energy was required for production, what by-products were produced, how the product was transported (energy for transport, pollution from vehicles), how it was consumed or used and, finally, how it was disposed of when it reached the end of its useful life (landfill, recycled).

cradle-to-cradle analysis design of products that do not generate waste or landfill at the end of their useful life, but that can be reused and recycled into new products

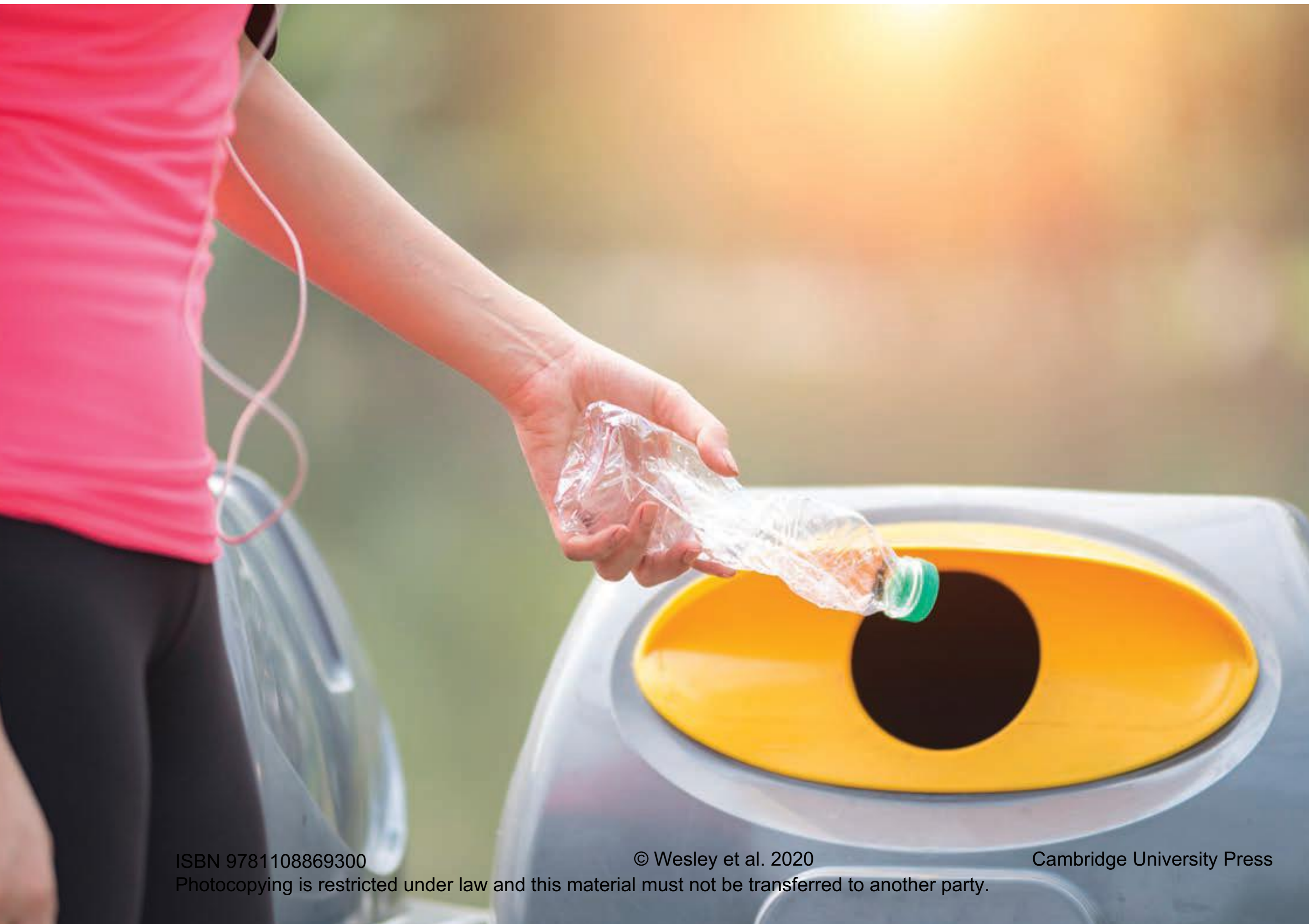
design for disassembly design for products that can easily be disassembled, separated and sorted for reuse or recycling at the end of their useable life

This is where the designer can make a significant impact on the environment. Rather than just analysing and designing products that have less of a negative impact on the environment from its initial design to its disposal (cradle-to-grave), what if the designer plans for the use of the material of a product after it has served its intended purpose?

A life-cycle analysis can sometimes be referred to as **cradle-to-cradle analysis**. This implies that designers are using sustainable design practice and ensuring that once a product is no longer functional it can be recycled or reused in some way. **Design for disassembly** is a sustainable design practice that ensures that components are easily dismantled for recycling purposes once the product has reached the end of its useful life.

Learn more about life-cycle analysis by watching the video 'Life Cycle Assessment as part of Strategic Sustainability for Product Design' on YouTube.

Figure 13.7 Design in recycling



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ACTIVITY 13.1

From the factors affecting design that you have read about in this section, select four that you consider relevant to your MDP.

1 Describe each factor.
2 Describe how each factor will impact on your MDP during the following stages:
   a design
   b production
   c consumer acceptance of the finished product
   d use of the product, system or environment.
3 Analyse your list of relevant factors and prioritise them in order of importance to the success of your MDP. Justify your ranking.
4 Discuss how the factors you have considered impact on each other. Draw implications between factors such as function and aesthetics, WHS and ergonomics, finance, time and quality.
5 Analyse the impact on your MDP if these factors had not been considered. Would it still be a success? Could it cause harm to consumers? Would it impact negatively on the environment?

13.2 Issues that influence design

While some of the preceding design factors will need to be considered carefully when developing your MDP, others will have little impact or bearing on your work. For example, if you were designing a christening gown, quality and aesthetics would need to be carefully considered, while a factor such as obsolescence may not need to be considered at all. Be selective and choose to evaluate only those factors that will impact on the design and construction of your MDP. Do not just describe the design factor in generic terms. Be specific and explain how each relevant design factor influenced the choices you made, how it assisted in the successful completion of your project and what the impact of ignoring that factor may have been on the resulting project. Specific detail related to your project will provide the 'critical' levels of detail, and in the relevant section of your portfolio you should indicate where these design factors are applied in your MDP.

Figure 13.8 Video game controllers were once accompanied by restrictive wires, connecting them to the console.

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ACTIVITY 13.2

As individual designers, we each have our own opinion about what makes for good design and ultimately a great product. A debate helps you, the learner, to synthesise the concepts and content, and to construct and articulate understanding. Under the direction of your teacher, select one of the following statements and prepare a formal debate, with two teams examining both the affirmative (arguing for the statement) and negative cases.

1. Function and aesthetics are equally important to the success of a product.
2. Planned obsolescence is necessary for technological advancement.
3. Quality does not always mean more expensive.
4. Sustainability comes at a cost to consumers.

ACTIVITY 13.3

After conducting your debates, spend some time as a whole group considering the impacts of design. Use the whiteboard or butcher's paper to brainstorm your ideas.

1. Who benefits from good design?
2. Who pays the cost of poor design? Identify a poorly designed product you have encountered and consider the impact of its use on:
   a. the individual
   b. society
   c. the environment.
3. How can we, as consumers, encourage good design?

13.3 Analysing examples of design

What makes a good design? Why are some designs hugely successful while others are doomed to failure? We tend to measure the success of a design by its success in the market or the amount of profit it generates. Design failures may refer to products that have not only failed to make money for the designer or manufacturer but may have caused harm to the user. Alternatively, through a process of evaluating the solution as the design process is evolving, the solution may not be performing as desired, or the materials being used may not be as durable as initially thought. Although failure, or 'trial and error', is an expected and unavoidable part of an iterative design process, we must work through and resolve any identified issues to develop confidence in the design's ability to meet the need. Any design flaws need to be addressed within the design process as allowing flaws to be evident in the finished product can become a very costly exercise.

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DESIGN FAILURES AND SUCCESSES

What causes some products to fail in the marketplace while others succeed? There is no one answer to this question, though some common factors should be considered:

- **Insufficient market research can result in poor assessment of the market's needs.** Designers need to know exactly what the situation is, what the consumers want and to be sure that their competitors' products are not meeting those needs more effectively or economically.
- **Insufficient testing during the product development phase.** Research, testing and design modification are costly but ensure an end product that is reliable and fit for purpose. Costs to the business after mass production could be much greater!
- **Lack of a suitable market.** Sometimes the market is flooded with similar products. Consumers need a point of difference to make them select a product. Careful market segmentation and target marketing techniques to ensure information about a new product reaches the right group of consumers are essential to the success of the product.

By examining the work of successful designers, we may be able to identify factors that can be applied to the design and construction of our MDPs. Likewise, by analysing those products that have been deemed a failure, we may be able to avoid repeating the mistakes of previous designers.

There are many examples of design failures that we can learn from. Failure is an important and sometimes sad way that we learn. As humans continue to design, innovate and produce, there will continue to be mistakes or considerations that we can learn from. At the time of writing this chapter, there are current investigations such as the Boeing 737 Max 8 that may identify design faults; The Opal Towers in Sydney; and the tragic Grenfell Tower fire in London. New innovations sometimes are ahead of current laws or societal expectations. As a result, designs may suffer from a backlash as people are not used to the existence of such technology or a product. Recent examples of this were the concerns over Google Glass's video recording without people being aware or the dumping and vandalism experienced by bike sharing companies in Australia.

Design successes can be considered the products, systems and environments that assist society's continuing development and growth. They may be small and simple (like the ballpoint pen) or complex and potentially dangerous (like nuclear reactors). In some circumstances their 'success' is viewed retrospectively as the innovation itself may not have been successful to begin with; however, it has become successful in its application to another situation.

ACTIVITY 13.4

The sinking of the *Titanic*, the dead-man's pedal safety device on trains, and the collapse of the Tacoma Narrows Bridge are other famous examples of design failure. Investigate one of these, or another of your choice, and compare and contrast what contributed to the failure in the Takata case study. Answer the following questions individually or in groups.

1. Identify the factors that led to the failure of the product. What could have been done differently?
2. How does examining such failures help today's designers?
3. How can we apply what we have learned from these failures to the development of our MDP?

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CASE STUDY 13.1

Takata airbag recall

According to the ACCC, the Takata airbag recall is the largest automotive recall in the world, affecting an estimated 100 million vehicles worldwide. Takata filed for bankruptcy in mid 2017 following pleading guilty to fraud in early 2017, based on deceiving automakers and knowing that their airbags could have been faulty.

A total of 19 separate car manufacturers including those common to Australian roads, such as Ford, Toyota, General Motors and Mazda, have been impacted in the Takata airbag recall across the world following a reported 29 deaths and over 320 injuries worldwide.

Airbags are designed to reduce fatalities and injuries as a result of a driver's car impacting on another object and have been increasingly incorporated into vehicles since 1990 and were incorporated into 90% of new vehicles in 2006. Driver's front airbags have been the standard safety feature, and, over time, their popularity has resulted in the introduction of passenger front airbags and side airbags (standard feature from around 1995). Overall, the introduction of airbags is considered a success according to the statistics published in 2015 that state that frontal airbags have reduced fatalities by 13% and side airbags have reduced fatalities by 4% (DIRD, 2015, p. 68).

Figure 13.9 It is important to consider all aspects of your design before production.

Airbags work when a bladder-like bag inflates. The inflation of the bags cushions and absorbs the forward moving energy (Newton's first law of motion) of the occupant as they move towards the direction of the impact. Thanks to electronic sensors that sense a collision, an electric signal ignites and explodes a metal cartridge inflator leading to a mixing of reactive chemicals that generate a gas. It is this harmless gas (nitrogen) that fills the airbag in 0.03 of a second.

Unfortunately for the victims of faulty airbags and the Takata company, the chemicals inside these inflator cartridges deteriorate or degrade with age or exposure to the environment. As a result of this degradation, the inflators can explode with too much force, sending sharp metal fragments to shoot out like a 'shot gun'. While the percentage of fatalities was relatively low compared to the number of cars on the road with a Takata airbag, a voluntary recall was announced. Unfortunately for the Australian victim killed in July 2017, the timing was devastating considering the airbag was due to be replaced two days before his death. Tragically, the airbag replacement was postponed until a later date.

On 28 February 2018, the Australian Assistant Minister to the Treasurer upgraded the voluntary recall to a compulsory recall of all vehicles fitted with a Takata airbag to have their airbags replaced.

The Takata airbag is one tragic example of design failure. In this example, the design of the airbags failed to consider the impact of the extreme conditions that vehicles are subjected to everyday. As an example of the diversity of conditions, our vehicles may be subjected to extreme heat, snow, water, potholes and accidents over an extended duration. In this example, unfortunately what may have been tested in laboratories did not simulate the realities on the road. Unfortunately, even when Takata was aware of the inadequacies of their design, they didn't act ethically or morally to address the design flaw immediately.

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CASE STUDY 13.2

Agricultural robots helping farmers, feeding the world

Even without the challenges that climate change brings to farmers around the world, we are facing increased pressures to feed a growing global population.

To see how field robotics can assist farmers to increase their productivity, Professor Salah Sukkarieh from the University of Sydney's Australian Centre for Field Robotics (ACFR) has been developing 'agbots' to work with farmers to assist with issues such as weed identification and elimination without the need for blanket spraying crops with chemicals.

Farming properties can be quite large and the elimination of weeds on an individual basis (spot weeding) is an enormous task for individual farmers. In some areas, finding workers to assist the farmers is another issue where the robots can 'lend a hand'. One example of the ACFR's innovations is the 'SwagBot'. This robot is designed to utilise solar power and four-wheel drive capabilities to navigate tough terrain.

The versatility of these agbots enables a farmer to control it using remote-control or through programming to detect and eliminate weeds, and even to monitor animals. From a sustainability perspective, the use of these technologies impact positively on the individual farmer as well as reducing the amount of herbicides used in cropping, which is better for the environment. In addition to this, because the bots are solar-powered they do not need the fuel that farmers use in their motorcycles and cars.

In 2017 Salah was awarded the highly prestigious CSIRO Eureka Prize and his work has recently been recognised by his nomination for the 2019 New South Wales Australian of the Year.

Video

Figure 13.10 Professor Salah Sukkarieh working on the Ladybird agbot

ACTIVITY 13.5

Answer the following questions based on Case Study 13.2. You may work as an individual or in a group.

1 Identify the main factor in the development of this design success.
2 What factors led to its success?
3 What can you learn from this success?
4 How can you apply this success to your MDP?

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CHAPTER SUMMARY

- Many factors affect design; however, this will be different for each design.
- What might initially appear successful may actually be rejected by the intended user.
- Thorough testing and prototyping are essential to mitigate problems and facilitate success.
- Honest market research to understand the needs and wants of the target market is essential.
- The factors affecting design are interrelated.
- Some design factors impact more heavily on a design than others.
- Long-term success requires discipline in an adherence to sound practice and procedure.
- Design success or failure is dependent on many factors and influences.

CHAPTER SUMMARY TASKS

1. In your own words, describe the five factors affecting design that you consider most important to a successful product.
2. Identify three products that successfully meet the needs of the end-user.
3. Make a list of all the resources you may use in the design and construction of your MDP. Divide the list into human and non-human resources.
4. Research a product, system or environment that in some way relates to your MDP. Identify areas of success and/or failure associated with this design. What can you learn from this to apply to the development of your MDP?
5. List five strategies that you will use to ensure the success of your MDP.
6. How would your project vary if it was to be undertaken in a developing country?
7. Identify three safety concerns that need to be considered during the development and/or use of your project.
8. Detail how you will ensure safety based on these safety concerns.
9. Name three ways in which sustainable design is considered in your MDP.
10. How have the case studies on success and failure in design impacted on the planning of your MDP?

EXTENSION TASKS

1. Conduct a life-cycle analysis on the major resource or material that will be used in the production of your MDP. Consider the impact of your MDP on the environment. Make a list of things that you need to consider as you develop your project to reduce this impact.
2. Make contact with a practising designer who works in a field related to your MDP. Find out about factors that influence their design work. Ask how they have responded to current issues such as sustainability and changing manufacturing trends in Australia. What do they regard as their most successful design? How do they avoid failure?

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14 Relating the practices and processes of designers and producers to the major design project

This chapter explores the relationship between the practices and processes of designers and producers and the major design project. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H1.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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14.1 Designers at work

Design is about applying a process to solve a problem or developing a solution to meet an identified need. Design can also be about responding creatively to an opportunity. While they may be labelled differently and value specific outputs, every designer works through a similar set of steps when creating a design, modifying the process to suit their specific needs. A design process is adaptable to virtually any design situation as a framework for managing projects to completion.

The ability to adapt a design process and apply the same basic concepts to solve diverse problems means that today designers are not limited to working with specific materials and the tools and techniques that are associated with a field of expertise or a trade. As an example, architects can engage in the design of furniture as well as the design of structures for a variety of needs.

Flexibility and the ability to respond to new and emerging materials, processes and technologies have seen the emergence of a new breed of designers who have crossed the boundaries of traditional design and work in a diverse range of materials to produce designs far beyond the scope of their original training. Marc Newson is an **iconic** Australian example of such a designer. Originally studying jewellery design and sculpture, he emerged as one of the most influential designers of his time, working across multiple design disciplines. Given this opportunity he designed a diverse range of products such as concept cars, uniforms for the Australian Olympic team, mobile phones, vacuum cleaners, the Qantas first-class Skybed, clothing for G-Star and luggage for Louis Vuitton.

iconic represented as worthy of celebration and great respect

Newson uses the design process as a tool, applying the principles to whatever need or design problem he is given. He does not limit his creativity by restricting his choice of tools, materials and techniques to those with which he is familiar. His success lies in his flexibility and adaptability to different design situations using the design process as a project development framework. As a student embarking on the major design project (MDP), there is much you can learn from Newson's courage to try new things and learn new skills. In some cases, your unfamiliarity with a material, a process or an application may enable you to freely entertain design possibilities without bias.

When developing the MDP, students conduct extensive research and testing to learn about the most appropriate tools, materials and techniques and how they can be applied to their project. Do not underestimate the value of researching the work of professional designers. By examining the process of others, we can gain valuable creative insights and learn about successful methods and ways of working as well as identifying problematic areas and things to be avoided. Professional journals, reliable sites such as IP Australia and design magazines frequently offer case studies and in-depth interviews with designers, exploring their identification of the need and the process that makes their work unique, or the troubles they have had commercialising their innovations.

The internet is a valuable tool for research into the work of designers from all backgrounds, allowing quick access and up-to-date information from a secondary source. However, the most valuable research may be gained by conducting interviews with practising designers who work in a similar context to the one you wish to pursue for your MDP. It may seem daunting to have to call or email a professional designer, but you may make valuable industry contacts and gain access to experts in your chosen field who may be able to offer guidance or advice. You may even be lucky enough to be offered the chance to observe them at work, either in the design phase or assisting them in undertaking the practical work of creating the design. Valuable experiences such as these will enhance

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your own design work, allowing you to learn from the successes of those who design for a living and pick up helpful hints to avoid the pitfalls and mistakes that they may have encountered in the early stages of their careers.

When examining the work of practising designers, it will quickly become evident that few designers work in isolation and that most work in conjunction with others to take their ideas from concept to finished product. While the modern-day designer has the freedom to work on projects across a range of fields, their expertise resides in the design process itself, and as a result, others may be called upon for materials or technical expertise. Many will be part of a collaborative team where professionals from different design backgrounds may be chosen to contribute their unique skills and expertise when developing a product.

Figure 14.1 It is important for a design team to be on the same page.

When producing your MDP, you do not have this luxury – you must carry out multiple roles – designer, manufacturer, marketing adviser, project manager, even client if designing for your own personal use. So take advantage of what you can learn from designers. Listen to advice about tips or tricks, short cuts or problem areas to avoid. Learn from their experience and apply this new knowledge to the development of your MDP where applicable. As one of your responsibilities is to manage the project, it is also your role to establish your team to assist you to realise a quality design solution. While your teacher may be very experienced and skilled in a number of areas, they will be the first to admit if the knowledge and skills you seek is beyond them. It is from this perspective that you should seek the advice of additional human resources such as subject-matter experts, parents and peers to name a few. Remember to document any assistance you receive from others.

14.2 Design processes

There is no one definitive design process. There are many graphical and written examples of processes of design indicating a series of basic steps that designers work through. A design process may be customised to suit the specific designer and what they wish to achieve. By examining a wide range of examples, you can determine what works best for you in the development of your MDP. Design processes may appear linear or circular, contain loops or diamonds, vary according to the order of steps or place greater emphasis on particular stages than others. Regardless of these differences, some aspects will be common to all of these models.

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Regardless of the model you use, the design process is not a linear start-to-stop process made up of steps arranged and followed in a specific order. Design ultimately is an **iterative/cyclical process** that continues until both the designer and client are satisfied with the outcome. In this process, feedback between the designer and the user or important stakeholders are used to improve and modify the outcome. This is an important process leading to successful design outcomes.

iterative/cyclical process a process where activities occur again and again until a desired state is achieved

When it comes to redesigning an existing product to increase market share or to incorporate new technology, there may be alternate entry and exit points to a design process. It may be appropriate to start with research and testing of new or emerging materials, technologies or processes rather than initial market research to determine consumer needs and wants, as these have already been identified and have created the need for redesign. Maybe in order to keep up with the competition, redesign is important to remain competitive. This is often the case for electronic products.

The concept of loops in design highlights that design is not always a one-way process, as sometimes we need to go back before we can continue to go forward. For example, researching and testing a design may reveal that there is a problem and that the design needs to be modified. This may require us to go back and conduct further research and testing to determine what needs to be changed and how to do it before continuing development.

Successful design requires that some steps in the design process will need to occur concurrently or at the same time as others. For example, developing initial ideas should be based on research and testing, both to gain inspiration and to establish a genuine need or opportunity. It is difficult to say which should happen first. While your ideas need research and testing to determine whether they are viable and likely to succeed, research and testing often generate more ideas. Research may uncover options that you may not have considered and can be helpful in providing direction if you get stuck and cannot decide how to proceed. Situations such as this are expected, but if this occurs remember to document it on your Gantt chart that documents your actions over time.

Evaluation is frequently included as the final step in a design process. Be careful to remember that while it is essential to conduct a final evaluation of the completed project against any success criteria, evaluation is carried out continuously throughout the entire project. An effective approach to the design and documentation of your MDP is to use evaluation as a management tool to ensure you stay on track and achieve the desired outcome by constantly referring back to the identified need or problem and judging the successful progress of your work against the criteria for success.

Remember that in many commercial design applications, the design process does not end when you get to the bottom of the list of steps. It is an iterative process that is ongoing, looking for continual improvements in processes, in productivity, in reducing impacts and continually responding to consumer demands and market trends. In industries such as the automotive industry, a project enters the redesign phase as soon as it is launched onto the market. Once consumer response can be gauged, the design team can begin to determine what modifications need to be made to increase market share or whether processes can be streamlined to reduce production costs.

You will encounter different design processes that have quite generalised stages, while others may offer more specific stages that require specific outputs. In the design, development and documentation of your MDP process, you are required to provide documentation of specific stages in your portfolio. Regardless of the particular design

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model used, most basic stages of a design process may include:

- **Analysis:** Identification of the need or opportunity; analysis of the problem; initial consultation with the client; development of the design brief
- **Investigation:** Initial research and consultation to establish constraints and parameters and generate ideas
- **Ideas and possible solutions:** Development of a range of ideas or solutions in response to the need or problem
- **Research and testing:** Relevant research and testing including design solution testing and prototyping to determine the best solution and ensure that it will work or solve the problem
- **Modification and refinement:** Development of the design; modifications in response to results of research and testing to improve the solution
- **Realisation:** Production of the final design or best solution to meet the identified need or opportunity

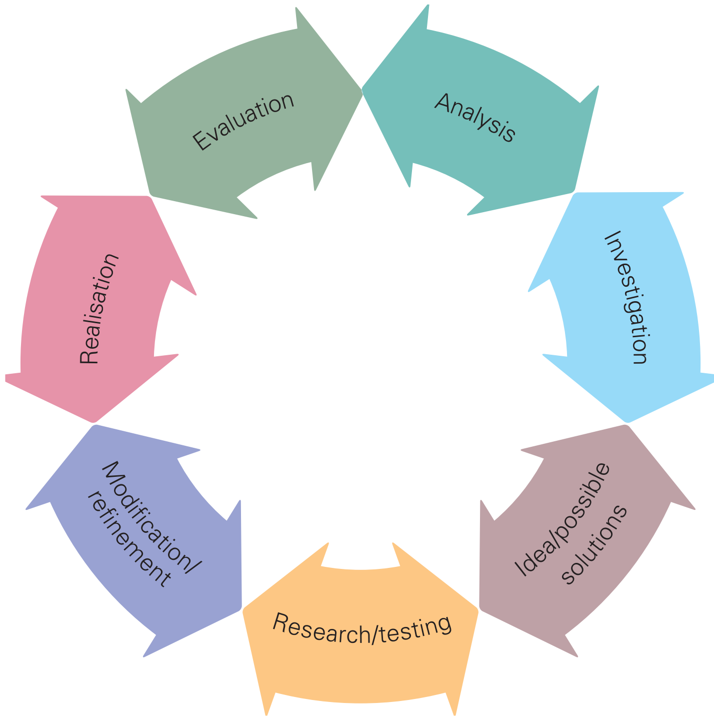

Figure 14.2 Basic stages of a design process

- **Evaluation:** Ongoing throughout design and construction; checking the outcome against the identified need or opportunity to determine the level of success

ACTIVITY 14.1

Develop your own customised design process that reflects your specific need or opportunity. Examine the design process above and other examples. (A Google Images search for 'design process' will reveal hundreds of examples.) Ensure your design process aligns with the marking guidelines and allows the HSC markers to see the process you worked through to develop your MDP.

Ask yourself relevant questions, such as:

1. When will criteria for success be written?
2. How will I show I have achieved each criterion?
3. How will I show design development and refinement after research and testing?
4. What method will I use to show ongoing evaluation? How and when will this be recorded in the folio?

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By examining the work of professional designers, we can hope to learn from their experience how best to approach and work through a design problem. Your investigations into the work of designers may reveal that they often have a specific set of values. As an example, some designers like to incorporate particular cultural themes into their work. Others may value sustainability and may develop specific criteria that will lead to more environmentally friendly solutions. Some designers are focused on solutions that may provide the best economic result. Recognising that each designer possesses their own individual views and perspectives about how design should take place, we can analyse and evaluate possibilities that could be applied to our own design situation.

CASE STUDY 14.1

Designer profile: Lyn-Al Young

Melbourne fashion designer Lyn-Al Young is a proud Gunnai, Wiradjuri, Gunditjmara and Yorta Yorta woman. In her designs Lyn-Al focuses on the inclusion of culture and storytelling, often using natural dyes and silk. She has been around design all her life, with parents who are artists and entrepreneurs. She began designing at eight years of age, making handbags out of 'old things' and within two years was incorporating beads and fabric and selling her wares at Indigenous markets.

As a recognised emerging artist, who has had her NAIDOC collection showcased in David Jones stores in both Sydney and Melbourne, Lyn-Al was one of 21 individual 'creators' who received funding in 2018 through the Victorian Government's ground-breaking Creators Fund. She used this opportunity to develop a range of clothing to exhibit at the Business of Design Week in Hong Kong.

Lyn-Al aims to represent and celebrate her culture through her designs, however the symbolism of her work does not finish there. In an interview, she said that she works 'in the spirit of protection and peace', where women who wear her designs feel safe, and happy. Lyn-Al's pride and confidence has been inspired by the examples set by the women in her life such as her mum and aunties and her grandmother. In her work, she also exhibits this confidence and wants to design items for women (both Indigenous and non-Indigenous) that also make them feel good about themselves. Her work demonstrates the process of empathising with the needs of her target market.

Lyn-Al connects her designs to a connection with the land, storytelling, and ultimately empowering women. In a collaborative project with her mum, Lyn-Al encourages goal setting through fashion dreaming, or 'fasheaming'. In this project, participants elaborate their goals through artistic works that tell a story. In groups, these stories are given a safe place where they can be shared to promote pride and the realisation of these goals. She has responded to the spiritual and cultural needs of indigenous people.

Watch the story behind the Indigenous guernsey at https://cambridge.edu.au/redirect/8868.

Another example of Indigenous design including the work of Lyn-Al can been seen in the interview between Tom Mosby from Blak Design Matters and the ABC. A copy of the interview is found here: https://cambridge.edu.au/redirect/8734.

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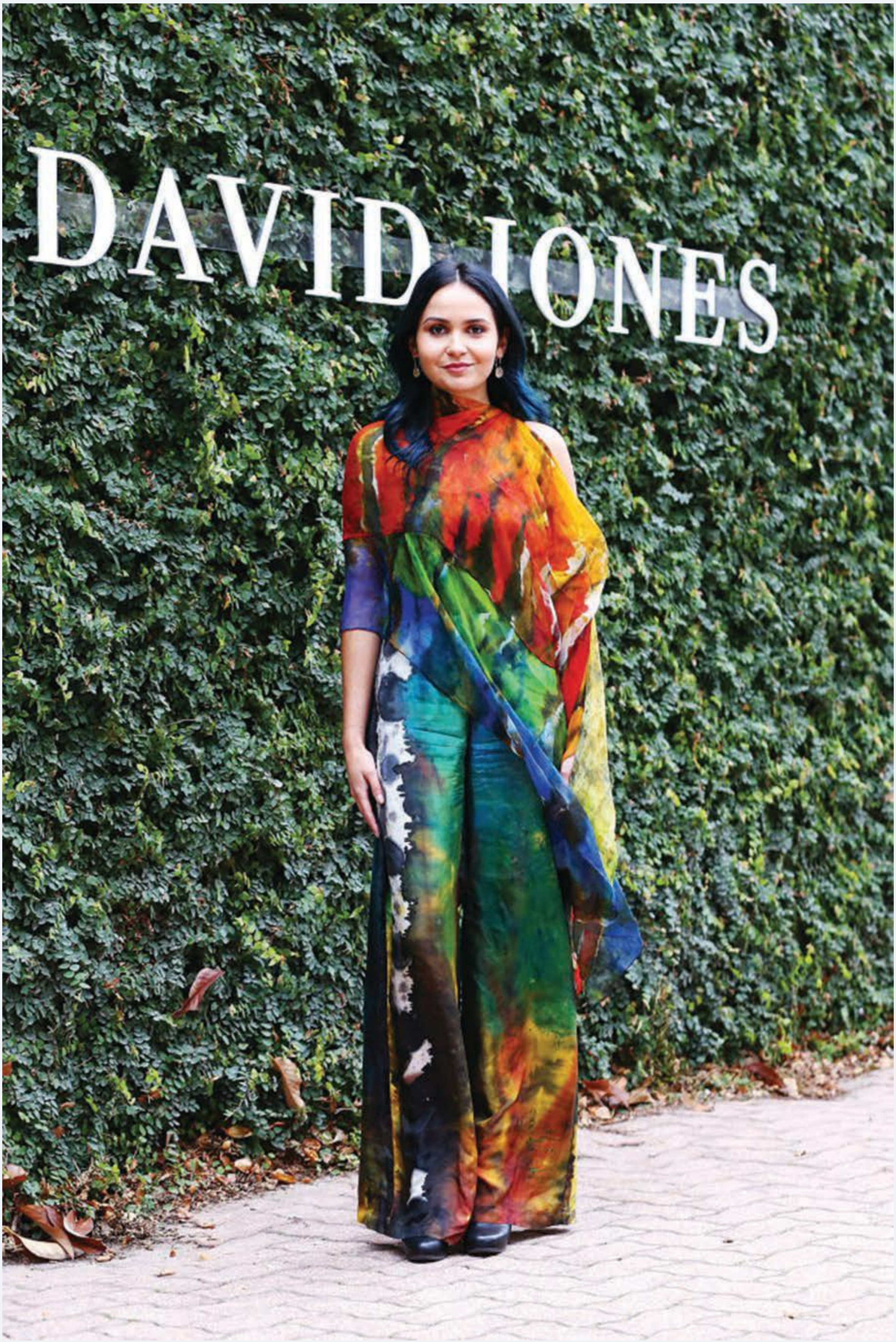
Figure 14.3 Lyn-Al Young posing in one of her creations from the David Jones Spring Summer 18 Collection



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CASE STUDY 14.2

Designer profile: Andrew Simpson

Andrew Simpson is an industrial designer, founder and head designer of Vert Design, a design house based in Sydney that was established in 2005. Andrew is passionate about environmentally responsible design with a focus on developing sustainable manufacturing processes and materials. His ability to blend traditional design skills and craftsmanship with cutting-edge technology resulted in a highly successful design business.

Andrew's work is not bound by a particular material or discipline. The diversity of his work includes glassware, ceramics and homewares and environmentally based projects for companies ranging from Sony to small start-up businesses. To facilitate design success, Andrew has developed a collaborative network of 'subject-matter experts', such as doctors and engineers, who can advise him when needed.

While his current work utilises cutting-edge technologies, Andrew stresses the importance of sketching and drawing as an essential part of the design process to both understand how things work from the designer's perspective and as a communication tool when negotiating with clients. Developments within CAD and CAM technology, particularly 3D printing, have changed the way he works through a design process. His work shows design modification and development from initial sketches to block models, multiple 3D-printed models to test form and function, through to presentation models and prototypes. The speed at which 3D-printed models can be produced to test ideas and the low cost of production mean more flexibility and refinement of design are available prior to the expense of committing to materials for production.

Andrew began by studying industrial design at the University of Technology, Sydney. While the value of a formal theoretical design education was undeniable, his passion for real-world design application saw him working as a glassblower while studying and attending lectures across disciplines to experience diversity of ideas and practice. Today, in the role of lecturer and tutor he passes on his knowledge to university design students. Andrew values getting hands-on in his design work and the process of experimentation that has enabled him to be innovative in his use of materials, examples of which include BioPak food containers and his Huskee cup made from waste coffee husks and eco-polymers.

Andrew is one of a handful of designers involved with Sydney-based Supercyclers, 'an international collective of designers who are focused on building a sustainable future'. In 2012, Andrew exhibited his Solar Vase at the Supercyclers' *Supercycle our Souls* exhibition in Milan, where it generated immense interest. The slim, elegant vase was produced from post-industrial solar sheeting, a very fine, clear glass, made from white sand mined off the west coast of Tasmania. Although incredibly beautiful in its finished form, the material created many design challenges for Andrew.

> To compensate for its lack of workability, we added a set of chemicals which made the design possible. A set of chemicals that required extensive testing and refinement to get the right balance!
>
> It's also important to note that people appreciated the vase as a formal piece of design, as opposed to a particularly environmentally friendly one.
>
> I feel strongly about the fact that using waste and recycled products doesn't have to translate into bland design. It's possible to create pieces that can stand on their own as beautiful objects.

Source: Andrew Simpson, https://cambridge.edu.au/redirect/8939

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Figure 14.4 Samples of Andrew Simpson's work

ACTIVITY 14.2

1. Identify three reasons why Andrew Simpson has experienced ongoing success as a designer.
2. Why is the testing of ideas and design solutions an important focus of Andrew Simpson's work?

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CHAPTER SUMMARY

- Design is a problem-solving and project management process.
- All designers follow a similar set of steps known as the design process, regardless of their field of expertise or the tools, materials and techniques they may use.
- Professional designers follow a design process very similar to the one we apply to the design and construction of the MDP.
- The design process can be expressed in many ways and is adaptable to a range of design situations.
- The design process is cyclical and ongoing.
- Designers are not limited by the traditional tools, materials and techniques associated with their training or profession.
- When developing your MDP, look to industry and professionals for inspiration and advice.
- Learn from the experience of others so you do not make the same costly and time-consuming mistakes they may have made. Failure is an effective learning process.
- Explore widely to gain inspiration, and always be inquisitive and open-minded.
- Consider the values that different designs place on certain things, and how this influences and provides direction to their designs.

CHAPTER SUMMARY TASKS

1. Define the term ‘design’.
2. List three methods that a designer may use to determine the best possible solution to an identified need or problem.
3. When should research and testing take place in the design process?
4. Why is examining the way other designers work through the design process valuable?
5. Collaborative design work is a common practice among designers. What does this mean?
6. How can collaboration enhance the final product?
7. Explain why successful designers view the design process as a cyclical, ongoing process.
8. Discuss the importance of sketching and modelling as part of the design process to Andrew Simpson.
9. Describe how Andrew Simpson and Cinnamon Lee (see the Interactive Textbook) have utilised technology to enhance their design and production.
10. Both Lyn-Al Young and Andrew Simpson are designers who have specific values. List six points to explain how these values have influenced their designs.

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EXTENSION TASKS

1 Prepare a case study on an Australian designer who works in a similar context to your MDP. Use the internet to search for suitable designers. Prepare a series of questions that you could use to conduct an interview with the designer. Seek advice from your teacher; however, undertake the steps necessary to arrange and undertake an interview with your chosen designer. Present your information using a range of media such as audio and video recordings. If you are unable to conduct an interview with the designer, you could email them a series of questions that will help you develop your case study.

2 Create a detailed Gantt chart based on the activities to be undertaken in your customised design process. Incorporate as many steps as you can foresee at this stage that you will need to work through when developing your MDP. Display the Gantt chart in a prominent place so you can refer to it when working on your MDP. Make it a dynamic 'work in progress' and continue to add new steps that are revealed as you work through the process. This will form a valuable resource for the development of your action plan in the project management section of your folio.

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15 The influence of trends in society on design and production

This chapter explores the influence of trends in society on design and production. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H2.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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15.1 Trends

As designers, it is important that we monitor trends. Keeping up to date with trends will ensure that designs meet the needs of the target market. 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.

SOCIAL INFLUENCES

'Social influences' is an umbrella term that encompasses subtopics 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 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 nationalities can understand them. If you were designing a new school uniform, you may need to include clothing that respects the cultural requirements of traditional followers of a number of faiths.

The cultural significance and etiquettes of Indigenous Australian peoples must also be a consideration. 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. An effort is being made to revive the different First Nations languages, and most media outlets will have an Indigenous affairs department to ensure the views of the first Australians are represented. Much of our early history is being rewritten to incorporate the stories of ancient Australia and the wars of the colonial times.

Social class

A person's socio-economic status is determined by the interaction of their social and economic situations. An implication 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 terms of 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.

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CASE STUDY 15.1

Mangkaja x Gorman collection

Lisa Gorman is a fashion designer from Warrnambool in Victoria. At the age of 13 she began making applique sweaters and selling them to the local craft store. After working as a nurse in Melbourne and in a sales role at a bridal designer, Lisa became inspired by the clothing designs she saw on a trip to Japan, and in 1999 she launched her first fashion collection. Twenty years later, with an Australia-wide reputation and 40 stores across the country, she was invited to collaborate with five Aboriginal artists of the Mangkaja Arts Resource Agency in Western Australia.

She had been interested in working with Aboriginal artists for some time, so she was excited by the invitation but also nervous.

> 'I always felt like I didn't understand the culture well enough or it was too culturally sensitive to work with the artists without the knowledge and support of their community'.

However, a key element of the collaboration was to ensure that the integrity of the artists' work would be protected. Previous designers who had approached Mangkaja had wanted to use work by the artists, without offering them any input into how it would be treated. Manager Belinda Cook approached Lisa because she had seen from Lisa's previous work that she was:

Figure 15.1 A Gorman shopfront

> 'so respectful of artists and showcased artists in their own right, along with beautiful design'.

The Australian Copyright Agency played an important role in negotiating the agreement between Lisa and Mangkaja, which set a benchmark in fashion licensing rights with Aboriginal artists. All of the artists also received appropriate compensation for their work, and at every stage of the process they were consulted on design decisions.

This collaborative approach meant that Lisa spent longer than usual developing this collection, but she feels it was worth it.

Social conscience

Social conscience refers to values; to an individual's and society's sense of right and wrong 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 they remain on the social agenda. Sometimes groups in society have moral or ethical opposition to some innovations (such as cloning). It is helpful for designers to be aware of this and to assess the ethicality of their design.

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GLOBAL INFLUENCES

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, facilitating trade, communication and travel. Satellite communications via phone, fax, email and online conferences are faster and simpler means of communication between nations. Teams in two or more different countries can undertake design and production projects collaboratively. Global trade has a great impact on the economic development of countries.

Design and production for an international market can translate into competitive prices for the consumer. The global reach of the internet means consumers can purchase goods from the other side of the world and have them delivered without ever leaving their homes. This places designers in competition with foreign enterprises, and places pressure on them to find less expensive ways of producing their designs. Producing on a large scale for a larger market is often more cost-effective for the designer, but it also presents a new set of logistical and cultural challenges.

Video

POLITICAL INFLUENCES

globalisation the ongoing process of integrating economies, societies and cultures through global networks

There are many government agencies and laws that influence design and production, operating to protect consumers and manufacturers. Laws in Australia operate on local, state and federal levels. Politicians must ensure through consultation with appropriate community groups that the laws that are enacted meet community needs as well as foster the nation's economic development.

Government funding can be a contentious issue for designers. At a time when global warming is high on the political agenda, there can be more funding available for environmentally friendly designs. Government grants are provided for the development of sustainable technologies like wind farms. In the fight against terrorism, governments will offer support for anti-terrorism and border protection technologies.

Figure 15.2 Government grants are provided for the development of sustainable technologies like wind farms.

The advantage of financial support from government bodies has meant that political trends often impact on the kinds of designs that can pass into the production stage.

Legal requirements can also impact on design and production work. Some of these are discussed below.

Commonwealth Trade Practices Act 1974

The *Trade Practices Act* protects Australian consumers in a range of areas, particularly pricing and product safety. The Act prohibits commercial behaviour or conduct that is unfair, misleading or deceptive. Consumers have implied guarantees and warranties that their purchased goods are of an acceptable quality. The Act also supports the right of consumers to seek compensation from any injury resulting from defective goods. The Commonwealth minister in charge of consumer affairs can also ban or recall products under the provisions of this Act. The full text of the *Trade Practices Act* is available at the Australian Government Federal Register of Legislation website.

Free trade agreements

Free trade agreements allow goods produced overseas to be sold in other countries, sometimes with lower or no tariffs. Visit the Department of Foreign Affairs and Trade website for more information.

Taxes, tariffs and quotas

The Goods and Services Tax (GST) in Australia is a value-added tax. All goods and services, except those that are considered essential, are taxed at a rate of 10 per cent. Tariffs and quotas are in place to protect local industries and to conserve foreign exchange. Tariffs are fixed taxes on goods that are imported.

ACTIVITY 15.1

1. Discuss the importance of having government agencies and policies in place.
2. Create a mind map on how political agenda might impact on design in Australia.

ECONOMIC INFLUENCES

Economics plays a vital role in the success of designers. The state of the economy, be it in surplus or in recession, will impact on sales and (most particularly) on design and production. If the economy is in surplus, people tend to be more than willing to spend money on non-essential items. Thus, when the public is confident, greater spending occurs. However, in a recession there is less public confidence and people show reluctance to use their earnings for non-essential or luxury items. They focus their spending on essential items such as food and shelter. Designers watch the state of the economy very closely.

Economics also plays a pivotal role in manufacturing. With higher costs of wages, land and insurance in Australia, many companies produce offshore. Motor vehicles are no longer manufactured in Australia: see Case Study 11.1 in Chapter 11. This trend is the direct result of the economic situation in Australia.

Overseas production generally involves lower costs, such as cheaper labour, thus providing companies with higher profit margins. This in turn provides the consumer with a more financially attractive product. Some pitfalls of offshore production need to be considered, particularly ethical concerns. Sometimes cheap labour is accompanied by poor working conditions. Taking advantage of economically vulnerable communities should not be condoned.

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Some consumers inform themselves about the labour conditions used in the creation of the product, and they make purchasing decisions based on whether the production of the product is ethically sound. Local industry can be adversely affected by offshore production. If production is sent offshore, workers in Australia may lose their jobs.

In order to ensure stable employment and ethical good practice, it is in our interest to support local production. Products are often identified as Australian made and designed, by packaging and logos. The Australian Government, in turn, promotes the 'buy Australian' message. There is a range of different 'Australian made' logos, including 'Australian Made', 'Australian Grown', 'Product of Australia' and more.

ACTIVITY 15.2

1. Research the meanings of the different logos on the Australian Made website.
2. Debate the following topic in class: 'All Australian designs must be designed and produced in Australia'.

ENVIRONMENTAL INFLUENCES

Every product, system and environment leaves an environmental footprint at some stage in its life cycle. Designers must consider the short-term and long-term effects that their product, system or environment design will have on the environment. Short-term costs may have long-term detrimental environmental impacts. For this reason, it is essential to do a life-cycle analysis. The impact of a design on the environment at all stages – from the extraction of the raw materials, to production and finally to the end-user and disposal of a product after use – should be examined. Designers work from the philosophy of cradle-to-grave; however, to be sustainable they need to be thinking cradle-to-cradle.

Figure 15.3 The Australian food labelling logo displays the percentage of Australian ingredients in the item.

It is a growing trend for companies to be concerned (or appear to be concerned) about the environment. Two major concerns are:

- **Pollution:** The level of air, water and land pollution created in the production and use of a product (focusing on the **greenhouse effect** and the release of carbon emissions).
- **Use of materials:** The use of raw materials, whether they are renewable, scarce or non-renewable resources. Wastage is also an issue.

greenhouse effect the gradual warming of the Earth's surface caused by an increase in gases in the atmosphere (caused by human activity)

Video

A number of environmental issues have become a focus of widespread concern. The use and disposal of plastic bags affects all Australians. We consume about 6.9 billion plastic bags every year. Up to 80 million of these find their way onto our streets and into our parks and waterways.

Video

Another issue of concern to Australians is the depletion of our natural resources – particularly water. Given Australia's propensity to drought and our ever-decreasing water supplies, it is important that suitable technologies are developed to use water wisely and sustainably.

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The cost of oil fluctuates unpredictably – it is a finite resource – and its production and use create a lot of pollution. A related concern is global warming. We are seeing hotter days, more intense and frequent extreme weather conditions, and rising water levels. As a result, there is increased interest in developing alternative energy sources such as solar energy and **biofuel**. Hydrogen fuel is a zero-emission fuel when burned with oxygen that is now being used in commercial fuel-cell vehicles.

biofuel fuel derived from biomass (recently living organisms or their metabolic by-products such as manure)

The trend to be green has impacted on design and production. It is important that we produce products that are ecologically sustainable. Using environmentally sound energy sources will ensure that we are making a positive step towards cutting down water, air and land pollution. Using biodegradable or totally recyclable by-products will ensure that waste disposal is significantly reduced. Government agencies monitor industries to check their compliance with environmental laws.

The need for new products that help minimise our impact on the environment – for example, innovations in solar energy collection such as solar roof tiles – also offers opportunities for designers working in these fields.

ACTIVITY 15.3

Create groups of three to five students. Discuss the following topics:

1. Every design must come complete with a life-cycle analysis that is included at point of sale.
2. Offshore production should not occur for Australian products.
3. Globalisation has improved the world of design.

15.2 Historical and cultural influences on designing and producing

As discussed earlier in this chapter, 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 (migration), economics, changing lifestyles and changes in family structures.

European colonisation 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 and cultural systems. They were self-sufficient and used sustainable land management and agricultural practices to live off the land while minimising their impact upon it. They took care of their needs and did not exploit their Country. They produced most of their tools and clothing using materials from the local environment, and obtained others through systems of trade. These systems of trade allowed them to import materials from outside their local environment. For example, Torres Strait Islander peoples traded goods with peoples from Papua New Guinea, including exchanging sea cucumbers for wood to create traditional warup/buruburu drums.

Modern immigration to Australia began with British colonisation and settlement. World events

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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 the world wars and other conflicts. Our immigrants have introduced many different customs, foods and cultures into Australian society. Therefore, we have seen new products and innovations not seen previously such as the electric wok.

NATIONAL ABORIGINAL DESIGN AGENCY

The National Aboriginal Design Agency (NADA) was established in 2012. The agency was developed to protect and advocate for Aboriginal design. They work on creating partnerships between Aboriginal artists and clients.

NADA hopes to create respectful, meaningful, geographically relevant visual projects and communicate Aboriginal cultural values to the world. Their aim is to incorporate the ancient Aboriginal tradition of storytelling into graphic design, which forms the basis of architectural work in public and corporate spaces, branding and logos, and other visual work.

15.3 Changing social trends

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 prominent positions in society. Women obtained more 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 added to the mix. We have also seen the cost of living rising and average working hours increasing. Domestic or family violence that used to be hidden is now more likely to be recognised, and society is offering assistance in different ways to those who are abused. In general, mental health issues receive assistance today and new programs have been developed to support those who have been diagnosed with mental health disabilities.

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

Let's consider the rise in 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 15.4 There is more support for people suffering from mental health issues.

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15.4 Cultural diversity

Australia is a product of a unique blend of established traditions and new influences. The country's first peoples, the Aboriginal and Torres Strait Islander peoples, are the custodians of the world's oldest continuing cultural traditions. The rest of Australia's peoples are migrants or descendants of migrants or refugees.

Culture may be regarded as a set of spiritual, material, intellectual and emotional features of a social group or society and encompasses the arts, literature, lifestyles, ways of living together, value systems, traditions and beliefs of these peoples. Cultural rights are part of human rights and provide that people have the right to express themselves and participate in the cultural life of their choice.

The cultural diversity of Australian society has resulted in various products, systems and environments based on specific needs of ethnic communities. Each culture has brought traditions and customs with it. These cultures have influenced fashion and food, bringing with them their tools, techniques and experiences. In our education system, and particularly in the world of online learning (where people from a range of backgrounds, cultures and groups may gather to learn), the concept of diversity has gained a new focus. Curriculum today considers gender, religion, ethnic background, language, socio-economic status and disabilities. Our art scene today reflects the nation's Indigenous cultural traditions within a rich mosaic of migrant cultures. Many new agricultural industries have been established to accommodate the changing tastes, often introduced by our migrant population; for example, Asian greens, nashi pears, lychees, olives and wine.

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.

15.5 The changing nature of work

The ways in which we work have changed significantly over the last century. Changes include workplace relations, technological advancements and an increase in the percentage of women in the workplace.

At the start of the twentieth century, the average working week exceeded 50 hours. Workers were expected to labour at least 10 hours a day for low wages. At the turn of the century, many children were introduced into the workplace for two reasons: many people could not afford schooling, so their children had to work; and it was not yet illegal for children to work. Leading into World War II, many professions started to form unions to protect workers' rights. Legislation surrounding minimum wages, maximum working weeks, sick leave, annual leave and long-service leave was introduced. During the 1960s and 1970s, there was more of an emphasis on education. The trend at the start of the twenty-first century was for a larger number of people engaged in part-time work and flexible work hours. Workplace relations have become a political issue, with governments imposing rules and regulations in regard to issues such as leave, dismissal and superannuation.

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Computerisation in the workplace has meant changes in the nature of available work. In many situations, the use of computers has meant the loss of jobs, such as robots replacing humans on the assembly line. At the same time, there has been an increase in employment in the information and communications technology industries.

Computers can be used efficiently to do repetitive and dangerous work, while humans are employed for their creative and problem-solving abilities. Technological changes have impacted on the nature of our work in offices and production settings, and in communication and production processes in many industries.

Figure 15.5 Advancements in communication technologies have enabled people to work from home.

15.6 Technological change

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 with 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.

Technological change has not only impacted on production, but the ways in which designers work. Up until recent times, office workers were required to be physically present at their workplace five days a week. Information and communication technologies now permit working from home or other locations. These technologies allow instant contact between colleagues, even if they are time zones apart. The ease of electronic communication has meant that design teams can work more easily. A medical doctor in Australia may communicate with an engineer in Canada and an orthopaedic surgeon in England to design a new prosthesis. Technological change has had an impact on virtually every aspect of our modern lives.

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

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CHAPTER SUMMARY

- Trends in society impact significantly on design and technological activity. These include public opinion on social, global, political, economic and environmental issues.
- Governments can play a significant role in the success of production and design.
- Tariffs, quotas and free trade agreements protect local industries.
- Legislation, such as the *Trade Practices Act*, monitors and protects consumers' and producers' rights.
- Over time, our lifestyles, nature of work and leisure time have changed vastly as a result of technological advances.

CHAPTER SUMMARY TASKS

1 Name and describe the government bodies that can influence the development of an innovation.

2 Discuss how political influences can impact on the design and production of a product, system or environment.

3 Make a list of products (such as microwave dinners) and services (such as dog-walking services) that have become more prominent due to consumers' busier lifestyles.

4 Discuss how social changes have allowed for developments in home appliances.

5 Identify and describe how environmental factors are being addressed in new innovations.

6 With reference to an innovation you have studied:

   a Critically analyse the ethical issues surrounding this innovation.

   b Discuss the issues arising from trends in design and technological activity. Give specific examples in relation to your chosen innovation.

7 Discuss the influence of consumer awareness of environmental concerns on designs.

8 Economics plays an integral role in the success of a product. Discuss this statement using specific examples to justify your argument.

9 Outline how technological change has impacted on our lifestyle and the nature of work in Australia in the twenty-first century.

10 Analyse the role of technological change in everyday products.

EXTENSION TASKS

1 Analyse how multiculturalism has influenced the design of some products. Provide specific examples.

2 Create a 15 to 20 minute-long podcast on an alternate energy source. You want to highlight both the environmental and social impacts of this technology.

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16 The impact of design and innovation on society and the environment

This chapter explores the impact of design and innovation on society and the environment. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H2.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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16.1 Ethics

Ethics is defined as doing right or wrong based on one's personal values, customs or beliefs. Ethical considerations can be subjective – they depend on a person's point of view and cultural influences. There are a number of ethical issues related to design and innovation. These include protection of intellectual property (such as patents, copyright and plagiarism), the rights and responsibilities of the designer and the impact of design on Australian society and the environment.

Design and innovation sometimes force us to consider our ethical position. Our values and morals may be called into question over the potential of innovations such as:

- genetically modified foods
- stem-cell research
- genetic engineering
- artificial intelligence
- surveillance technology.

drone an unmanned aerial vehicle (UAV)

As environmentally aware consumers, we may choose products that are promoted as 'green', but do we consider all the other factors involved around this product – the packaging, the energy used in its production, the transport to bring it to the retailer? Sometimes a 'green' product has just changed in one small area, such as packaging, but the manufacturer is still using the same harsh chemicals or is responsible for huge emissions in their transport.

There has been a steady move towards making industries more accountable for their actions, decisions, production methods, working conditions and the treatment of employees. Businesses continue to be held morally and ethically responsible not only for the health and safety of their employees, but also to the wider community. The law enforces safe working conditions and systems of work. Designers must account for the health and safety of the end-user.

Developing technologies often amaze and excite us. However, we have a responsibility to consider the consequences of new technologies – and make an ethical stand. Often this means making difficult decisions.

Surveillance technology has generated mixed reactions. Many will feel negative about the use of **drone** technology in war or in spying, but we should also consider how it can be used to take emergency medical supplies to areas where there are no roads, such as in parts of outback Australia, or where congestion traffic is impeding movement. Satellite technology is used to protect the world's forests and wildlife – tracking animals in their natural habitat, monitoring the health of wildlife or detecting poachers via thermal imaging. As designers, we will be making decisions about the uses and possible consequences of our products, systems and environments.

Designers should consider the short, medium and long-term effects of their work and aim to reduce negative consequences. Ethical issues are not only relevant to the product or the community at large. Designers have ethical obligations to themselves, their peers and their design.

A DESIGNER'S RESPONSIBILITY

In an ideal world, all designers would operate with a sense of responsibility towards individuals, society and the environment.

Designers have legal and ethical responsibilities that include:

- working within customers' deadlines, budget constraints and quality expectations
- ensuring that the goods are priced reasonably and of good quality

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- avoiding any conflict of interest and maintaining client confidentiality
- rejecting all forms of plagiarism
- considering social and cultural implications of their work
- addressing environmental and sustainability issues.

There are many questions that designers have to consider in their decision making. Would you use a material that was produced in a questionable environment or with child labour, even if it was cheaper and of good quality? Would you take on a client whose business was ethically disturbing to you, even if the payment was going to determine your business survival? How far would you stretch the truth to help a client market their product or service? When you take inspiration from another designer, how much of that designer's work becomes incorporated into your design and how close might you be to copyright infringement?

Read the Design Institute of Australia's Code of Ethics which is available online.

INTELLECTUAL PROPERTY RIGHTS

Organisations and legislation that protect designers include IP Australia, Standards Australia, and the *Trade Practices Act*, workers' compensation and the Australian Competition and Consumer Commission (ACCC). These organisations and legislation are in place to protect the safety and rights of the designer. The following are some of the systems in place for protection of designers' intellectual property rights.

Registered designs

Some designs are formally registered, protecting the visual appearance of the product that makes it unique. This registration protects the shape, configuration, pattern and decoration, but not the actual workings. The design must be new (not previously used in Australia) and distinctive (no other product that is substantially similar in appearance exists in the public domain) to be registered.

Patents

A patent is a legal right that may be granted to protect a device, substance, method or process. The patent gives the owner the legal right to promote the product for commercial gain. Artistic creations, mathematical models, plans, schemes or other intellectual processes cannot be patented.

Patents have to be applied for through the Patent Office of IP Australia. A standard patent will provide protection for up to 20 years while an innovation patent is a faster and less expensive option, although it only lasts a maximum of eight years. Once an invention is patented, the owner is obliged to provide a full description of how the invention works. This information becomes public and may be used by others for further research and development.

Copyright

Copyright protection is free and is granted for original works of art, music, sound recordings, films, broadcasts, computer games and literature. Material is protected as soon as it is created, both here in Australia and overseas. Under the *Copyright Act 1968*, licence must then be obtained to perform, copy, broadcast, adapt or publish that work in public. The symbol denoting copyright is ©.

Trademarks

A registered **trademark** provides the legal right to use, license or sell a particular item or service in Australia. Trademarks are used to differentiate between goods and services. They may take the form of a word, phrase, letter, number, sound, smell, shape, logo, picture, aspect of packaging or any combination of these. The symbols denoting a trademark are ™ or ®.

trademark the name or other symbol used by a manufacturer to distinguish its products from those of competitors

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CASE STUDY 16.1

Driverless cars

Most modern vehicles now have some form of partial automation, while a growing number now offer advanced systems, such as adaptive cruise control, and self-parking capabilities are becoming increasingly common.

The term 'driverless' refers to all vehicles which have higher levels of automation, beginning at the point where a driver may not need their hands on the steering wheel but is ready to take over control, right through to where a vehicle does not need a driver and may not even have a steering wheel.

As technology evolves, driverless cars will continue to use a variety of technologies to monitor their surroundings such as radar, laser light, GPS, odometry, **algorithms** and computer vision.

algorithm a set of steps used to solve a calculation or problem

Advanced control systems will be able to interpret sensory information to identify the most appropriate navigation path, as well as detect obstacles and relevant signage.

ADVI (Advanced Driverless Vehicle Initiative) is the peak industry body accelerating the safe and successful introduction of driverless vehicles onto Australia and New Zealand's roads. According to this body, there are five distinct levels on the journey towards fully driverless vehicles, ranging from no automated technology right through to vehicles that can operate without anyone and may not even have a steering wheel.

When discussing the ethics around driverless cars often the topic of the Trolley Problem emerges. The Trolley Problem is a thought experiment paper published in 1967 by a philosopher named Philippa Foot. In her paper she discussed a scenario of a driver of a runaway tram (trolley) who is faced with a dilemma. 'He can only steer from one narrow track on to another; five men are working on one track and there is one man on the other; anyone on the track the tram enters is bound to be killed.' (In recent years, the Trolley Problem has also been popularised by the television comedy *The Good Place*).

In June 2016, a study on moral preferences for machine intelligence was held and the paper on the project was published in *Nature*, in October 2018. People were invited to play a game called Moral Machine. In the game, players were presented with an adaptation of the Trolley Problem. In the game the participants were faced with a situation where a driverless car can either stay its course and hit what is in its path or swerve and hit something else. Each round featured a new version of the problem, with different obstacles and different groups of people to be killed or spared.

In the next two years, more than two million people took part in the study, registering more than forty million decisions.

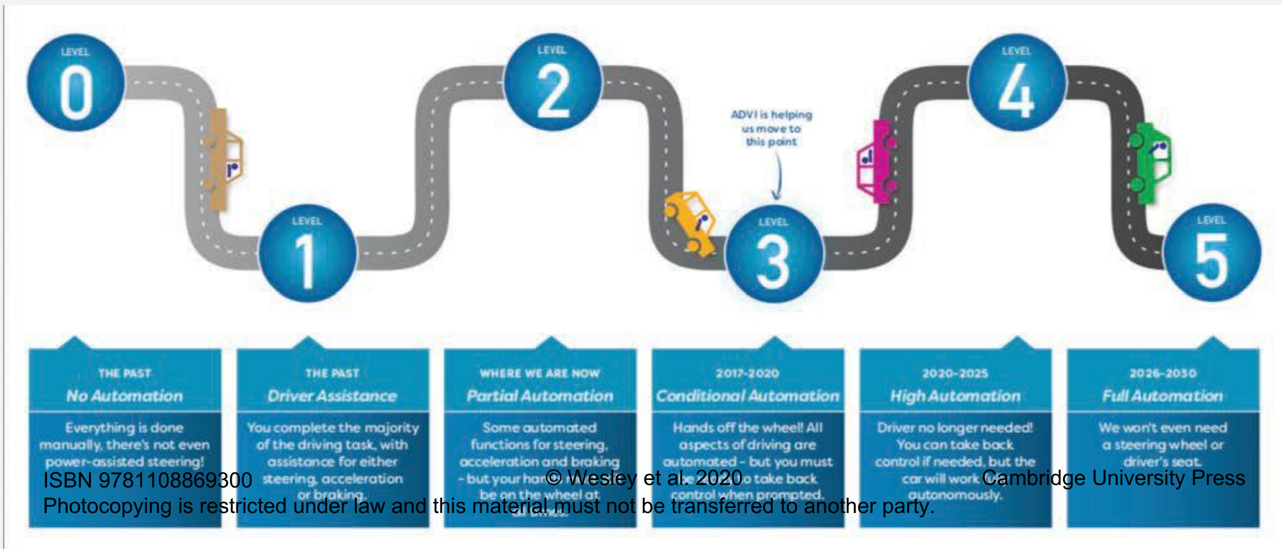
In 2017, the German government released a report that suggested a set of guidelines for driverless vehicles. The report contained twenty propositions, which included 'In the event of unavoidable accident situations, any distinction based on personal features (age, gender, physical or mental constitution) is strictly prohibited.'

In the not too distant future, a large proportion of cars could be driverless. If companies decide to adjust software to choose the driver over pedestrians, then many of us could feel very unsafe.

Video

Figure 16.1 The interior of a driverless taxi, September 2017. A test engineer was present in the car during the rides in order to monitor the car systems operation.

Figure 16.2 Levels of automation



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ACTIVITY 16.1

Based on the information in Case Study 16.1 and further online research, critically analyse the ethical concerns regarding the introduction of driverless cars in Australia.

16.2 Environmental issues

Environmental groups have made society and our governments more aware of the need to protect the environment through lobbying, organising petitions and protests, and issuing media releases. Many industries and employers readily adopt green technologies and take advantage of government assistance and subsidies to do so.

The Environment Protection Authority (EPA) now requires all industries to take reasonable steps to preserve and protect the environment and habitats, and even to recycle their waste. There have been several legislative changes that reflect this heightened concern for ecological sustainability and the EPA continually develops programs to encourage sustainable activity. Waste Less, Recycle More is the largest waste and recycling funding program in Australia. It is designed to stimulate investment in infrastructure to meet the ambitious recycling, illegal dumping and littering targets adopted by the New South Wales Government. There is growing community concern about the impacts on health and amenity associated with particulate matter (PM) emissions from coal mining in New South Wales. The EPA has undertaken a range of initiatives and actions in relation to the management of PM emissions from coal mines.

Visit the EPA of NSW website to find out more about their activities.

ACTIVITY 16.2

Visit the Department of the Environment website and explore the topic of air quality. Debate the issue: 'Air pollution is the most important environmental issue of our time.'

GLOBAL WARMING

Global warming is caused by an increase in greenhouse gases in the Earth's atmosphere. The main greenhouse gases are water vapour, carbon dioxide, methane and nitrous oxide, as well as some manufactured gases such as chlorofluorocarbons and some of their replacements. Governments, industry and communities now recognise the necessity of reducing the level of greenhouse gases caused by human activity – particularly by the burning of fossil fuels and land clearing.

POLLUTION LEVELS

Pollution includes water, soil, air and noise pollution. Water pollution occurs where run-off and waste from production plants are pumped into the water system, thus impacting on the life forms in the waterways. Soil pollution occurs when toxic waste seeps into the soil, thus making the area contaminated and unproductive. Land pollution and landfill are often the result of packaging or single-use products that do not easily biodegrade, such as plastics.

Air and noise pollution can be created in the production process, by transportation and at the end-use stage. In the production process, it can be quite noisy when high-powered tools and hydraulics systems are used. It is the manufacturer's responsibility to ensure that noise restrictions in particular areas are abided by and that workers use correct protective equipment. Users of modern technology can even contribute to noise pollution by speaking loudly on mobile phones in public places and playing loud music in their cars.

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ACTIVITY 16.3

Read the article 'Australia's cotton production halved as drought and low to no water allocation takes its toll', which is available online at https://cambridge.edu.au/redirect/8732. Alternatively, research other articles on drought in Australia.

16.3 Impact on society

Design can have both a positive and a negative impact on Australian society. If a park in the centre of a town is well designed, it can strengthen community relations and improve the quality of local life. A poorly designed area, such as one that is poorly lit, can encourage antisocial activity. The subjects of sustainability, energy saving and use of resources have featured heavily in cultural debates about urban design and have led to greater consideration of design impacts on society. A consideration of both the spatial and visual quality of the civic realm is a staple concept of urban design and management.

Design has an impact on our economy, safety and well-being, and community and cultural spaces. Good design can bring enormous social benefits and reduce costs to finance and health.

ASSESSING THE IMPACT OF DESIGN

Designers should complete an in-depth assessment of their product, system or environment. Thorough assessment may reveal the kind of impact on society a design will have and help ensure that it is a positive rather than a negative one.

The life-cycle analysis (LCA) is a critical step in the design and production process. The impact of each material, tool and technique on the environment and society cannot be overlooked. Moreover, an LCA must be employed from the extraction and processing of the raw materials to the disposal of the products after their useful life. Life-cycle analysis identifies energies used and its environmental impacts AND material and its environmental impacts used at each stage in production and design.

ACTIVITY 16.4

Discuss with a partner how the following innovations have impacted on Australian society. Consider both the positive and negative repercussions of their design:

1 social media applications
2 industrial robots in assembly lines
3 high-rise apartment blocks.

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Figure 16.3 Wind power is one of the cleanest sources of renewable energy available.

16.4 Sustainable technologies

The philosophy behind sustainable design is to use a design process, and produce a final design that is socially, economically and environmentally sustainable.

Sustainable design is common practice among modern designers, who seek to reduce their impact on the environment and use technologies that can be produced and maintained without exhausting other resources such as energy.

SUSTAINABLE ENERGY SOURCES

Fossil fuels are finite. One day there will not be any crude oil, natural gas or coal left. It is important that research and development is conducted to devise alternative sources of energy for future generations. It is also important to ensure that these technologies are environmentally friendly and sustainable. Renewable energy systems are becoming more efficient and cheaper and their share of total energy consumption is increasing.

Solar power

Solar power systems convert energy from sunlight into direct current electricity. An inverter then converts this direct current to alternating current, to make it compatible with grid electricity. Solar power systems are oriented to the north and inclined (tilted) in order to generate the maximum amount of electricity from the sun. Many solar power systems store electricity in batteries for use when the sun is not shining and are called stand-alone power systems.

Biofuel

Biomass is biological material derived from living or recently living organisms, plants or plant-derived materials. Conversion of biomass into biofuel can be achieved by different methods – thermal, chemical and bio thermal. Plant energy is produced by crops specifically grown for use as fuel. Biomass can be converted to other usable forms of energy such as methane gas or transportation fuels such as ethanol or biodiesel.

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Biofuel is the only renewable energy source that is able to store solar energy. It can be found in a solid, gas or liquid state and used in a number of different ways. There has been a popular push to use biomass energy in cars, as it is not as polluting as petrol and is more cost-effective. Hydrogen fuel is a zero-emission fuel when burned with oxygen. It can be used in fuel cells or internal combustion engines to power electric vehicles or electric devices. It has been used in commercial fuel-cell vehicles, such as passenger cars, and fuel-cell buses – and it has also been used for spacecraft propulsion. Hybrid cars are becoming more popular for personal use.

Energy from hot rock

Australia has a great source of geothermal energy. It is derived from well below the Earth's surface. This energy is harnessed by drilling bore holes to penetrate the hot granite rock, which is situated approximately five kilometres below the ground. Water is pumped through the holes. As the water travels through these bores it heats up, producing steam that can be used to generate electricity.

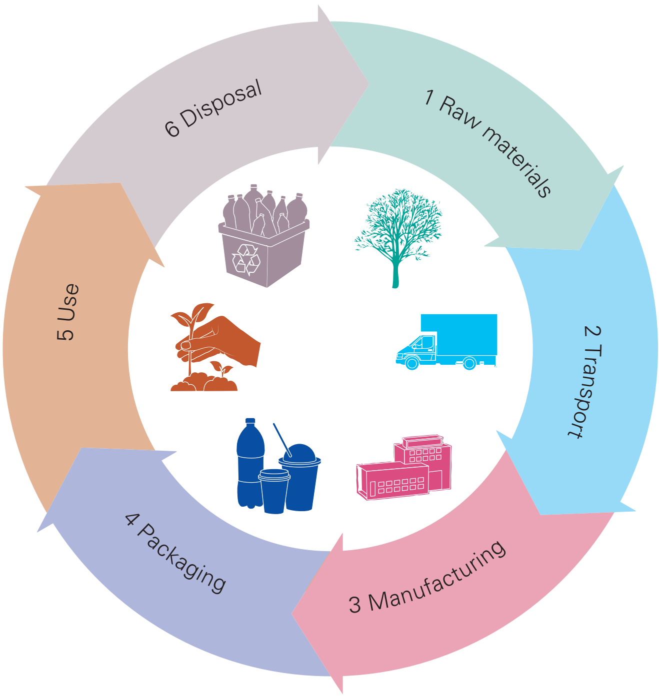

Figure 16.4 The production process

Energy from water

Energy can also be harnessed from flowing water. It is called hydroelectricity. Usually water from a river is collected in a dam and allowed to flow through a turbine, which uses a generator to produce electricity. The flow rate of the water determines the amount of energy produced. The generation of hydropower does not produce any greenhouse gas emissions. Water can be a scarce resource, but it is a renewable resource because it is constantly replenished through the process of the hydrological cycle. Wave power, which captures the energy of ocean surface waves, and tidal power, which converts the energy of tides, are two forms of hydropower with future potential.

Wind power

Wind turbines are used to convert wind energy into a form of energy such as electricity. Large-scale wind farms are connected to the electrical power transmission network. This is a popular form of energy, and one supported by the government, because it is plentiful, renewable and clean, and there are no greenhouse gas emissions.

Video

Most Australians are not aware that over 90 per cent of the electricity they use is generated by burning coal. This creates greenhouse gas pollution that contributes to global warming and climate change. The government provides support for the development of technologies like clean coal energy production.

WHAT IS GREENPOWER?

The GreenPower Program (the Program) is a government-managed scheme that enables Australian households and businesses to replace their electricity usage with certified renewable energy. The Program was launched in 1997 after

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considerable consultation with the energy industry and various non-government organisations including the Australian Consumers Association (now Choice), Greenpeace, the Australian Conservation Foundation and the World Wide Fund for Nature.

The aims of the Program are to:

- facilitate the installation of new renewable energy generators across Australia beyond mandatory requirements
- encourage growth in consumer demand for renewable energy
- provide consumer choice for and increase consumer confidence in credible renewable energy products
- increase consumer awareness of renewable energy and greenhouse issues
- decrease greenhouse gas emissions associated with electricity generation.

As a result of Australian businesses and households purchasing GreenPower, more than $500 million has been invested back into Australia's renewable energy sector in the last five years. GreenPower lists providers for businesses and households by state on their website.

Source: GreenPower, https://cambridge.edu.au/redirect/8940

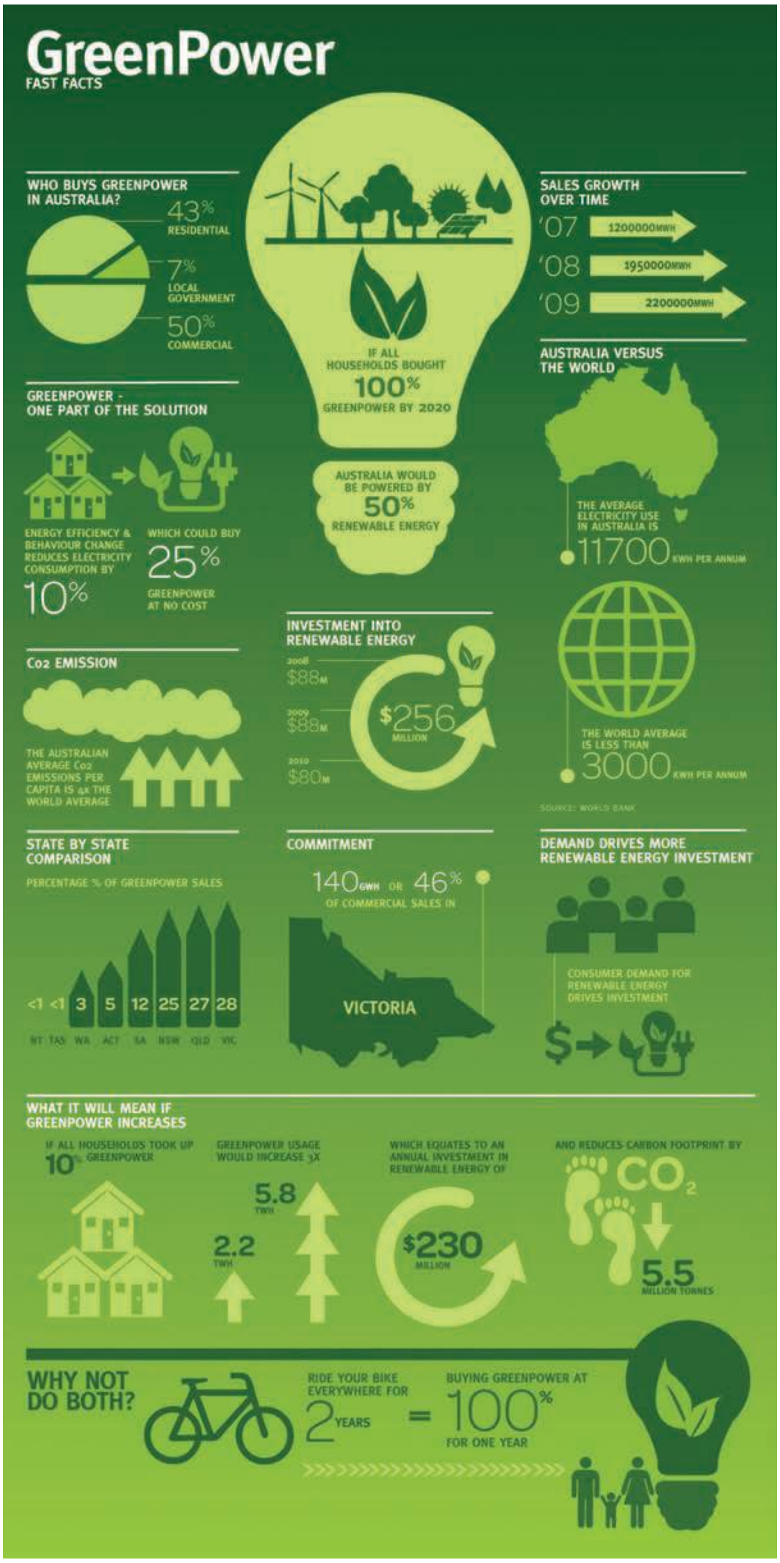

Figure 16.5 GreenPower: fast facts

ACTIVITY 16.5

1. Define GreenPower and why it is important to invest in.
2. Complete a life-cycle analysis for a product, system or environment that you have studied in class. Include the energy and materials used in each stage and the impact the product has on the environment.

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CHAPTER SUMMARY

- Designers should consider ethical and environmental issues when designing.
- Designers must carry out a life-cycle analysis on each product, system or environment and their components, as part of the design process.
- It is the responsibility of the designer to protect their ideas through IP Australia. This can be done through patents, trademarks and registered designs.
- Designers have rights and responsibilities and must ensure that they carry them out.
- All products, systems and environments have an impact on society in some way.

CHAPTER SUMMARY TASKS

1 Define sustainable technologies.

2 Identify and describe the ways in which designers can protect their intellectual property.

3 Critically evaluate the impact an innovation you have studied has had on the environment and society.

4 Describe the ethical and moral responsibilities designers should abide by. Give specific examples.

5 Identify the factors that contribute to global warming and describe the impact of global warming on the environment.

6 Discuss the importance of using renewable resources. Use examples to support your answer.

7 Explain the importance of educating consumers on the life cycle of a product.

8 Complete a life-cycle analysis on the following products: a wool blanket, a pair of jeans and a glass vase. Discuss ways in which these products could be manufactured more efficiently to lessen their environmental impact.

9 Designers must carry out a life-cycle analysis on each product, system or environment. Complete a life-cycle analysis for your major design project (MDP).

10 Analyse the impact that your MDP will have on society and the environment.

EXTENSION TASKS

1 Critically analyse ethical and environmental issues relating to expanding urban development.

2 Drone technology is used in many different environments. Discuss the ethical issues in relation to this innovation.

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17 The factors that influence innovation and the success of innovation

This chapter explores the factors that influence innovation and the success of innovation. In order to develop a clear understanding of the content of this chapter, carefully examine the ‘Students learn about …’ and the ‘Students learn to …’ statements relating to **Outcome H3.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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17.1 Design and innovation

Innovations are changes or improvements to existing product design and manufacturing processes. Innovative designers are involved in change and the creation of opportunities to bring about change in order to improve our quality of life.

Three hundred years ago, we lived in an agricultural environment, relying on land and labour. During the Industrial Revolution of the nineteenth century, machines were developed to produce goods and services on a large scale. Production was the key to economic success – the more that was produced, the more the economy grew. Technological development focused on the plant and equipment needed for production.

Today, knowledge has replaced land, labour and finance as the most important resource for economic development. The leading organisations of the future will be those that are able to gain value from information; in other words, that can innovate.

17.2 Factors that contribute to success or failure

There are many factors that contribute to making an innovation successful. These include:

- timing
- available and emerging technologies
- historical and cultural, political, economic and legal factors
- marketing strategies.

An innovative design will not only be aesthetically pleasing but will also function better than its precursors and bring benefits to the economy and culture into which it emerges. The innovator will always be looking to find a point of difference for their product, system or environment.

Innovation is about taking new ideas or improvements successfully through to the marketplace. It concerns predicting and satisfying customers' needs and wants, leading to improvements in people's lives and increased prosperity and well-being.

TIMING

In addition to function and aesthetics, another factor that can impact on the success of innovation is timing. The timing of when a product emerges can determine its success or failure. Manufacturers and retailers may wish to stimulate demand for a new product, which they will do through effective marketing. Most fashion items, whether clothing or household goods, are cleverly marketed to ensure a demand is created. At the other end of the scale, consumers may create the demand for a product, and this will often be in response to trends. Innovators respond to consumer trends in order to ensure success. Many products are launched at particular times of the year. Mother's Day, Father's Day and Christmas are peak marketing times.

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CASE STUDY 17.1

Dyson Lightcycle task lights

The Dyson Lightcycle task light is designed to promote well-being as well as limit eye strain for users.

The main feature of the Lightcycle task light is that it is engineered to emulate natural light throughout the day, imitating the brightness and colour temperature range of natural light for that time of the day. As such, it aligns with the body's circadian clock. In the workplace, it aims to boost productivity while reducing eye fatigue.

The Lightcycle task light contains an ambient light sensor that enables it to detect any variations in the background light and to then react to the variations to assure a consistent light level on the workspace.

Moreover, in order to lessen its carbon footprint, and save on energy bills, the light includes an infra-red movement sensor that switches the light off if its user has been away for two minutes and switches it back on once the user comes back. The motion sensing can easily be turned off temporarily if the activity (such as typing on a keyboard) is susceptible to mislead the sensor into presuming its user is away.

The light also incorporates slide-touch controls enabling the user to manage their light preferences, in terms of brightness (from 100 lux to 1000 lux, with the recommended light level for indoor activities being commonly in the range 500–1000 lux) and colour temperature range (from warm whites to daylight).

The user can also use the Dyson Link app on their mobile phone to control and adjust the light, in accordance with their activities and daily routine.

To reduce maintenance costs, the light uses heat pipe technology (heat-transfer device relying on both conductivity and phase transition) to cool its LEDs, mitigating their overheating, which can lead to fading and discolouring. As a result, the light quality should remain the same up to 60 years.

The Lightcycle task light also includes convenient features such as a USB charging point and simple controls to position the light horizontally, vertically and through 360°.

Video

Figure 17.1 Dyson CEO Jim Rowan introduces the Lightcycle.

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AVAILABLE AND EMERGING TECHNOLOGIES

When the reasons for the development of new products are discussed, two terms are often used: 'market pull' and 'technology push'. The marketplace will often pull companies to produce items that are demanded by the consumer. At the same time, the development of new technologies enables new products to be pushed into the marketplace. Usually there is a combination of both. Often new technologies will enable a designer to improve on an existing product that has already been accepted by the marketplace.

The Global Positioning System (GPS) uses a set of satellites to pinpoint the position of a GPS device. This technology, an essential element in the global information structure, has led to the development of many new products. GPS capability is now a feature of a wide range of devices and machines, including mobile phones, wristwatches, bulldozers, shipping containers and ATMs. GPS technology boosts productivity in a range of industries – farming, construction, mining, surveying, package delivery and logistical chain management. The continuing development of this technology has enabled the entrepreneur to find new uses and successfully bring them to the marketplace. You may have a navigation system in your car that operates using GPS, or you may have a wearable device that will determine your position when you are hiking, or you may have a find-my-phone app – all products developed from GPS technology.

Technologies can be divided into three different categories – critical, enabling and strategic. Critical technologies are those that are used to develop products. Enabling technologies are those that are needed to make use of the critical technologies. Strategic technologies are emerging technologies that are crucial to further development and new products – they become the critical technologies of the future.

ACTIVITY 17.1

1 Discuss the benefits of GPS technology to delivery companies.
2 Research the use of GPS technology in field and team sports. Discuss the expected benefits.

ACTIVITY 17.2

Search for the video 'What is RFID? How RFID works? RFID Explained in Detail' by All About Electronics on the internet.

1 Describe how the RFID technology works in the smart school bag.
2 Research how the RFID chip can be used in other industries, select two examples and describe how this technology is used.
3 Discuss how RFID technologies can lead to the emergence of innovations such as RFID blocking technology and products.

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CASE STUDY 17.2

Smart school bag

Dr Hamid Abdi, an engineer from Deakin University, led a team of university students to invent the smart school bag. The idea came to him after his son left one of his school assignments at home. (Does this sound familiar?) Dr Abdi spent the next year asking other parents to what extent they were plagued by the under-packed school bag. This research showed a need for such a product. His brief required the team to engineer a 'smart' school bag that knows whether or not it is packed properly according to the demands of the day's timetable.

The school bag has built-in hardware and software, which ensures that each item that is required for a particular day (including lunch and sport gear) is packed in the school bag. By using this technology, you will only pack what is required. The school bag, through an app, can send messages and alerts to students, parents and even teachers!

The smart school bag uses radio frequency identification (RFID) tags to detect items in the bag and the Internet of Things (IOT) technology to check its contents against the daily school timetable. An RFID chip is a tag attached to items in order to track them using an RFID reader and antenna. They are similar to barcodes, but don't need to be in the line of sight of the reader to be recognised. A mobile application identifies the items in the bag and checks them off against the school needs, identifying any missing items.

This technology has many side benefits including ensuring only the necessary equipment is taken to class, thereby increasing productivity and limiting the bag's weight, causing less strain on the back.

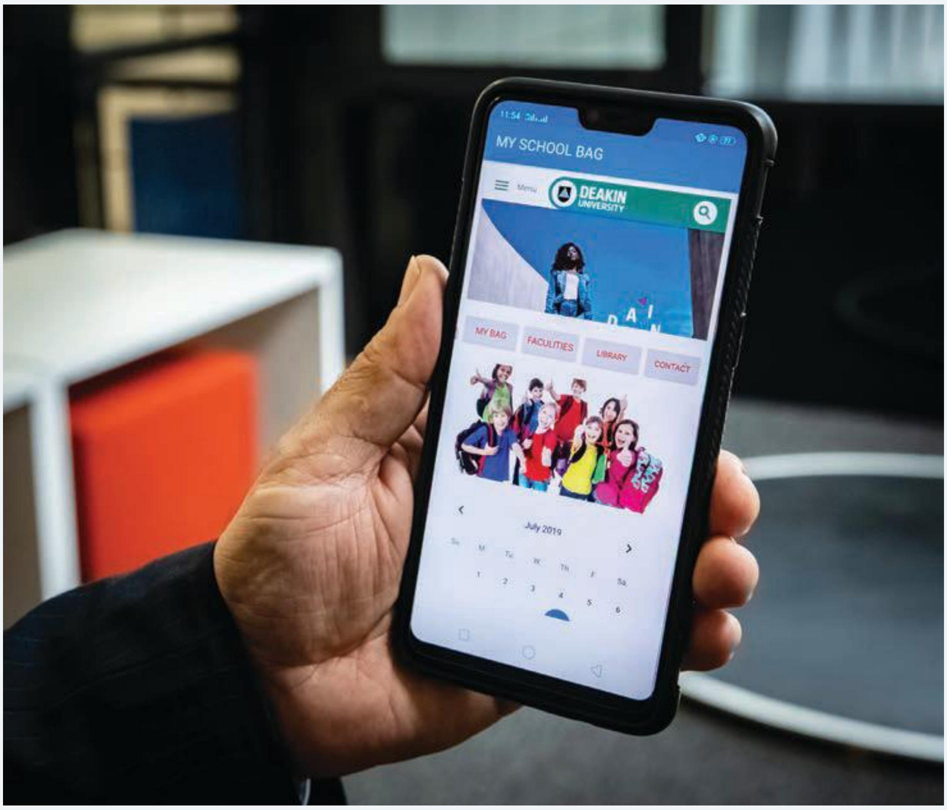

Figure 17.2 Mobile app for smart school bags

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HISTORICAL AND CULTURAL FACTORS

The innovator must consider the historical and cultural environment – the beliefs, values and behaviours of the consumers who form the target market. Companies actively work with pressure groups such as animal liberation activists, environmental groups, cultural leaders and religious groups to ensure that their products are appropriate, both socially and environmentally. Today, for example, consumers will not accept washing detergents that are not biodegradable, as society is concerned about the environmental impact of products.

POLITICAL FACTORS

Governments can also influence the success or failure of innovation. The government plays a significant role in trade agreements and policies. Wind farming as a source of renewable energy has developed in Australia because the state and federal governments support sustainable living. Likewise, government support (in the form of funding) is provided for the development of water-saving designs that respond to the environmental concerns of the time.

ECONOMIC FACTORS

A growing economy can be good for designers of new products, as consumers are more willing to spend money and try new ideas. At the same time, financially secure buyers expect quality and sophistication in their products and will not accept goods that do not meet expectations. A slowing economy may also affect innovation, as products must become more efficient.

LEGAL FACTORS

legislate to create, provide or enact laws

The governments of Australia **legislate** to protect the rights of workers and consumers. Labelling laws are in place to ensure consumers are well informed. Industry must be aware of these laws if its products are to be successful. The Australian Tax Office (ATO, which collects revenue for the Commonwealth Government), trade agreements (regulating the importing of resources or offshore production) and the Australian Competition and Consumer Commission (ACCC, which monitors the legality of trade) are three examples of government-led impacts on product development. Standards Australia sets the standards for new and existing products. Innovators must meet these standards.

MARKETING STRATEGIES

A product's marketing strategy (which includes the size of the market, the consumer demand and the product promotion) can impact on the success of an innovation. Even the best product will be hard to sell if no one knows about it. To be commercially successful, a product must satisfy consumer demands. The marketing strategy explains how a business plans to market a product. It involves evaluating the market environment, determining the demand, making decisions about supply of the product and setting achievable goals. The elements of marketing are often described as:

- people – potential customers
- product – aesthetics, function and special features
- price – setting the price at an appropriate level
- promotion – advertising the product through a number of media, including TV, radio, magazine advertisements
- packaging – providing information, protection and presentation of the product.

Each of these elements interacts with the others in the marketing strategy. To be successful, a new product must stand out from its competitors. A good innovation will have unique selling points.

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ACTIVITY 17.3

Visit the CSIRO website. This organisation uses government funding to research and develop new technologies. Explore the section titled 'Research divisions' and select three innovations that interest you. For each innovation:

1. Describe the innovation. Ensure that you clearly identify the underlying and emerging technology.
2. Analyse the factors that impact on the success or failure of that innovation.
3. Evaluate the impact of that innovation on the individual, society and the environment.

17.3 Agencies that influence innovation

There are many agencies that impact on innovation. The innovator needs to be aware of those that protect their designs, those that will provide assistance in the development of the innovation and those that regulate design and production. Some of these were explained in the previous chapter and more are explained below. There may be others that could impact on specific innovations.

STANDARDS AUSTRALIA

Standards Australia is recognised for its role in maintaining standards and setting benchmarks for industry, government and the Australian community. It is a non-government organisation that operates with the support of government.

Standards are published documents setting out specifications and procedures designed to ensure products, services and systems are safe, reliable and consistently perform the way they were intended to. They establish a common language which defines quality and safety criteria. If an innovation meets these standards, it is more likely to promote consumer confidence, global competitiveness and also financial support from investors. Thus it is advantageous to innovators to ensure their products meet the Australian Standards.

Maintaining these Australian standards in the development of innovations provides consumer confidence, assists in attracting investment and allows global competitiveness – all key factors in the success of a new product.

Source: Standards Australia, https://cambridge.edu.au/redirect/8941

IP AUSTRALIA

It is important that designers protect their intellectual property. Inventions, trademarks, original designs or practical applications of ideas all need to be legally protected, as intellectual developments are often the edge that sets successful companies apart from their less innovative competitors. Innovators go to IP

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Australia to protect their designs. A range of different protections exists for intellectual property, including:

- patents for new or improved products or processes
- trademarks for letters, words, phrases, sounds, smells, shapes, logos, pictures, aspects of packaging or a combination of these, to distinguish the goods and services of one trader from those of another
- designs for the shape or appearance of manufactured goods
- copyright for original material in literary, artistic, dramatic or musical works, films, broadcasts, multimedia and computer programs
- circuit layout rights for the three-dimensional configuration of electronic circuits in integrated circuit products or layout designs
- plant breeder's rights for new plant varieties
- confidentiality/trade secrets including know-how and other confidential or proprietary information.

Source: https://cambridge.edu.au/redirect/8942

An innovator must take formal steps to obtain legal ownership of their idea by registering for intellectual property protection. Through the Patents Office at IP Australia, innovators can apply for a patent on their design. The Patents Office will decide whether or not the design meets the legislative requirements. Registering with IP Australia does not provide international protection; this needs to be done separately.

The electrical powerboard is an example that demonstrates the need to apply for a patent. The design team at Kambrook produced this innovation in 1971, but failed to patent the powerboard concept. Today, Kambrook has to share the market for this highly successful product with many other manufacturers.

Visit the IP Australia website for more information.

SMALL BUSINESS COUNCIL

In 2003, the Australian Government established the Small Business Council (SBC) to advise on the broad range of issues that impact on small businesses. This consultative body offers advice to government, identifies factors that impact on the growth and development of small businesses and investigates possible solutions to problems associated with this sector. Other organisations that support small businesses are the National Small Business Forum, the ACCC Small Business Advisory Group, the Office of Small Business and the Commissioner of Taxation's Small Business Consultative Group and Small Business Advisory Group.

Figure 17.3 Durable polymer bank notes are an Australian innovation.

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Through the SBC website innovators can remain informed of current issues and changes as well as provide feedback to the government. Some of the topics discussed in this forum include:

- reviews conducted by the Professional Standards Board for Patent and Trade Marks Attorneys
- information about government funding for research and development
- an action plan for Japanese tourism, to help address the downturn in the Japanese tourism market
- information about innovations coming onto the market
- information about relevant conferences such as the Energy Users Association of Australia Conference.

Another government initiative to assist new businesses is the highly successful Business Entry Point. Visit business.gov to view information about this service.

AUSTRALIAN COMPETITION AND CONSUMER COMMISSION

The Australian Competition and Consumer Commission (ACCC) is an independent authority that administers the *Trade Practices Act 1974*. It works to protect consumer and business rights while also monitoring industry regulations, pricing and unauthorised anti-competitive behaviour.

Penalties are quite severe for those who do not abide by the *Trade Practices Act*, so it is important that all designers are aware of its regulations.

Visit the ACCC website for more information.

AUSTRALIAN SECURITIES AND INVESTMENTS COMMISSION

The Australian Securities and Investments Commission (ASIC) regulates financial services, ensuring that trading is fair and ethical. An innovator can receive advice from ASIC about opening, running and closing a company, as well as information about licensing and compliance. The wide range of knowledge available through the ASIC website will be useful to all people in business. The site provides information about managed investment schemes, scams, financial tips, markets, financial reporting and publications, among other things.

Visit the ASIC website for more information.

AUSTRALIAN CENTRE FOR INNOVATION AND INTERNATIONAL COMPETITIVENESS

The Australian Centre for Innovation and International Competitiveness (ACIIC) addresses a broad range of issues related to the development of effective strategies and policies in science, technology and innovation in the public and private sectors.

Visit the ACIIC website for more information.

Video

ACTIVITY 17.4

Spend 10 minutes exploring the ACIIC website, then answer the following questions:

1. What is the role of ACIIC?
2. Explain why ACIIC believes innovation is important to our economy.
3. Why would this agency be useful to an innovator?
4. After reading about each of the following, write one or two sentences to explain the meaning of each of the following concepts:
   a. globalisation
   b. knowledge economy
   c. connectivity
   d. futures.

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17.4 Entrepreneurial influence on design and innovation

Entrepreneurial activity is concerned with the creation, evaluation and exploitation of ideas – making good ideas into a commercial success. It involves recognising those ideas that have potential for a successful commercial venture and the ability to take those ideas through to the creation of a successful product. There is a certain amount of risk-taking involved in entrepreneurial activity, including an understanding of all the factors that can impact on the success or failure of business and the ability to manage these factors to achieve a position of advantage. It is often stated that entrepreneurs create their own futures, rather than accepting the roles determined by others. These people have particular personal characteristics that foster the process of entrepreneurial activity. They are usually:

- passionate about their work
- problem-solvers
- innovative in the use of technologies
- prepared to persevere
- risk-takers – fearless about changing direction
- visionary
- unorthodox
- willing to delegate
- good managers of finance, time and people
- creative
- energetic
- optimistic
- ethical.

Research some successful entrepreneurs who possess many of the characteristics listed.

Read about Emma Isaacs and Toby Heap's successful enterprises in the article 'Business Chicks' Emma Isaacs and entrepreneur Toby Heap reveal successful business tips' on news.com.au. Make a list of the advice they offer to other entrepreneurs.

ACTIVITY 17.5

Create a case profile on one of the above entrepreneurs. Outline their entrepreneurial activity, the characteristics they possess and the product, system or environment that they have developed.

17.5 Legal and ethical issues

Entrepreneurs do not necessarily come up with their own ideas. However, they are good at spotting opportunities. They usually have the abilities needed to turn good ideas into commercial successes. Thus they are important to the innovator and inventor. Most innovators will need investment in order to follow through with their idea. The entrepreneur will have the enthusiasm and skills needed to find investors and convince them of the potential of an idea. They will also have the necessary knowledge of government regulations and legal requirements relevant to starting a new business. They would ensure that the idea is legally protected, and all trading and production activities meet required standards.

ACTIVITY 17.6

Using the internet, explore a new innovation that is compact and portable.

1. Describe the innovation and the associated technologies.
2. Using your knowledge of the factors that impact on innovation and entrepreneurial activity, predict the success or failure of this product.
3. Discuss the legal and ethical issues related to the marketing of this product.

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CHAPTER SUMMARY

- Not all innovations become commercial successes. A number of factors can impact on the success or failure of an innovation. These include timing, available and emerging technologies, cultural, political, economic and legal factors, and marketing strategy including market size, demand and product promotion.
- A variety of agencies can influence the development, implementation and acceptance of innovation. These include Standards Australia, IP Australia, Small Business Australia, the Australian Competition and Consumer Commission, and the Australian Centre for Innovation and International Competitiveness.
- Entrepreneurial activity is concerned with the creation, evaluation and exploitation of ideas – making good ideas into a successful product, system or environment. It involves recognising those ideas that have the potential to become successful commercial ventures, and the ability to turn ideas into products. Those who participate in this activity possess special characteristics.

CHAPTER SUMMARY TASKS

1. Define innovation and outline the factors that can impact on its success.
2. Describe why the factor of timing impacts on the success of an innovation. Provide examples of innovations that have been successfully launched.
3. Describe the terms ‘market pull’ and ‘technology push’.
4. Evaluate the major considerations of responsible designers.
5. Outline three categories into which technologies can be divided.
6. Discuss how marketing strategy and consumer demand impact on the success of an innovation.
7. Identify and describe the characteristics that an entrepreneur espouses. Discuss how these may lead to successful business ventures.
8. Explain how entrepreneurial activity influences design and innovation.
9. Discuss the role of governments in the success or failure of innovation.
10. Describe the process you will go through if you decide to obtain legal ownership of your idea for your major design project (MDP).

EXTENSION TASKS

1. Select two different innovations. Compare and contrast the factors that have impacted on their success or failure.
2. Choose three agencies described in this chapter. Explain how they may be used to assist in the development of innovation. Use examples to support your answer.

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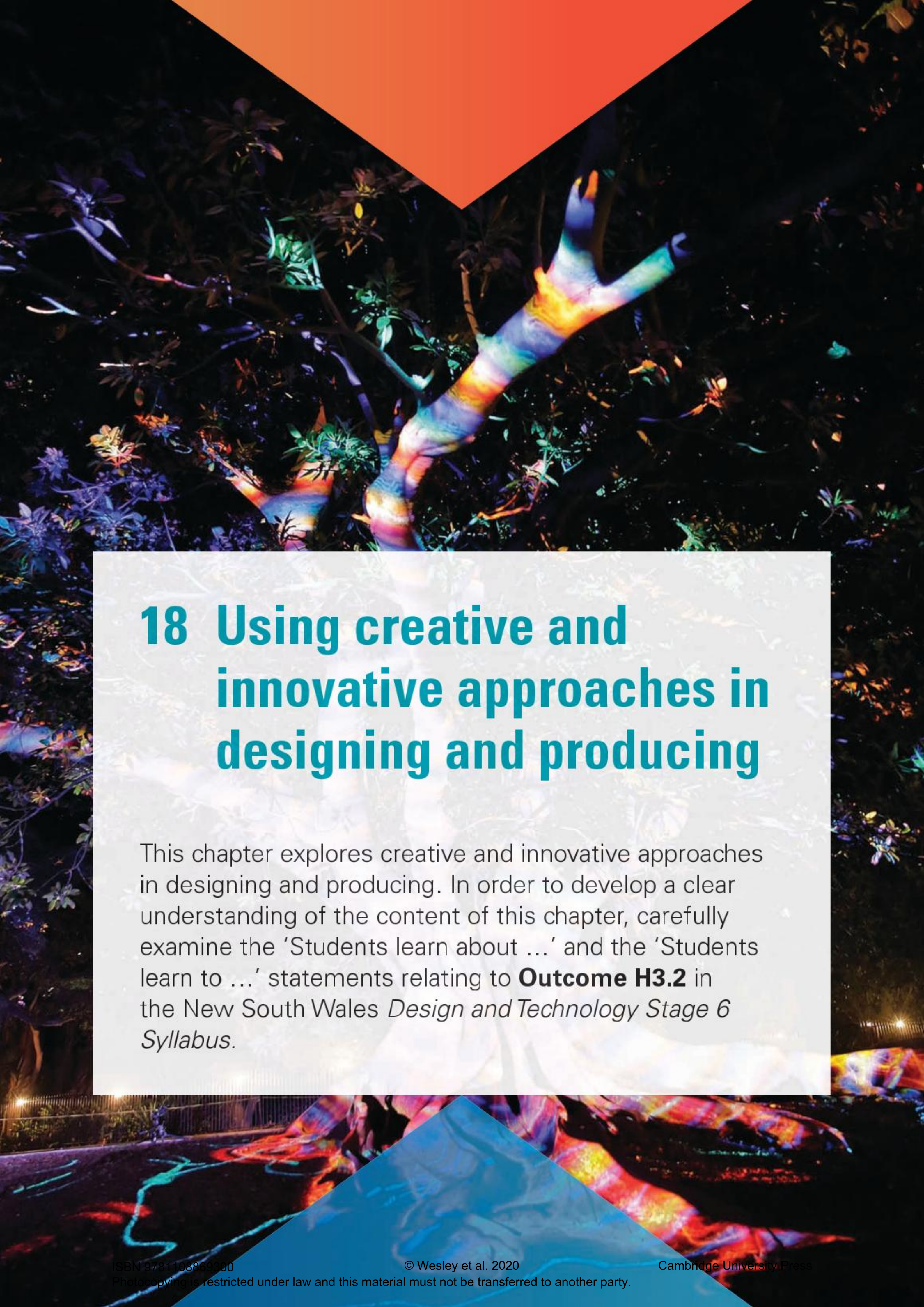

18 Using creative and innovative approaches in designing and producing

This chapter explores creative and innovative approaches in designing and producing. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H3.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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18.1 Creativity and design

We often hear people remark on the creativity evident in a designer's work, or how innovative a design is. Creativity does not mean starting from scratch; in the context of designing, it can be defined as developing solutions to challenges, or the ability to enhance the quality of life with techniques and/or use of resources that have been carefully brought about through methodical reasoning. True innovation involves building upon others' ideas and designs to change or make something better. Clarifying how this occurs is very difficult, but as designers ourselves we want to **emulate** the work of those successful designers in being creative and innovative. Your major design project (MDP) can be a product, system or environment, and it provides you with the opportunity to demonstrate your ability to be innovative and creative. In this chapter, you will learn about the creative and innovative design practices used by designers, and how they adapt and develop ideas and respond to motivational stimuli.

Creativity can occur by changing the way something is done as much as by changing a physical environment or product. Critical analysis of successful innovation will help you to understand such concepts as quality, innovation and creativity. In your MDP you must provide evidence of creativity, ensuring that your project stands out from the others.

emulate attempt to equal or surpass through imitation

18.2 Demonstrating creativity

DESIGN PROCESSES

Many people have tried to analyse the processes used by successful designers in order to emulate them. This is difficult and can lead to conflict between intuitive design (relating to the designer's personal perception and feedback) and systematic design (which is more deliberate and methodical). One thing that can be learnt from analysing the processes used by successful designers is that there is no one correct approach to designing. Actually, most successful designers work both systematically and intuitively to greater and lesser degrees. There are as many different design processes as there are products! In Year 12, there are specific guidelines to be followed as you work on your designs, set by the syllabus and found in the marking guidelines for the MDP. Following these guidelines will help you to maximise your chance of a good mark. Aside from following guidelines, however, you still need to show that you are innovative and creative. It is important to read about the work of other designers in a range of areas, reflect on the processes used by these designers and critically analyse and evaluate them. Here are some suggested websites to check out:

- Marc Newson
- Alessi
- Collette Dinnigan
- Car Body Design

Develop the process that works best for you. You need to find the balance between your personal design process for your own project and the requirements of the HSC markers. When you become a rich and famous designer, you will be able to ignore such constraints!

DEVELOPING IDEAS

Designing can be noisy, creative and exciting at some stages and a slow process of systematically developing and refining ideas at other stages. It will require some persistence and passion too. One technique that you can use to illustrate innovation

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and creativity is sketching. Your sketches can help you to think. You should try to draw to show your feelings as well as communicate your ideas. Never be satisfied with your first sketches but remember to include them in your folio as they illustrate the evolution of your thoughts.

It is always useful to discuss your ideas with others. Collaboration is a design technique utilised by many successful designers. Annotate your sketches to provide evidence of the development of your ideas. Sometimes you will hear a designer say, 'The idea just came to me!' This may also happen to you, so you need to be prepared at all times. Always carry a sketchbook with you so that you can record your thoughts and ideas wherever you are or take a picture. Creative designers may be inspired by an event, a need, frustration with an existing product, or something of beauty.

Collette Dinnigan, a successful Australian fashion designer, says she used the faded grandeur of yesteryear as a stimulus for her autumn/winter collection. Graeme Murphy, choreographer for the Sydney Dance Company, used the piano as his stimulus for the ballet *Grand*. As a new designer, you must keep your mind open to the motivational stimuli around you. Keep your eyes and your mind open to inspiration at all times.

Iain Reid, a lighting designer, was inspired by the artwork of Piet Mondrian when he designed the harbour light show for Vivid Sydney 2014. A flotilla of ferries, cruise boats and water taxis turned red, yellow, pink, green, cyan, magenta and blue as they travelled about the harbour.

David Handley was inspired by a visit to a sculpture park set among thirteenth-century ruins in Prague. Handley knew that the coastline was what typified Australia and thought that this sculpture park idea could be transferred to the beach. His Sculpture by the Sea exhibition has developed into a very successful event since it began in 1997 as a one-day gamble. This is an example of taking a successful idea and transforming it to fit a new context. You might follow the same strategy in the development of your idea for your MDP.

Figure 18.1 Sculpture by the Sea

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18.3 Critically analysing innovation

A successful innovator will consider a number of factors as they develop a design and take it through to production. You can learn from the work of other designers, and you might like to consider some of the factors listed below as you work through the development and realisation of your project.

- Search for inspiration.
- Document all ideas.
- Develop a vision for your design idea.
- Consider both aesthetics and function.
- Check the market potential.
- Research the characteristics of your target consumer.
- Investigate competing products. You want to have the edge over other products.
- Collaborate. Share with others. Listen to advice but be strong in your own ideas and challenge criticism.
- Model and test your designs.
- Detail the requirements for production. Identify all parameters.
- Consider resources – both availability and environmental impact.
- Check and confirm costs.
- Identify a quality-assurance system.
- Make a prototype, evaluate and modify it.

ACTIVITY 18.1

Study the work of a designer of your choice. Comment on each of the factors listed and how they have or have not impacted on the work of your chosen designer.

18.4 Quality, innovation and creativity

The marking guidelines for your MDP refer to the application of high-quality practical skills in the development of the product, system or environment. In industry, quality is matched against specifications, often described as being 'fit for the purpose'. This view of quality involves measuring against predetermined specifications and meeting customer requirements. However, just as making a product to specifications does not guarantee sales, some products of good quality are rejected by customers because they do not meet their needs.

Setting quality for products, systems and environments may involve meeting the specifications, ensuring the product is fit for the purpose for which it is designed, aiming for zero defects and using correct techniques the first time and every time. Quality for customers will include customer satisfaction, exceeding the customer's expectations and pleasing the customer.

Quality control refers to the techniques used when inspecting for quality and detecting faults during production. Quality assurance is the planned procedures used to ensure the product meets the quality standards. Total quality management creates a **holistic** culture of ensuring quality at all times in an organisation. You should plan a strategy to ensure

holistic an approach that emphasises the importance of the whole

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quality for your MDP. This should be documented in your production plan, showing your expectations and when and how you intend to check and assess this quality. Here are some questions you can ask yourself:

- What level of quality am I aiming for?
- How will I ensure this quality is achieved?
- When will I check that I am meeting these expectations?
- Do I need to make any changes to my processes?
- Do I need to improve on any skills?
- Are there other ways of achieving this?
- What can I improve?

ACTIVITY 18.2

Critically analyse the innovation described in Case Study 18.1. Think about the concepts of research, collaboration, learning from nature, innovation and creativity. In order to analyse, you must identify the components and the relationship between them. It might be helpful to develop a mind map showing all the components you plan to consider. Remember that a critical analysis should demonstrate a depth of knowledge.

CASE STUDY 18.1

Facett modular self-fit hearing aid

Since the invention of the bionic ear (also known as cochlear implant) by professor Graeme Milbourne in 1978, Australia has led the way in hearing-aid development.

Recently, Dr Leah Heiss, a Melbourne-based designer and RMIT University senior lecturer, and hearing aid company Blamey Saunders Hears co-designed Facett, the world's first modular self-fit hearing aid.

In 2018, Facett received the 2018 Good Design Award, CSIRO Design Innovation Award and two Best in Class Good Design Awards (Product Design – Medical and Scientific and Social Innovation).

Figure 18.2 Dr Leah Heiss with her award-winning hearing aid

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> Leah Heiss works the 'nexus of design, health and technology'. Her process is deeply collaborative and she works with experts from nanotechnology through to manufacturing. She is dedicated to the idea that design can radically improve the development of wearable health technologies.
>
> Her projects have included: jewellery to administer insulin through the skin for diabetics; biosignal-sensing emergency jewellery; and swallowable devices to detect disease. Leah has an extensive knowledge of next-generation materials and processes and her toolkit contains shape-memory alloys, magnetic liquid, electroluminescent cable and electricity conducting textiles.
>
> Source: https://cambridge.edu.au/redirect/8943

During the design process, Dr Leah Heiss and Blamey Saunders Hears had the hearing aid users at heart, designing a product with unmatched ease of use and upgradability options.

In addition, for the gorgeous jewel-like design of Facett, Dr Leah Heiss took inspiration from the mineralogy collection at Museums Victoria.

> The crystalline form seeks to shift stigma, to move hearing aids *from* disability *to* desirability.
>
> In addition to *looking* different to traditional hearing aids Facett *functions* differently – the intuitive magnetic connector bypasses the need to change tiny batteries, an ongoing frustration for older people with arthritic fingers or vision impairment.
>
> I designed Facett through a human-centred approach, spending time with over 25 hearing aid users to understand what it's really like to depend on a technology to live and work.
>
> Source: https://cambridge.edu.au/redirect/8944

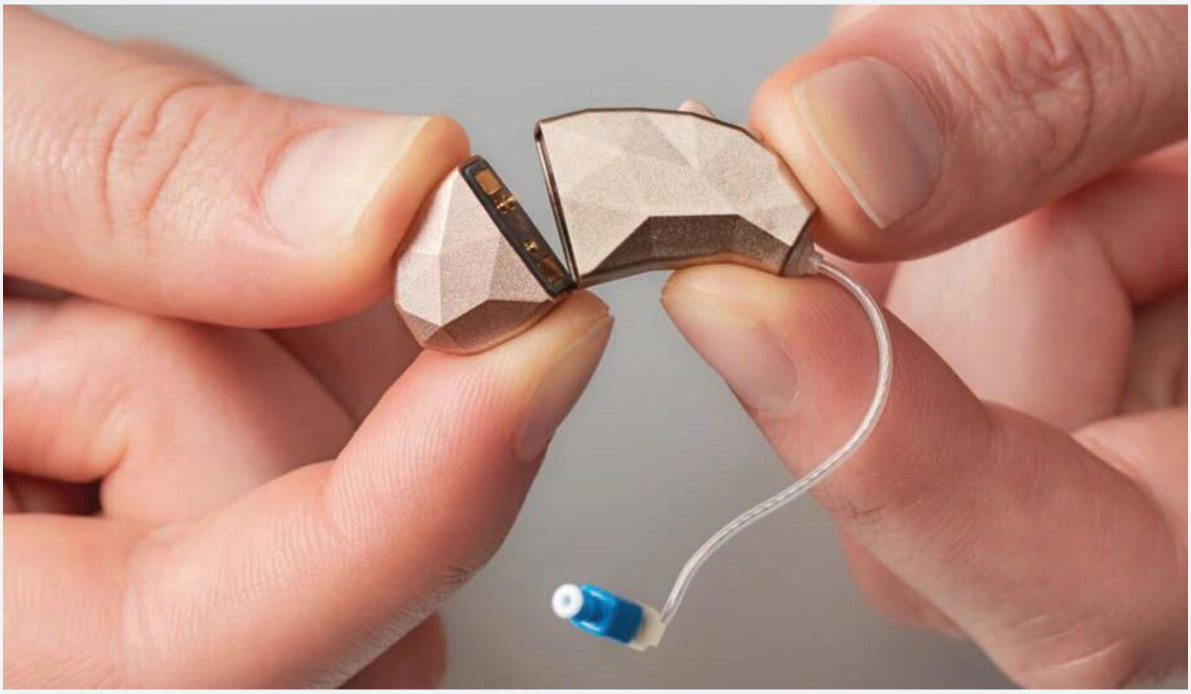

Figure 18.3 The aesthetic of Facett was inspired by the mineralogy collection at Museums Victoria.

Video

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CHAPTER SUMMARY

- Successful designers are innovative and creative in their approach to design. They work systematically and intuitively and often collaboratively.
- Strategies such as sketching and brainstorming can be employed to assist in the development of designs. Following this up with modelling is often necessary.
- Designers may be inspired by an event, a personal experience, their environment, a need, nature, market forces, an existing product or the urge to create.
- Not all designers follow the same process.
- Designers learn from an analysis of the work of other designers and from inter-disciplinary collaboration.
- It is important to demonstrate creativity in the development of the MDP.
- Quality of the final product and quality control during production are vital to the success of a design.

CHAPTER SUMMARY TASKS

1 'There are as many different design processes as there are products.' What is meant by this statement?

2 Justify collaboration as a useful design technique. Use the development of the Facett hearing aid outlined in Case Study 18.1 as an example.

3 Discuss how you can learn from the work of other designers. Relate your response to your MDP.

4 'Making a product to specifications does not guarantee sales.' Clarify this statement using specific examples of good designs that were not great sellers.

5 Changes to economic, political, social and environmental events can change the way designers need to think if they are to have commercial success. Enterprises cannot rely upon existing circumstances to remain the same and must adapt to the markets' expectations. Discuss.

6 Explain the terms 'quality control', 'quality assurance' and 'total quality management'.

7 Assess sketching as a technique and explain how you can use it to demonstrate creativity in your folio.

8 'There is no one "correct" approach to designing.' Discuss this statement.

9 Outline how critical analysis of successful innovation assists understanding of concepts such as quality, innovation and creativity.

10 How do HSV and Dr Leah Heiss and Blamey Saunders Hears differ in their design processes?

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EXTENSION TASKS

1. Identify and evaluate three different strategies you could use to develop creativity and innovation in your MDP.
2. Explore the great tradition of Australian designs with reference to the saying 'Necessity is the mother of invention'. How does the size of the market relate to the processes of design and manufacturing? Can you make comparisons between how designing a product might be different in different countries and how manufacturing on different scales may change the processes?

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19 Identifying a need or opportunity and exploring ideas for design development

This chapter explores needs and opportunities, and ideas for design development. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H4.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

ISBN 9781108869300

19.1 Researching and developing ideas

Try to approach your major design project (MDP) with an open mind. Try not to start with a preconceived notion of what you would like to make, as you may eliminate other possibilities without fully exploring their potential, and your design documentation may appear disingenuous and biased. Look for everyday problems that users encounter, flaws or limitations in existing products, and opportunities that are waiting to be explored. When considering an exploration of a need, the designer needs to adopt a mindset where they connect and understand the needs of the user and the environment from where a need is generated. This connection may consist of a cognitive understanding or an emotive one, where the designer develops their insight or **empathy** for the need.

IDENTIFICATION AND EXPLORATION OF A NEED

To begin your MDP design journey, you should begin by identifying a need or recognising an opportunity. This is not always easy to do, so keep a journal and ask yourself questions about products, systems and services that you have used. To identify a need, it may be a problem that you, or another user, have encountered on a regular or rare occasion. To provide an example of common problems, consider these questions:

- Why do shopping trolleys never go the way you want them to?
- Why is my school backpack so heavy and uncomfortable to carry?
- Why does the screen on a smartphone have such small letters and numbers that my grandmother, who suffers from arthritis, cannot use it?
- Why do visitors to our school have difficulty in finding their way around?

ACTIVITY 19.1

Cognitive organisers are visual tools that are useful when generating ideas. To start you thinking about a need for your MDP, create a spider diagram or mind map about 'My interests, likes and dislikes'. Create a separate bubble for each of your interests and the things you like to do. Identify things that impact on those interests both positively and negatively, materials and equipment used, safety considerations and, most importantly, problems encountered. Circle the area of problems and difficulties encountered in red.

Every day we encounter products, systems and environments that could be improved. You may identify an opportunity to improve an existing product. To provide some examples of how current items could be improved upon, consider:

empathy our ability as designers to understand the different perspectives of users regarding what they may say, do, think, feel and experience

- The materials used in the item. Could the item be manufactured more ethically? It may incorporate recycled or renewable resources to reduce environmental impact.
- The number of parts to make up the design. Could the item be re-designed to be leaner with less parts?
- Could the system operate more efficiently or with increased functionality?
- Does the design cater for a niche group or the needs of a specific user?

Opportunities may result in financial profit for the designer, producing a product that will meet consumers' needs more effectively than others on the market. Therefore, a need is often consumer-driven, with the designer responding to the demands of the target market; whereas, an opportunity

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may be designer-driven, fuelled by the designer creating solutions that will hopefully be desirable to consumers and have impact.

Your MDP does not necessarily need to be a new innovation, though it is still an opportunity for you to be innovative and incorporate concepts from existing designs and improve on them. Many innovative products are the result of design modifications enabled by advances in technology, materials, tools, creativity or knowledge.

Starting your MDP journey with preconceived ideas about what you are going to make will limit your ability to be innovative and subjectively entertain the possibilities. So think big and begin with many possible ideas that can gradually be narrowed down as you work through the design process until the best is identified.

Every designer works differently, but as you develop ideas you will cover the following:

- identifying a problem or recognising an opportunity
- establishing a need from that problem
- exploring different areas of that need.

NEEDS ANALYSIS

A needs analysis is very much a questioning exercise to help the designer to clarify and define the design task. The answers generated through an analysis help to enable a solution to meet the needs or wants of the target market. Conducting a needs analysis can help you to find that **niche** or gap in the marketplace and to learn more about what your intended project must be able to do to meet the specific needs and wants of your target market.

niche a gap in the market; a small, specialised group of consumers for whom no adequate product exists

Some questions to guide your needs analysis may include:

- Knowing the situation: What is the situation or context that has provoked this need? Are there any external influences that have impacted on the situation?
- What type of need have I identified? Is it a personal need, a community need, an environmental need or other?
- Are there multiple needs in this situation? Can you prioritise them?
- Define your users: Who is the target market and what are their demographics?
- What impact does the solution need to have or be able to do?
- The difference between what is needed and what is currently available: What are the existing designs and how do they fail to meet this need? Have I identified a niche?

It is important to carry out initial research to confirm the existence of a genuine need or opportunity and to eliminate designs that do not meet these criteria. This may involve surveys of potential end-users, observation of consumer behaviour, discussion with focus groups and exploration of the range of similar products available to consumers. You will want to understand your user's needs and to develop a deeper understanding of the persons you are designing for.

Your needs analysis will assist you in developing your individual design proposal. After your identification and exploration of a need, your greater understanding of the need will enable you to document your design task or proposal in the form of a design brief. This broadly outlines what you

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ACTIVITY 19.2

We all need to know what is going on around us – locally, nationally and globally. Consider the evolving nature of the communication of news. Brainstorm methods used throughout history and create a time continuum indicating what is still used and what has become obsolete. The need to be well informed has led to much technological advancement. How have the needs and wants of news consumers impacted on product development? In pairs or groups, discuss possible future developments.

aim to design and construct and clearly identifies the target market at which the project is aimed. Be careful not to be too specific at this stage as this forms part of the Project Proposal section of your MDP portfolio.

You should not know exactly what your finished project will look like or precisely what materials, tools and techniques will be used in its construction. Keep your options open and allow your research and experimentation to guide many of these decisions.

In your major project development, even though you may have a set project to complete for submission, there may be other applications of your project. Consider these future opportunties that could be pursued at a later date.

AREAS OF INVESTIGATION

A designer would carry out a thorough investigation of everything relevant to the design from material options to suppliers, as well as market competition, prior to suggesting the project progress or the expense of setting up manufacturing. You will need to investigate all the possibilities that relate to your identified need and your design solution. You have already investigated the situation in the previous section of your portfolio, but now it is time to propose what may be relevant to your project.

You can record your areas of investigation using mind maps or tables, but you need to describe how and why the investigation is important to your individual MDP. This explicitly provides the relevance to your project. To get you started, begin by first creating a spider diagram of relevant aspects to your project such as existing ideas, materials used, the user, and the environment or context that the solution will be situated in. This will help you to categorise the different 'areas' to be investigated.

Next, for each area, make a list of all the things you need to find out about in order to design and construct your MDP. Please remember that this is the proposal stage of your project and the list may grow as you investigate and discover things like new techniques and alternative materials that you may not have considered. At the end of this section, you must evaluate and explain how your investigations have impacted on the development of your ideas and how they will direct your future actions.

The areas of investigation section is designed to 'provide direction for further action', so think about how you can show that your investigation has been helpful in leading you in the right direction. A diagram, flow chart, bubble diagram or other visual representation may assist here. Remember that you need to clearly and effectively communicate this in your MDP portfolio!

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CASE STUDY 19.1

Angelina Arora's exploration with bioplastic

Video

Our prior knowledge and experience have shaped the way we view and begin to understand the world. From a constructivist perspective, our understanding is shaped from our experiences. This difference of perspective is evident when someone comes up with what appears to be an obvious, but simple and fantastic idea. In these situations, have you ever wondered 'why didn't I think of that?'

Sometimes ideas 'pop-up' when you least expect them, or there are times when your prior knowledge and experience has transported your understanding of a problem to a point where you have the capacity to see solutions to this problem. Sometimes ideas are created through our thoughts that link our existing knowledge and different experiences. Using an example of how knowledge and experience can enable designers to identify and explore design solutions, we will use the example of Sydney schoolgirl Angelina Arora.

The diversity of the sources of information that educate us are enormous. In some cases, we construct our knowledge from others. This may involve our engagement in reading books, listening to others, or learning from other perspectives gained through teamwork. In other cases, we generate our own knowledge through experience, experimentation and play.

Since she was a young girl, Angelina Arora has been active in developing her understanding of a real-world problem – waste. She has been looking for potential ways that plastic waste can be mitigated. This case study will deconstruct the individual ways in which Angelina has explored the problems surrounding plastic waste and the ways that she has experimented with possible solutions.

Problem one: Plastic waste in water

Angelina's work on identifying the problem led to her realisation that the concerns regarding plastic waste polluting the water were justified. Microplastics (extremely small pieces of plastic < 5 mm in size) are the result of discarded plastic entering our water and breaking down into tiny pieces. Unfortunately, these microplastics are also being ingested by and killing marine life. This is also a concern for humans as these microplastics are becoming a part of our food chain. In her own research of 80 samples of fish, Angelina discovered that on average, 4.62% of the body mass of each fish was plastic waste. This determination led to an understanding that plastic entering the water was a problem, but how did it get there? Angelina had her suspicions based on her observations while shopping.

Plastic bag waste as an environmental problem

It was when 11-year-old Angelina went shopping with her mum at a local supermarket that she started to 'connect the dots' to see an opportunity for bioplastic (plastic materials produced from renewable biomass sources rather than oil). Angelina observed the number of people walking away with single-use plastic bags, and her mum paying for plastic bags at the supermarket. She asked the cashier why customers were required to pay for plastic bags, and the response from the cashier was 'to deter people from using plastic bags, and to save the planet'. It wasn't the use of plastic bags that appeared to be the issue but what happens to the plastic bags after their use. According to Angelina in her 2019 TEDx presentation, 1.2 trillion tonnes of plastic becomes waste each year. With this knowledge, Angelina was able to see the opportunity for reducing plastic waste and its impact on the environment through a new approach to plastic bags.

Exploring plastic alternatives

Quoted in the Sydney Morning Herald, Angelina said that 'The dream is to basically have every single plastic in the world made out of my plastic' (8 December 2017). Finding a solution to reducing plastic waste has been an ongoing journey for Angelina. For a school science project in 2016, Angelina developed six bioplastics from three different types of starches using everyday common items, and tested their characteristics based on clarity, decomposition and endurance. The development of a plastic bag made from corn starch earned her an STANSW Young Scientist Award, even though she determined that corn starch bioplastics were not an appropriate material for shopping bags, as it decomposed

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too quickly when it came in contact with water. She needed something more durable. Like many designers before her, design solutions are an iterative process; she did not fail, but found one bioplastic that did not work. Fortunately, thanks to her Young Scientist's Award, she has been mentored by scientists from the CSIRO.

Problem two: Seafood waste

What do you do when you are sitting around, waiting for your fish and chips? Angelina's experience of purchasing prawns at a local fish and chip shop when she was in Year 9 revealed another issue related to waste pollution that is ending up in our oceans – food waste. Noting a pile of discarded prawn and crab shells, Angelina though that they looked like plastic, and she considered whether this waste could be made into a bioplastic. This was the start of her shrimp bioplastic journey.

Bioplastics from prawn shells

Using her foundation of knowledge and skills that have been developed in her journey of understanding microplastic pollution and developing bioplastics, Angelina made use of the resources that were available to her. To develop bioplastics from the discarded prawn shells, published research conducted in 2011 by Harvard's Wyss Institute and project work undertaken at Egypt's Nile University provided a process of using prawn shells to develop bioplastic.

CSIRO scientists mentored Angelina over a number of months in the extraction of carbohydrates from the prawn shells (called chitosan) and proteins from the silk cocoons from silkworms. This combination led to Angelina developing a bioplastic that exhibited flexibility and strength (comparable to conventional LDPE, or low-density polyethylene, plastic bags), while able to completely break down in 33 days (1.5 million times faster than commercial plastics). This was a significant improvement over Angelina's corn starch bioplastics, but also enabled Angelina to consider other applications such as packaging, fertiliser and dissolving sutures.

Figure 19.1 Angelina Arora. © Copyright CSIRO Australia

Cleaning up our water

Videos

Angelina is using her knowledge and motivation of cleaning up our water in another ongoing project. She was working on a project using algae when she accidentally spilled some oil near her work. Angelina is looking into the use of algae to clean up oil spills after the algae in her 'happy accident' soaked up all of the spilt oil.

Other opportunities for bioplastic

What is in store for Angelina's bioplastic in the future? She is not content with just limiting her material to the supermarket. Angelina is now considering other opportunities for her bioplastic, and is working in a lab before and after school to explore other applications of her material. She is currently testing whether her plastic could act as a wound dressing that encourages blood clotting.

In 2018, Angelina won the Innovator to Market Award in the BHP Billiton Foundation Science and Engineering Awards. Angelina has other projects on the go; however, in 2019 she was juggling these with her Year 12 HSC study.

This case study has elaborated on Angelina's journey as she has explored and observed the relationships between different problems. In order to recognise and develop a deeper understanding of the problem, Angelina's journey in creating and testing bioplastics has led her to a place where she can use her knowledge and experiences to entertain plausible solutions and alternate opportunities.

Source: CSIRO and Australian Geographic

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Table 19.1 An example of how 'areas of investigation' could be set out. You need to be descriptive in your writing.

WHAT (DESCRIPTION)	WHY (RELEVANCE)	HOW (DIRECTION)	WHERE (EVIDENCE)
WHAT IS TO BE INVESTIGATED Make a comprehensive description of areas that you believe clearly relate to the need. This states what you are going to investigate in your project. Please make sure you investigate it!	WHY THIS FACTOR IS IMPORTANT Please keep your need in mind. How will finding out about this be successful in your MDP's ability to address the identified need? Or alternatively, what would be the result of not investigating this factor?	HOW YOU WILL INVESTIGATE IT This column will direct you with further action. As an example, will you use sources of information from surveys, interviews, books, magazines, images, professional journals, the internet, talk to experts, look in shops and catalogues and so on? Will you use a primary or secondary research source?	WHERE IS THIS FOUND IN YOUR PORTFOLIO? To show the markers exactly where they can find this in your portfolio, add the page number here.

19.2 Parameters of design

All designers work within boundaries or parameters; for example, architects design solutions according to the unique constraints on a given site. Car designers seeking to design a car for the Australian market need to comply with strict Australian Design Rules, such as omissions standards. Wetsuit designers need to consider the anthropometric measurements of people to design a wetsuit that is snug and will keep the cold water out. For your MDP, you will work within parameters that are internally imposed (your personal skills and abilities, likes and dislikes) and others that are externally imposed (deadlines for completion, school rules, NESA requirements). You may like to consider how you will work within the following parameters and what limitations they might impose on your design development:

- time
- cost/budget
- skills and knowledge
- materials
- tools
- techniques
- dimensions.

CRITERIA TO EVALUATE SUCCESS

Criteria to evaluate success gives the designer the opportunity to explain what the MDP must do and how it must look in order to be considered successful. This is possibly the most important section of your design folio, as it allows you to set the goals you wish to attain, allows the markers to understand what you have set out to achieve, and provides a standard against which success can be measured. These criteria become a vital tool that you will use throughout the development of your MDP, to evaluate your work, determine your success and ensure that your project stays on track. This process will require you to constantly refer back to your criteria to check that you are making what you said you would make, how you said you would make it, and that it is doing all you said it would do.

The criteria must be written in positive, achievable terms that are evident in the finished product, system or environment. You need to be able to prove that you have achieved each criterion, so write them in a way that allows you to judge your level of success. The criteria must clearly relate to the need or opportunity you identified and/or should address the problem identified in the design brief.

Two broad types of criteria, functional criteria (explaining what your MDP must do to be considered successful) and aesthetic criteria (explaining what your MDP must look like to be considered successful) are essential. Within these two categories, you will establish highly specific and appropriate criteria. You may also consider adding criteria to address areas such as cost/budget, safety,

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sustainability, ergonomics, time management and intellectual property to name a few.

To achieve good results, the marking guidelines require you to 'establish and analyse appropriate criteria to evaluate the success of the product, system or environment'. Do not just list the criteria. Clearly state what the product must do, weigh up the pros and cons, and draw out implications of the impact on your product should you not be able to achieve each criterion. You may further analyse your criteria by considering methods you will use to judge the level of achievement and you may indicate the standard or minimum requirements necessary to be deemed successful. Finally, not all criteria are of equal value to the success of the MDP. Some criteria may be vital and needed, while others may be nice to have. A good approach is to rank the importance of your criteria. This is another way that you can demonstrate criteria analysis.

Table 19.2 Criteria to evaluate success

CRITERIA	CRITICAL ANALYSIS	IMPACT IF NOT ACHIEVED	IMPORTANCE
In the rows below, enter functional and aesthetic criteria written in achievable terms, e.g. 'It must . . .'	Why it is essential to achieve this criterion?	What would be the impact on your MDP if you were unsuccessful in achieving this criterion?	How important is this criterion to the success of the MDP?

19.3 Research and experimentation

Research and experimentation will occur throughout the design and development of the MDP; however, a formal section is located in the Project Development and Realisation section of the MDP portfolio. Sometimes the methodology may be formal scientific investigation in the form of an experiment, and at other times it will be drawn from informal observations and discussion. Each is equally important and needs to be recorded appropriately. Be selective and only conduct research and experimentation that is relevant and appropriate to the successful development of your MDP.

Ensure that you show your design inspiration, document your findings and show design development. That means clearly showing how what you have found has impacted on the development of your design.

Research allows us to draw on our own experience, or the experience and knowledge of others to help in the production of a solution. Research can be obtained from a variety of sources. To achieve good results, you will need to demonstrate a range of appropriate research, experimentation and testing. Some examples of different sources are below:

- **The internet:** Sources must be checked for authenticity and reliability, and information should never be obtained from only one site; that is, without supporting information from other sources. Information from the internet comes in text, sound, still and video formats. It is useful when appropriate, current and up to date.
- **Journals and professional magazines:** Use these whenever possible, as data from these sources is considered reliable. Journals are excellent for inspiration about current and future trends and fashions.
- **Books and library resources:** Information contained in books may be more thorough, better illustrated and sometimes more appropriately pitched at the level of understanding than that found in technical journals and magazines.

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- **Interview and observation:** These allow us to share the knowledge and expertise of relevant professionals and practising designers. Expert opinion and guidance from those with greater skills and knowledge are always valuable but be aware of personal opinions and bias when taking advice. Like any other source, consider the reliability and relevance to your project. Observations also form part of the knowledge we gain from our own experimentation.

Research, testing and experimentation are essential to the success of the MDP, so make sure you dedicate sufficient time to this part of the development of your project. Record all findings and keep both physical samples and photographic evidence of all testing. Keep everything, but do not include everything in your folio when you are putting it all together due to the page limit restrictions set by NESA. When compiling your folio, you will be selective and only include material that demonstrates a range of research that is relevant, appropriate and informs the decisions you make in your project's development.

Collecting and analysing information is just one part of the process. Reporting on the results is very important as you need to be able to communicate this effectively. Consider what would be the most effective way for the audience to understand that you have made the most appropriate decision from the given results. Not all graphs are effective. One suggestion is to seek feedback on how you have communicated the results from others. Also remember to keep the details of your sources, as a bibliography will be required to document the sources of your information. This way, the reliability of your information is well supported, and other people can access the same source if they wish to follow it up.

PRIMARY RESEARCH

One type of research activity involves the information that you generate yourself. This primary research methodology requires you to be active in the collection of data and to make meaning from activities such as interacting with the ecology of the stakeholder such as potential consumers. Visiting stores, using existing products, and talking with manufacturers and suppliers to collect first-hand evidence are some ways to collect primary research. Some of the insights that primary research provides could include:

- identifying the target market (the group your product would appeal to) through observation or survey
- looking at existing products that serve a similar purpose and conducting a gap analysis to identify areas for improvement
- deepening your empathy of the situation through conducting surveys, interviews and questionnaires with potential consumers, manufacturers and retailers
- evaluating the findings of primary research and using this to inform and justify your decision making in the development of the MDP.

SECONDARY RESEARCH

Secondary research means drawing on the findings of others using established information and knowledge. Ever heard of the term 'fake news'? With this type of research, the credibility of the source is extremely important. In research, 'triangulation' is a technique where multiple forms of data are used to see if there is an overlapping of the results. You are not expected to formally triangulate your research; however, any information 'overlap' from different sources can support the validity as well as the reliability of your information you have received. Examples of some of the different approaches collecting information for secondary sources include:

- Conducting a search on the internet: It is a wonderful tool for secondary research. Sources such as Wikipedia are a good first start but may not be completely reliable. You need to extend

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your search for information beyond that to ensure the information is accurate.

- Using statistical data such as census information and reports to justify decisions about your target market.
- Using your local library, books and textbooks or researching articles and technical journals for current information.
- Using newspaper articles as a landing page, then investigating other secondary sources to support the reliability of the information.

TESTING AND EXPERIMENTATION

How do you know that a technique is most appropriate for your desired result? Or that a component of your MDP will be durable and perform in its intended environment as expected? Is it good enough for you to use this technique based on what someone has said, or should you test it out for yourself in similar test conditions? It is quite likely that the construction of your MDP will require you to work with some new and unfamiliar tools, materials and/or techniques. Extensive experimentation with tools, materials and techniques, evaluating the results and making informed choices will help ensure the success of your MDP.

YouTube contains a host of videos to teach new skills. If you find you need to use a material, tool or technique with which you are not familiar, do a search on YouTube and watch some tutorials to help you learn the new skill. Please ensure that if you intend on replicating any techniques that you refer to your teacher for advice regarding the safest approach.

Do not conduct meaningless or irrelevant experiments. Remember there is a page limit for your portfolio! Carefully consider what your project hopes to achieve, how and where it will be used, and who will use it. With this in mind, establish a list of tests that will inform your decision making and provide direction in the development of your project.

Examples of 'relevant' materials testing for a timber outdoor chair could include durability and UV resistance tests, while inappropriate materials testing for a timber outdoor chair could be an impact test or an abrasion test.

To document your experiments, a suggestion would be to write it up with the following headings:

- Aim – what you hope to find out about
- Method – a step-by-step procedure of the experiment
- Result – what you saw happen (photos may be included)
- Conclusion – what you have learned (and how you will use this in the development of your MDP – best material, best technique and so on).

You need to show evidence of the results. Photographic evidence is useful, but also provide physical material evidence where possible. These can be presented with your project and portfolio for examination.

Figure 19.2 Secondary research

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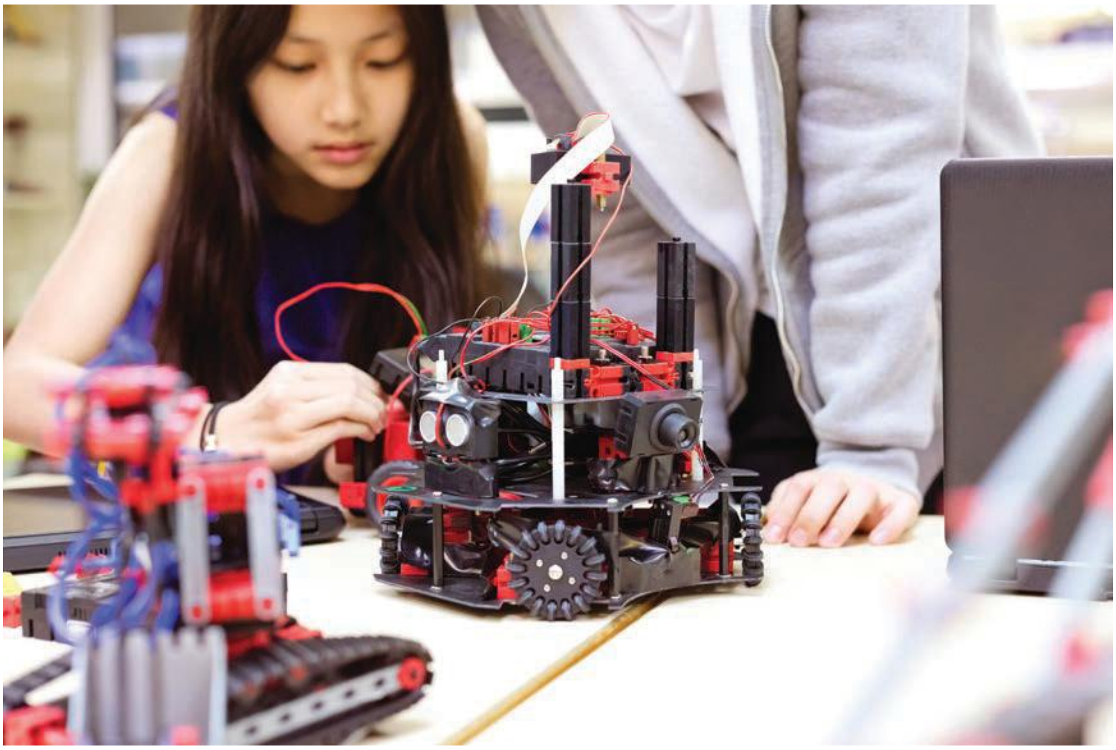
Models and prototypes

Testing does not only mean scientific experiments. It is common practice in design to make and test models and prototypes at different stages of the design process to test and refine ideas. Models and prototypes act as 3D representations of the ideas in your portfolio and they provide important evidence of the evolution and development of your design. A series of models can show the journey of your design project from a rough idea to a functional prototype. Keep all of your models and prototypes as evidence. When it is time to examine your project and portfolio, label and display all artefacts as evidence of process for the markers.

Figure 19.3 You can experiment from home or in class.



ACTIVITY 19.3

1. Create a table that you will keep and add to as you work through your MDP. Include two columns with the headings 'What I need to know' and 'How I'm going to find out about it'. Use this to brainstorm ideas and to keep track of development of your investigations, research and testing.
2. Make a list of the primary and secondary research methods you will use to get the information you need. This could be generated from the 'how' column in the 'areas of investigation' example. To help you to manage your time, add a time frame indicating when you will start and complete each investigation.
3. Conduct a series of meaningful and relevant experiments that will assist in the development and successful completion of your MDP. You need to have experiments for:
   - **a** tools
   - **b** materials
   - **c** techniques
   - **d** design solutions.

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RESPONDING TO THE FINDINGS OF RESEARCH AND TESTING

Your research and testing will only be of benefit if you use the findings to produce a better design solution. Do not ignore the results that you obtain! There is little point in conducting tests on the suitability of a range of metals for creating a series of rings if you already know that you will be working with sterling silver because it possesses the qualities you need, you have the skills to manipulate it successfully, and it is within your budget. What may be more appropriate in this situation, may be to test unfamiliar construction and joining techniques, surface finishes and decorative techniques, and research into possibilities for reproduction using techniques such as 3D printing and lost wax casting.

APPLICATION OF CONCLUSIONS

The MDP provides evidence of the decisions that have been made and informs the markers on whether you have applied the conclusions drawn from your research or not.

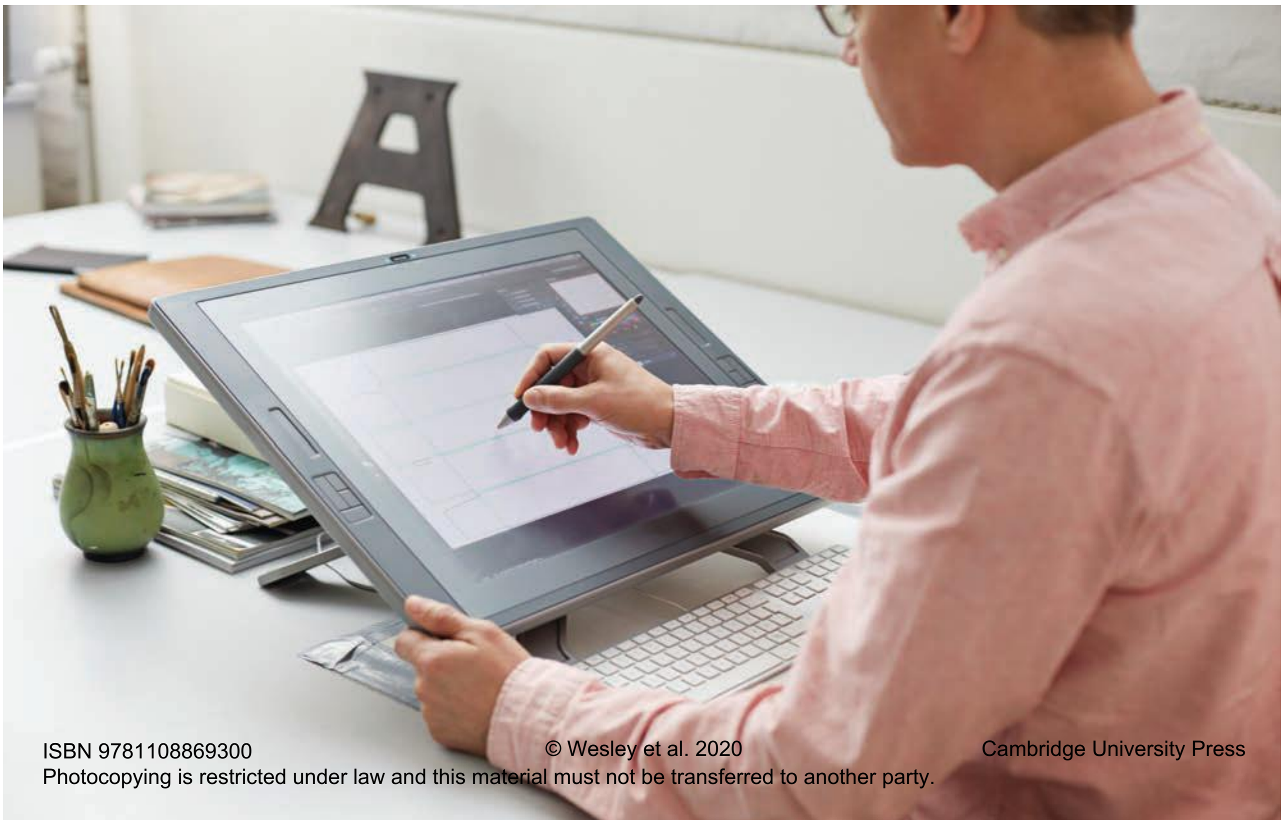
Apart from the project, there are other ways where your application of conclusions can be demonstrated. Examples of where the results of research and testing have been incorporated include:

- **Show ongoing design development.** The design folio should tell the story of the development of your MDP. Start with a broad idea to meet the identified need or opportunity. You should not have all the answers at the beginning! Demonstrate design development and ongoing evaluation throughout the process, showing how you have modified your design and responded to the findings of research and testing.
- **Use sketches and drawings to show design development.** You can demonstrate exactly how you have incorporated the findings of your research and testing by showing changes, making variations, sketching possible options and adapting your designs. Always explicitly annotate and evaluate your sketches.

Video

- **Analyse and evaluate the results of tests and apply them to your MDP.** If your experimental work shows that a material is the most suitable

Figure 19.4 Creating a final design drawing



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for the construction of your project, you should be using that material in your final product. If you choose to use something different, then you must justify your selection.

- **Do not conduct meaningless surveys.** If you do not want to respond to the opinions of those you survey because they may make choices about colours, styles and materials with which you may not agree, do not conduct a survey. Surveys are relevant if trying to determine the needs and wants of the target market to ensure that you are producing a product that they will want or need. This is pointless if you are creating something to suit your own personal taste and will be considered disingenuous.
- **If you do conduct surveys, analyse the findings, then graph the results.** Use an appropriate form of graph. Column graphs give an excellent visual comparison of responses, line graphs are good to show market trends and pie charts clearly show the percentage of the whole group who selected each response. Analyse the findings and say how they will impact on the development of your design.
- **Create a final design drawing.** Always show your final design in an appropriate format. A working drawing with all dimensions and standard drawing conventions and a cutting list may be appropriate if constructing a table, but a production drawing with front and back views, list of notions, sample fabrics and colour choices may be more appropriate for a garment.

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CHAPTER SUMMARY

- Begin by identifying a need rather than settling on a project you have always wanted to make.
- To identify and explore a need, use market research techniques. Search for a gap in the market or a point of difference for your product.
- If your design is a modification of an existing product, be very clear about the differences, the need that the existing design does not address and the advantages of your design.
- Look for ways that will enable you to empathise with the situation. This is the exploration stage where you become familiar with the ecology of stakeholders in a given situation.
- After you have identified and developed empathy from exploring the need, you are in a position to define your task with a design brief.
- Plan and document all of the research required for the development of your MDP in the areas of investigation section of the folio.
- Showcase your planning and management skills. A well-documented areas of investigation section will show:
  - what you will investigate
  - why you think it needs to be investigated
  - how it is to be investigated.
- The criteria to evaluate success are the goals that the design solution must meet in order for it to be deemed a success. Establish and analyse your criteria in terms of their appropriateness and importance– do not just list or describe them.
- Relevant and appropriate testing and experimentation are the practical primary research tasks that you conduct to assist you in the selection of appropriate materials, tools and techniques.
- Secondary information sources should be scrutinised for accuracy and appropriateness.
- Report on what you have learned in your research, experimentation and testing, then explicitly state what you have decided as a result.
- Communication is the key to success. Be clear and unambiguous, be concise and to the point and use multiple forms of communication, including sketches and drawings to show evidence of decision making and design development.
- A good MDP portfolio will succinctly communicate the journey that the designer worked through when developing the design solution.

CHAPTER SUMMARY TASKS

1 Explain the difference between a need and a want. Explain which of these will be addressed in the development of your MDP.

2 What cognitive organisers will be used to generate and develop your ideas? Make a list of when and where this will occur.

3 Why is conducting a needs analysis useful to the development of your MDP?

4 What are parameters of design? Who imposes these on the designer?

5 What prior knowledge and understanding enabled Angelina Arora to come up with her bioplastic idea?

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6 What is a 'point of difference'? How may it impact on the success of a design?

7 How can outlining areas of investigation provide focus and direction for the development of the MDP?

8 Explain the difference between primary and secondary research.

9 When should models be constructed in the development of a product?

10 What is the purpose of a prototype? How can prototypes assist in the success of a product?

EXTENSION TASKS

1 This task is an exercise to develop empathy for a given situation. Along with the benefits that mobile phones bring to society, there are a number of negative impacts that the mobile phone brings to a school community. Whether you agree or not, in an attempt to mitigate the problems, the Victorian Minister for Education James Merlino announced on 26 June 2019 that 'Mobile phones will be banned for all students at Victorian state primary and secondary schools from Term 1 2020.' In groups complete the following:

- **a** Create a spider diagram of the problems that mobile phones bring to a school community.
- **b** To better understand the root cause for one of these problems listed in part **a.** create a cause and effect diagram (fishbone diagram) to understand the relationships between the contributing factors and better understand how these impacts are caused.
- **c** Using your increased understanding of the situation, undertake a needs analysis using the six dot points suggested earlier in this chapter.

2 The number of adolescents exposed to alcohol-fuelled violence is increasing. You have been commissioned to design an awareness campaign to educate young people and promote responsible behaviour.

- **a** Clearly outline the need or opportunity this project poses.
- **b** Write a design brief for this project.
- **c** List and justify the areas of investigation you will undertake.
- **d** What form/s of media will you use in your campaign? Justify your selections.
- **e** Write criteria for success to use throughout the process of developing your campaign.
- **f** How will you determine the success of your campaign?

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20 Selecting and using resources responsibly to realise a quality major design project

This chapter explores the responsible selection and use of resources to realise a quality major design project. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H4.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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20.1 Safety

Today, designers are taking responsibility for the products and systems they create and are considering the environmental impact of their actions. They must take into account safety as a prime component in any process they undertake and as a result of any action they perform. This means consideration of safety throughout the whole MDP must be a priority and documented accordingly. Everything including the selection of materials to be used, manufacturing methods to be undertaken, intended purposes and use of the MDP, the end of life or new life of the project (understanding the target audience is a factor here), and waste and energy must be considered. Design choices now must have safety considered at all times. You will need to constantly consider your own safety when selecting and applying resources. You also need to consider the safety of the consumer of your MDP, and you are ethically responsible for ensuring you comply with any legal requirements.

SAFETY FOR DESIGNS FOR YOUNG CHILDREN

An example of a product where designers must be very conscious of the safety of the end product is children's toys. Designers of children's toys should always refer to the Australian Standard AS/NZS ISO 8124.1:2002: Safety of toys. Safety aspects related to mechanical and physical properties (ISO 8124.1:2000, MOD) specify design requirements in relation to characteristics such as size, shape, sharp points, tip angles and warnings. The Australian Competition and Consumer Commission website is a good reference.

These standards provide parameters to which the designer must adhere if the product will be made available to the public. Potentially dangerous elements, such as toxic paints, should be given consideration, and all materials and parts should be assessed for safety. Often you will hear of product recalls due to unsafe or defective components. If you were designing a bed for young children, functional criteria would include basic design elements such as ensuring the mattress fits correctly, while the use of non-toxic paints and having no sharp edges (aesthetic criteria) would be essential for safety. When undertaking research, you may have come across various products that have safety usage advice or recommended usage controls from the manufacturer of the product; for example, a children's toy that is recommended for specific ages or 'may contain choking hazards'. This is how manufacturers can advise on safety, but the end-user of the product may not read the safety usage advice. This is why designers must test for safety, comply with standards and be aware of legislation. Safety in the design and safety in the usage of a product are not always the same.

SAFETY IN THE EXECUTION OF THE DESIGNS

As a designer, your own personal safety and the safety of those who execute your designs will require careful consideration and planning. There are often safety issues to be considered regarding the materials you have selected, working with the materials and even machining the materials in a safe manner.

The supply of raw materials in your MDP should be investigated, as many imported items can have unknown origins, particularly if they are not purchased from a reputable supplier. Online e-commerce has enabled such purchases, with many products being from non-Australian supply chains, resulting in questions about who is responsible if a product is unsafe. Generally speaking, if you import the resource from another country and bypass the Australian supply chain, you become liable for the resource's usage, as it may not comply

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Figure 20.1 Designers must test for safety, comply with standards and be aware of legislation. The end user of a product may not read the safety usage advice. Relying on web-based product disclosures or safety advice may not be appropriate for many products or the intended user of the products (e.g. a product for an elderly person with no digital literacy would be risky if these details were only available online).

with Australian laws. You, as the designer of your MDP, must consider all resources to be included in your MDP. Ask questions and do your research. In industry, designers will often be part of the team that create the instruction manuals and safety advice for the users of the products, and you should consider doing the same for your MDP as part of your responsibility as an ethical designer.

WORKPLACE HEALTH AND SAFETY

What about safety in the workshop or when you are using equipment? This is where you will need to work with your teachers, follow safety signage and observe the tool manufacturer's usage advice. In industry, to comply with Work Health and Safety (WHS) legislation, standard operating procedures (SOPs) or safe work procedures (SWPs) for all machinery and equipment that is used in a workshop situation are either developed by the business or referred to from the equipment manufacturer's safety advice. These should be displayed prominently at the machine and read before using it, thus ensuring you and your fellow students remain safe while being creative in the workshop.

Safe operating procedures for equipment and materials must be adhered to. Students need to consider whether they have been adequately trained, are competent to use machinery and have undergone the relevant safety tests. Talk to your teacher about what is available at school and what you should be doing in relation to your specific MDP. Do not just assume you know how to use a piece of equipment. Practise your skills before you attempt to construct your final design. This is part of the learning and research about the safe use of equipment.

Ask yourself these questions before attempting any construction process:

- Have you researched the most appropriate production techniques? Will you be using a similar process to that used in industry?
- Were you properly trained in the use of this tool or procedure?
- Have you completed the relevant safety tests? Do you have documentation to prove this?
- Have you developed a satisfactory degree of competency when working on a previous project or test piece?
- Do you understand the necessary hazard and control procedures that apply to yourself and your fellow classmates?
- How do you safely dispose of any waste material from your production process?

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ACTIVITY 20.1

Select a piece of equipment or machinery and develop an SOP or SWP for its use. Do an internet search – there are many websites for guidelines.

The Safe Work Australia website provides information on a range of work health and safety issues. There is a special section relating to safe design that should form part of your reading.

Your relationship to safe working practices must be documented as part of your written folio. You do not need to include all the safety tests you have done but reference them in your folio with pictures of the equipment and a summary about the safety procedures you have followed. Some students tend to meticulously document their research on what stitching to use or what glues they've chosen, but then neglect to include their research on safety and do not include a plan that clearly demonstrates safe procedures. Some research into safety is simple, like reading about disposal methods on a paint tin, while others require more foresight. Safety research should be included in your folio. Some items that could be incorporated include:

material safety data sheet (MSDS) describes the identity, relevant hazard information, precautions for use and safe handling of a hazardous substance

personal protective equipment (PPE) a device or appliance designed to be worn individually to protect the user against potential hazards

- research on safe operating procedures
- safety tests
- reference to **material safety data sheet (MSDS)** information
- health and safety plans developed to assist and protect you during the production process.

When you purchase chemicals, be sure to ask for the corresponding material safety data sheet. Take note of the chemicals' safe use, disposal and first aid instructions. All businesses that supply chemicals should provide copies of MSDS information or you will be able to access the MSDS sheet on the internet (as part of the manufacturer's responsibilities for work health and safety). If all else fails, contact the manufacturer directly. If it is a specific product that you are intending to use based upon a recommendation from an expert, ask them about the work health and safety procedures they employ when dealing with the material such as wearing certain **personal protective equipment (PPE)**.

Figure 20.2 Comply with safety regulations and use the required PPE at all times.

Some examples of common PPE equipment are:

- safety glasses
- overalls
- ear muffs
- hard hat
- gloves
- dust mask
- covered footwear.

You may need to rethink construction of certain elements of your design or consider outsourcing parts of the manufacture if it is unsafe to machine or manufacture in a school environment. Hazards could include dust, noise, space, fumes and so on and be specific to your school environment. The safe development of your MDP and the safety of others must be considered at all times.

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ACTIVITY 20.2

1 Identify three different manufactured materials or chemicals you are planning to use in your project and justify their choice.

2 Go online to get a copy of the material safety data sheet for each of the materials. There are many websites that can help with MSDS information and each manufacturer usually has its own.
   - Safe Work Australia
   - National Safety Council of Australia
   - MSDS FAQ
   - WorkCover

20.2 Ethical issues

Video

Ethics refers to the standards of conduct that indicate how people ought to behave, based on a set of values and principles. We make ethical decisions throughout our lives, based on our own set of values. Occasionally, you may experience an ethical dilemma when there is conflict between core ethical values. As designers, the core value of our ethical code of practice is responsibility – responsibility to the consumer, to the environment, to society, to the manufacturer and to other designers.

When we are making choices about the resources we are considering, such as whether to use an imported material or a local material, we are making ethical decisions. Some questions we can ask ourselves are:

- What are my options?
- What are the consequences of my decision?
- How does my decision impact on others?
- Will my choice support any unethical practice?

Ethical designers have a responsibility not just to the design community for developing solutions to design briefs and acknowledging those who have worked in the field before them, but to the sourcing of the raw materials and the production of their designs. Often this leads to compromises and conflict if you are to be ethical. How well do you know the supply chain that leads to the product getting to market?

Many big design contracts and projects investigate every detail of the supply chain in order to satisfy the customer's needs. Large national and international brands often pride themselves on being ethical in the design and production of their products and sometimes find it embarrassing when their claims are not true. The rise of cheap production capacity in other countries, combined with government-ratified free trade agreements, has changed the way designers need to consider their part in ethical consumerism.

When you source a resource for your project, do you think about where and under what conditions it was made?

Many Australian-designed products are manufactured offshore because it is cheaper. Some of these products are made in sweatshop conditions. Sweatshop conditions are where hundreds of employees work in cramped and unsafe conditions for excessively low wages, for up to 12 hours a day, six days a week. Sweatshops prey on economically disadvantaged people, including children. These workers can even be exposed to harmful chemicals, solvents and other fumes. Domestically, it has been reported that some leading fashion designers employ immigrant families to manufacture clothing in Sydney garages and

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CASE STUDY 20.1

Annukka

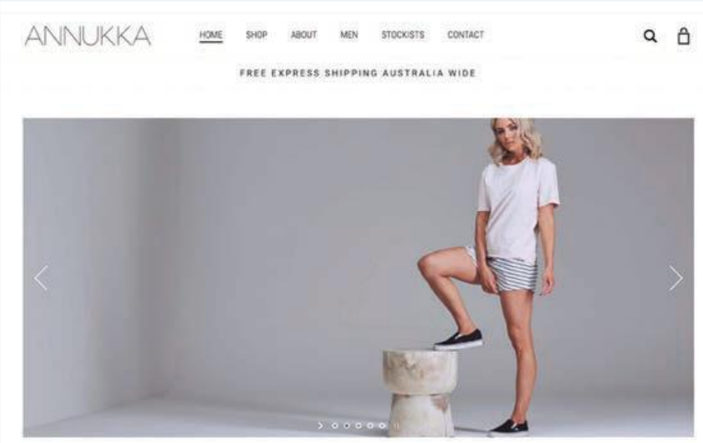

Figure 20.3 Annukka website

Annukka is a clothing business with the head office in Byron Bay. Their clothes are sold in over 50 stores around Australia and New Zealand. According to their website the health of their family became a powerful catalyst to reinvent their way of living. As they learned about the wellness benefits of an organic, chemical free lifestyle firsthand, certified organic cotton – free from toxic dyes and treatments – became the cornerstone of their clothing range.

Their mantra is RESPONSIBLE PRODUCTION. A RESPECTFUL AND LASTING RELATIONSHIP.

They believe that fair trade and sustainable development should be expected: respecting your skin with soft materials; respecting the people who make your clothes with ethical working conditions; and respecting the world that we live in by minimising our impact on the environment.

The product is made 95% in Australia and 5% overseas. They believe that manufacturing in Asia is a positive thing – if done properly. Their website states: 'And properly means respecting the rights of the men and women employed. It means giving them the means to acquire new skills and to receive education and training'.

The following statement from their website explains why they have chosen the materials used for their clothing range:

Why choose certified organic cotton

Did you know that conventionally grown cotton uses more pesticides than any other crop in the entire world? These toxic chemicals are harmful to not only farmers and workers but to us as consumers and entire wildlife ecosystems as well. We believe that choosing certified organic cotton is socially, ethically & environmentally responsible and is the best choice for your health. Did we mention it's beautifully soft & looks and feels good too?

Annukka clothing proudly features only the best certified Organic Cotton (GOTS Global Organic Textile Standard and ACO Australian Certified Organic). We keep production local and sustainable by manufacturing all clothing in Australia and our factory is ACO & ECA (Ethical Clothing Australia) certified as well. Our Merino Wool Cardigan is Woolmark certified.

Benefits of organic cotton

Certified Organic Cotton farming introduces no chemicals into the environment and is GMO free. Certified Organic Cotton is free from toxic dyes & fabric treatments including formaldehyde, heavy metals & aromatic solvents. People with chemical sensitivity and allergies can wear organic cotton safely.

Certified Organic Cotton has a notably lower carbon footprint, using less fuel, water and energy to produce. Certified Organic farming is safer for workers on cotton plantations, avoiding exposure to harmful chemicals. Certified Organic Cotton promotes a sustainable supply chain. Factories must abide by strict manufacturing criteria, fair working conditions & use no child labour.

Source: https://cambridge.edu.au/redirect/8945

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apartments. These outworkers are underpaid, work long hours and live in fear of losing their jobs. In recent times, cheap overseas labour has forced the closure of many once-thriving manufacturing activities. The announcements in 2013–14 by the global companies Toyota, Ford and Holden to stop production in this country in 2016–17 may impact the local economy. The loss of many manufacturing jobs in the supply chains for this industry may result in less designing taking place in this field. The support of employment with fair conditions and pay versus the economic benefits of global production in a cheaper labour economy is certainly an Australian ethical decision of our time.

Looking back now, as of 2019, over 200 000 jobs have been lost or displaced due to Australia no longer being competitive in mass production manufacturing in many industries. Australian businesses are very flexible in being able to undertake batch production, large industrial or specific need engineering projects and high-tech specific manufacturing. Having a highly skilled work force in specific industries has been a success for Australian enterprises; however, many jobs and support employment activities have been impacted by political removal of tariff protections by successive governments. The question to ask in 10 years time is how the decisions of the past will continue to shape designers' activities in the future. How will they be able to access resources and expertise? If many of the experts are no longer in the industry, this is going to be a challenge.

Read online about the factory collapse in Bangladesh in 2013 in the ABC news story 'Factory collapse a "wake-up call" for fashion industry'.

As a responsible designer, you can also consider the different tools and materials you purchase. Buying Australian-made products is one way that consumers can support the nation. When you purchase something made in Australia, rather than in other countries, you are not only supporting local industries and jobs, but you are also reducing the air pollution and greenhouse pollution involved in the transport of the product to Australia. The Australian Government has set criteria that manufacturers must meet in order to make the claim 'made in Australia'.

Using environmentally friendly materials and processes is also an ethical issue. If we care for the future of our world, we will aim for sustainability in all our work. Sustainability is usually expressed in environmental or scientific terms, but it is also a social challenge that involves ethical decision-making on the part of governments, industries and individuals.

ACTIVITY 20.3

Use the internet to research sweatshops in Australia and Asia. Consider the dilemma of an emerging designer who needs to begin mass production but wants their final garments to be sold at an affordable price to the consumer. Discuss the issue of whether or not they should have their garments made offshore.

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20.3 Environmental issues

Environmental factors should also play an important part for designers during decision-making. Materials that are known to be detrimental to the environment should be avoided. Just because a particular material has traditionally been used does not always mean it is the safest option available today. Consider the alternatives by asking the following questions:

- Are there safer alternatives for the materials, size, shape and operation?
- What will happen after the project's life cycle is complete?
- How will the various parts be disposed of?

Figure 20.4 Your designs should consider the environment and future sustainability.

ACTIVITY 20.4

Research three materials that have been removed from manufacturing processes in the past 50 years and detail the reasons for their removal.

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CASE STUDY 20.2

Richard Cole

Sustainability is high on the agenda for today's architects, and they must have an all-inclusive understanding of the environmental concerns influencing their designs – including lighting, acoustics, thermal control, plumbing, fire protection, elevators and emergency plans. This approach shows how the interconnection between science and aesthetics holds the key to creating buildings that are not only structurally sound but also socially responsible.

Architects want to make buildings that are friendly to the environment. They need to consider an efficient use of energy, water and other resources, protecting residents' health and improving people's productivity and reducing waste, pollution and environmental degradation. Green buildings are a trend today for their positive effect on the environment as they take the landscape into account.

Richard Cole is one architect who has taken on this challenge in his work. Richard believes that buildings are not only shelter, but they can provide a fundamental connection with the world, embody the way we choose to dwell and affect our day-to-day lives in the most essential way. Richard aims to incorporate the site, the budget, special requirements and the environment into his designs.

One project, a timber house on Sydney's northern beaches, has achieved a sustainable design by using recycled materials, orientating the house in the right direction and maintaining a smaller floor space. Louvre windows strategically placed to allow a breezeway and the positioning of the living area and bedrooms to take full use of the sun to warm them are other environmentally sound approaches to the design. By using sturdy but light steel piers to lift the home off the steep site, Cole ensured that energy-intensive excavation was not needed. An additional strategy was to incorporate a series of horizontal window bays to control the amount of light entering and making lights unnecessary until late in the evening. Another consequence was that only a small amount of heating was required on winter mornings. This home also won an Australian Timber Design Award for its extensive use of sustainable hardwoods.

This design reflects Richard Cole's view that a well-considered design can be used to encourage sustainable living. Other residential designs include Angophora house in a densely urbanised heritage conservation area in Waverton, a panorama house located on a small escarpment with spectacular views over Bronte Beach and a Cottage Point house located in the isolated settlement within Ku-ring-gai National Park. Richard Cole has also been involved in the design of commercial spaces like the Rozelle Bay Marine Centre, the Avalon and Palm Beach Surf Life Saving Clubs and the PPB accounting firm office fitout. At all times he considers the environmental impact of his buildings and the need to create sustainable spaces.

Search online for information about Richard Cole's 'Hilltop House'.

Figure 20.5 A house designed by Richard Cole

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20.4 Use of resources based on research results

Having completed your research into resources for your MDP and considered the safety, ethical and environmental issues, you must justify your choices. You need to tell the story of your MDP, how you came to choose the materials and colours, and other stylistic choices you made along the way.

While journal writing may be an obvious choice, another option for presenting such information is in table format, where the progression of the story is told sequentially under column headings. Resource, use and justification headings set left to right across the page will convey the story quickly to readers.

For example, a student listed PVA glue as a resource. Its use was to glue two pieces of wood together. The justification detailed the research gleaned from a strength test of glues as well as a chat with an industry professional on what glues could be used. The PVA was chosen following a favourable test result and verbal support from the professional. By using a table format to convey the information, it is much easier to visualise and track the realisation of the work – that is, how the choices made through testing and research resulted in the end design.

Not every resource you select for your project is obvious. While students tend to focus on tangible factors, like the sewing machine or hammer, it pays to take a step back and think about the less obvious resources you employ for the task as well. Time, money and logistics can be considered resources and should be accounted for and managed in your project as they are not infinite!

Attention to detail in your justification of why you have chosen one item over another strengthens your folio and demonstrates your reasoning skills.

Your final solution gives evidence of the decisions made. A strong design folio tells the complete story of how you evolved the project. The finished project is, in essence, a 3D prototype version of the folio, because it shows how the research has been applied. Your folio must complement and support your project with fully documented research and all choices justified. The reader should be left in no doubt that your final product is the best available of its kind, given the resources, skills and knowledge you had to work with. Make sure you:

- identify a wide range of resources used
- describe the use of resources
- justify the selection of resources.

ACTIVITY 20.5

Testhub

Identify five resources used in the construction of a project that you have completed in the past. What was the use? Justify why you selected those resources and include tangible evidence of the research you undertook. Include all the information in a table like the one below.

RESOURCE	USE	JUSTIFICATION	EVIDENCE

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CHAPTER SUMMARY

- Safety is a paramount issue in design. Standards Australia publishes guidelines that designers can follow in the development of a product.
- Safe working practices are usually developed with knowledge gained from research, past experience, understanding of the properties of the material and analysis of any potential hazards. Your school has developed a set of safe working practices for every machine in its workshops.
- When selecting resources, ethical issues should be considered.
- A life-cycle analysis is the examination of the environmental impact of a product from cradle to grave – from raw materials to use to eventual disposal.
- A design folio should accurately tell the story of all the decisions made in the development of an MDP. It should detail the identification of resources and the justification of their use.

CHAPTER SUMMARY TASKS

1. Outline the Australian Standards and evaluate their importance.
2. Write a list of questions you should ask yourself when selecting resources.
3. 'We should only use Australian-made products.' List the points for and against this statement.
4. Define the term 'life-cycle analysis'. Create a graphic interpretation of a life-cycle analysis for a specific product.
5. Where could you access information about safe operating procedures? When would you use this information?
6. Identify what the acronym MSDS stands for. Describe its use.
7. List some examples of PPEs.
8. Explain the difference between a hazard and a risk. Develop a basic risk assessment for a piece of equipment you have used.
9. Outline examples of different types of resources.
10. Explain how ethical issues will influence your choices for your MDP.

EXTENSION TASKS

1. In approximately 250 words, describe why you consider yourself an ethical designer.
2. In relation to the environmental issues, how could you improve on the end-of-service life of a product? How has this become a significant issue for society? What systems could you consider to change the way in which Australian society deals with consumable products; that is, products that have a short lifespan?

Figure 20.6 Solar hot water systems are more common in northern parts of Australia where they are more reliable.

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21 Evaluating the processes undertaken and the impact of the major design project

This chapter explores the evaluation of processes undertaken in the major design project, and the impact of the major design project. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H4.3** in the New South Wales *Design and Technology Stage 6 Syllabus*.

ISBN 9781108869300

21.1 Project evaluation

Evaluation is not an activity that is exclusive to designers; we all evaluate or make judgements throughout life. In the context of designing, the act of evaluation is ongoing and can occur informally as well as at formal points in the design process.

FUNCTIONAL AND AESTHETIC CRITERIA

Design project criteria are a set of established goals, features or characteristics that the designed solution must have in order to successfully satisfy the need. Picture in your mind a set of scales; one side is labelled 'Function' and the other side is labelled 'Aesthetics'. Finding the most appropriate balance between function and aesthetics always poses a challenge for designers, as some criteria are more important than others. In identifying these two types of criteria, designers need to develop a close relationship with their clients and a thorough understanding of their needs.

When it comes to identifying functional and aesthetic criteria for your MDP, you are asked to recognise and to distinguish between these two fundamental design aspects. It is suggested that you present them separately in a table but remember that they are related. While one may be more heavily weighted in the design of a product, it is difficult to find a product that does not consider both function and aesthetics. High-fashion apparel places greater emphasis on aesthetics than function, whereas professional sporting goods may place more emphasis on function. However, neither is created without some consideration of both aspects of design, and finding the right balance contributes to a successful product.

By identifying functional and aesthetic criteria, you set yourself goals for the project; a key to ensure that the solution 'stays on track' and addresses the identified need. The finished product should reflect your criteria – the things you selected as important. Through analysing criteria, you will discover that some of your criteria will be more important than others for the solution to be considered successful. Remember, design processes encompass both divergent and convergent thinking, so it is imperative to identify criteria for your project without limiting your ability to explore widely and respond to findings of research and testing. If the initial criteria for your project are too specific, you may find it difficult to demonstrate the process of design development. Also, too many criteria can narrow your design to the point where you find it hard to evolve and develop your design as you make decisions along the way.

Video

In terms of the establishment and analysis of appropriate criteria, consider how you will assess whether the MDP has achieved specified functional and aesthetic criteria. In some cases your assessment of your designed solution may be a simple yes or no answer. However, in other circumstances your assessment may comprise incremental levels of achievement against specific criteria.

Figure 21.1 Modern phones offer a balance of function and aesthetics.

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Evaluation opportunities

Examples of the circumstances when designers evaluate both formally and informally include:

- The decision to choose one idea over another
- When a designer identifies an opportunity from a specific situation
- When the analysis of data suggests a particular process or direction
- The overall success of the MDP in relation to the need or opportunity identified in the project proposal
- When feedback is convincing
- The impact of the MDP on the individual, on society and on the environment
- Whether the MDP meets each of the functional criteria and aesthetic criteria
- The level of success of processes undertaken throughout the design and construction of your MDP, such as experimentation.

Read the article 'The world cup: design, technology and innovation through football boots' online at Design Boom.

ONGOING EVALUATION

Project evaluation may be the heading for the final section of the design folio, but do not be led into believing that evaluation will only be formally documented in your project portfolio after you have completed your MDP. A process of ongoing evaluation is essential to ensure you stay on track and produce the best possible outcome to meet the need or opportunity you identified. In the management of projects through a design process framework, often many of the decisions that designers make occur informally, and without explicit documentation. In your senior Design and Technology studies, to tell the story of the development and evolution of your MDP you are required to be explicit, reflect on your decisions and document your evaluation throughout your portfolio so that you give the markers a better understanding of the decisions made throughout the development of the project.

ACTIVITY 21.1

Consider the design requirements of the following three products:

- football boots such as those worn by elite level players at the FIFA World Cup
- the design of a wedding cake
- a website that sells pre-prepared, healthy meals for 'fitness-minded' clients

1. Describe the functional requirements of each.
2. Analyse how the functional requirements have influenced the form and shape of each product.
3. Describe the aesthetic requirements of each of the three items.
4. Analyse how the aesthetic requirements have influenced the form and shape of each product.

Figure 21.2 Consider how football boots have developed to assist performance.

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As the designer and producer of your MDP, the requirement to make both seemingly insignificant and crucial decisions will be ongoing. From your initial thoughts and concepts to the finishing touches on your project, you will make selections that will impact on the outcome and success of your work. Evaluation is the critical process of reasoning. You need to assess the relative value of alternatives in relation to their ability to achieve your criteria for success. You need to justify why you made decisions about ideas, materials, tools and techniques. You also need to evaluate the design development and justify why things may have changed as you progressed through the design process, explaining why deviations from your original plan were required.

When evaluating, refer back to both the criteria to evaluate success and the identified need or opportunity, and weigh up what you have done in relation to what you set out to achieve. Your whole project should be in response to the need identified in the project proposal. Always remember this and use your ongoing evaluation to demonstrate that you are working towards the goal you have set.

Your criteria for success provide a means of judging the level of success you have achieved at various points throughout the development of your project. If your criteria have been carefully written in clear, achievable terms, it will be easy to assess the level of accomplishment. For example, if you are designing a range of culturally inspired jewellery pieces reflecting your family's heritage, your criteria for success may include those listed in Table 21.1.

Clear, **unambiguous** and **measurable** criteria written in positive, achievable terms make it easy to see whether you have wandered off track. You can assess whether any of these have not been achieved and take action to get back on task and work towards completing them.

unambiguous clear meaning that can only be interpreted in one way

measureable something that can be quantified, or is able to be measured

Table 21.1 Criteria for success for a range of culturally inspired jewellery pieces

FUNCTIONAL CRITERIA	CRITICAL ANALYSIS	PERCEIVED IMPORTANCE OF THIS CRITERIA BY FAMILY MEMBERS (Based on a survey where 1 is extremely important and 5 is not at all important)
The pieces must be made from sterling silver.	The intrinsic value of precious metal will add importance and worth to the pieces. It is also durable and will ensure that the pieces last for many years.	4
There must be one piece for each member of the immediate family.	The aim is to create a family heirloom set that is shared by all members of the immediate family and that can be passed down to future generations.	2
AESTHETIC CRITERIA	**CRITICAL ANALYSIS**	**IMPORTANCE SCALE**
The pieces must not be gender specific.	The aim is to create pieces that can be handed down through the generations, so they should not be designed specifically to be worn by either a male or female.	2
The pieces must use identifiable symbols from the family's cultural background.	It would be pointless to create pieces that are supposed to show cultural heritage if they were not recognisably connected to that culture.	1

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You may choose to add additional columns to your criteria table that identify the method of evaluation or standard to be achieved for each criterion. This encourages you to consider how you will determine the level of success (will you survey end-users, consult experts, test the finished product for specific performance outcomes?) and the standard of work or the quality of the finished product necessary for it to be deemed a success.

To assist you in the establishment and management of design criteria to complete the MDP and documentation required in the portfolio, use Table 21.2.

A quality design portfolio effectively tells the story of how your project is realised through concise documentation that presents the specified information to the detail that is required in the project marking criteria. A person examining your finished project and wondering why you chose a certain material or process should be able to open your folio to the appropriate page and see your corresponding evaluation. As an example, if you painted your project deep blue in line with a marine theme, there should be an evaluation explaining why you chose that colour.

Table 21.2 Evaluation checklist for an MDP

ESTABLISHING CRITERIA	
☐	Go back and read your identified need or opportunity. What are the goals that you are trying to achieve?
☐	Establish and analyse what you want the project to do (functional criteria). Use Table 21.1 as an example.
☐	Establish and analyse what you want your project to look like (aesthetic criteria). Use Table 21.1 as an example.
☐	Check whether the criteria are both appropriate and achievable.
☐	Check the criteria against the identified need or opportunity. For example, will the need be met if the criteria are achieved?
EVALUATING AGAINST THE CRITERIA	
☐	Continually refer your decisions to your criteria throughout the development of the project to stay on track.
☐	Critically evaluate the decisions and processes, and document this as your formal ongoing evaluation.
☐	Critically evaluate the functional and aesthetic aspects of the project against the criteria established in the project proposal.
☐	Critically evaluate the impact of your project on the individual, society and the environment.
☐	Analyse the finished project against criteria for success and the identified need or opportunity.

ACTIVITY 21.2

1. Consider the functional and aesthetic criteria used to develop your school bag. How can a school bag impact both positively and negatively on the individual?
2. Propose how a school bag may have both positive and negative impacts on society.
3. Research to find critical information on how the material or processes used to manufacture a school bag can have negative impacts on the environment.

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Even though you may have been documenting your evaluation since you started working on your MDP, the marker only has a finite amount of time to assess the quality of your work. By using an evaluation symbol or key, you can save yourself work and make it easier to identify your ongoing evaluation. Instead of scouring pages of text searching for a buried comment, a reader can locate your evaluation headings and easily understand the processes you have used. If you have been documenting your evaluation throughout the portfolio, you will have ample evidence of ongoing evaluation, and the visibility of this work be located easily by the marker.

ACTIVITY 21.3

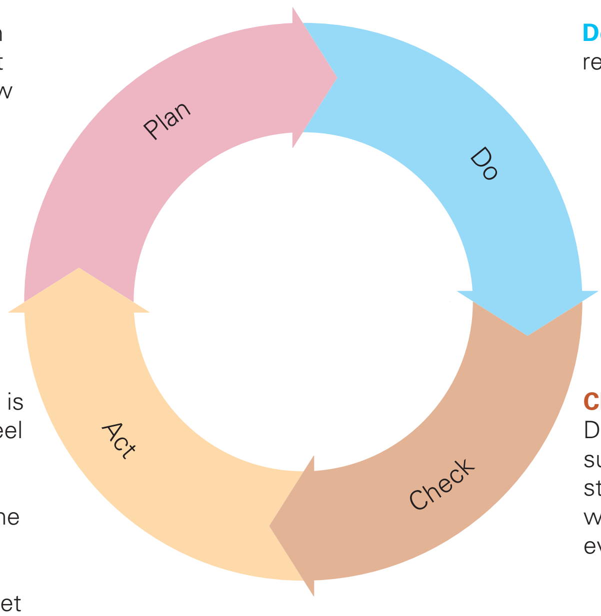
1 Develop a symbol that you will use to draw the marker's attention to your ongoing evaluation.
2 Create a theme and/or colour scheme to use for your ongoing evaluation.
3 Consider using a different font, border or graphic to make your ongoing evaluation stand out.

There are occasions when your ongoing evaluation does not yield positive results or suggests that you may need to make changes to your approach in order to satisfy the need. If this is the case, then it is what you do next that could have a positive or negative impact on your MDP.

To assist you in planning your next move, a useful tool for ongoing evaluation is the Deming cycle, which is also known as the plan-do-check-act cycle. This was first developed by Dr W. Edwards Deming to improve industrial processes after World War II. This four-step process is an effective way to manage ongoing evaluation with the aim of continual improvement. The use of the Deming cycle is not a requirement in the documentation of your MDP; however, informally, the stage of planning may enable you to think about engaging with human resources who can advise you on what to do next.

Plan What do I need to do? Plan one step at a time. Work out what you want to do and determine how you will do it to achieve the desired results.

Do Carry out the required action.



Act If the outcome of the action is in line with your criteria and you feel you have achieved success with this step, plan the next step and repeat the process. If your outcome is not in line with your criteria and you feel you have not achieved success, take remedial action to get back on track. Plan the next step to get back to meeting your criteria.

Check Is it working? Determine the level of success of this step/process. Compare with criteria for evaluating success.

Figure 21.3 The Deming cycle

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21.2 Implementation of design solutions

Your aim is to design and construct a project in response to an identified need, problem or opportunity, utilising the most appropriate technologies. The best way to achieve this is to remain open-minded, think laterally and explore all options. In other words, test possible solutions and implement the best choices. But how do you know which solution is the best one to pursue and develop? There are a number of methods a designer can take to evaluate the appropriateness and suitability of design ideas. In some circumstances, the information you need has already been undertaken by others and is already available, such as data from the Bureau of Statistics. Using this example, your access to available information is secondary research. There are other times when the information you seek on the suitability of your design solution is not available. This could be due to the innovative or unique nature of your project or need. If this is the case, you may have to collect the information yourself to be able to inform you to make the right decision. This is primary research!

Figure 21.4 Not all solutions are straight-forward

21.3 The importance of practical research

Whenever you see the word '**testing**', it really means practical primary research – the hands-on experimentation you work through during the design and construction of your project. It may be a big-picture test – is your initial idea possible to make, will your design solve the problem? Or perhaps you are simply testing a component of the design, something as simple as the type of seam finish or the method of joining that will work best to achieve the look and durability you desire.

'Testing' and 'experimentation' are terms that may be used interchangeably. An experiment is just a test. Recording the aim, procedure, results and conclusion of a test using scientific methods is one way of recording a test or experiment. Making a video of your completed MDP in use in the environment for which it was designed and evaluating its effectiveness or impact is another way of recording a test. Be creative and use multiple forms of communication to show your process. Remember you are trying to communicate your evaluation of these tests as effectively as possible to assist the marker.

testing a process of trying something to see if it works or is appropriate

Sometimes it is difficult to know where to start and what to test. Direction for testing should come from the 'Areas of investigation' section of the folio. You will already have identified what you need to find out about and how you intend to find out about it. Individual tests should flow from what you have already planned and documented. However, as you conduct research and testing, allow room for the development of your design in response to your findings. New information may come to light that will help your project to evolve; information that may lead to further unplanned testing. You may be well

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into the construction of the design when evidence is discovered about a previously unconsidered tool, material or technique, and you may need to stop and undertake further testing to determine the appropriateness for your project.

Next we must consider the more holistic testing and evaluation of design solutions. Design solution testing usually takes the form of models and prototypes, and considers factors such as physical characteristics like balance, proportion and scale. Sometimes the use of the term model and prototype is interchangeable; however, there are differences. Depending on the project, these differences may be difficult to determine; however, generally speaking, the difference between a prototype and a model is that the prototype is a full-size functional version of a concept. From a mass-production perspective, the prototype is an early version that would inform and assist in the development of a design.

From a Senior Design and Technology MDP perspective, the final design that many students finish with would realistically be considered an early version of the design if the MDP was to be developed further for marketing purposes. The project as a prototype would assist in the evaluation of functional features such as closures, moving parts, size and fit. Design solution testing is not a last step at the end of testing, but it should be seen as an ongoing means of testing to see whether the project is working and meeting the established criteria. It should be part of an iterative process of design showing how the designer has responded to research and testing, advice from experts and target market input.

Models do not have to be elaborately constructed and time-consuming – they may be virtual or physical; full size or to scale; a simple, three-dimensional representation of a part or the whole design project. Models of varying complexity and finish should be used when and where appropriate to aid the development of the design and usually fall into one of the following categories:

- **Sketch models:** Used in the early stages of design development to allow the designer to explore three-dimensional aspects of their design and consider size, scale and proportion. If virtual, these may be constructed using 3D modelling software. Alternately, materials used in physical models may include cardboard cartons, empty plastic containers, styrofoam, balsa blocks and other found objects.
- **Block models:** Used to show the visual appearance of a product. Used as a visual representation to show a client or focus group to allow them to evaluate aesthetic features such as colour scheme. Created using the same or similar materials to the finished product, but not fully functional; may be without internal workings and electronics. May be used in industry for initial advertising development.
- **Working models:** These may represent either the entire project or some part of the whole project. May be undertaken to examine or test a working part during design development or to demonstrate the same to the client as a selling feature of the design.
- **Prototypes:** Used for final testing and evaluation of the product before the expensive process of manufacturing is established. A prototype may be hand-produced as a one-off model prior to the tooling up for full-scale production. Prototypes are also used for market research and advertising purposes prior to the release of the product.

Figure 21.5 Models can be used to test design solutions and communicate ideas to the client.

All models should be kept, simply labelled and displayed to demonstrate design development and modification in response to ongoing evaluation throughout the entire production of the MDP.

Read the article ‘Build it, break it’ at https://cambridge.edu.au/redirect/8733.

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21.4 The impact of the MDP

One requirement in the design portfolio is the documentation of the impact that the designed solution may have. All forms of designing and producing have widespread impacts that need to be considered. Best practice expects that designers will be ethical in their activities. As a result, they have a responsibility to consider all impacts their designs may have as some may be positive or negative. Some are obvious and occur at specific stages of development or upon market launch. Others accumulate over time and may not be evident until well into the future.

As the designer of your MDP, you are asked to examine its impact on three levels:

1. impact on the individual
2. impact on society
3. impact on the environment.

IMPACT ON THE INDIVIDUAL

Consider the impact on the individual as a consumer or end-user. Some provoking questions that may assist you to critically evaluate the impact may be:

- Does the product improve the quality of life?
- Does it make life easier?
- Does it save time or energy?
- Does it make the consumer happier or more contented?
- Does it promote some form of social awareness?
- Does it prompt the consumer to consider environmental issues such as sustainability?
- Does it affect the consumer's health or well-being?
- Does it impact on self-esteem or self-worth?

The impact on you, the designer, should also be examined. Did you learn new skills? Has the MDP increased your awareness of issues such as growing consumerism and negative impacts on the global environment? Will you be able to apply the managerial skills developed in the MDP to future life situations? Do you feel proud of your achievements? When you are considering these questions, if the answer is yes or no, explain why and add 'critical' levels of detail to satisfy portfolio requirements.

IMPACT ON SOCIETY

Society may be viewed as a body of individuals that come together as a community. Within that grouping there may be numerous subsets based on cultural background, religious beliefs, socio-economic factors, education, occupational experiences and many other demographic definers.

When examining both the positive and negative impacts of the design project on society, try to look at issues such as:

- improved cohesiveness and developing greater community pride and spirit
- factors that may reduce the burden on infrastructure, such as hospitals and the health-care system
- anything that may cause offence to any group within the community
- the ability to make members of the community feel safer or free from harm
- whether it could lead to employment opportunities.

Frequently, past examples of MDPs have been developed as a one-off production designed for personal use. This may mean that the impact on society is limited to the impact on those who immediately interact with the product (a group of people with a common interest). Explore this fully, then try to extrapolate and consider the impacts if the project were developed for commercial production and distributed among an appropriate group of users.

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ACTIVITY 21.4

Watch the video 'Demodern Case study from AR Fashion Assist' on YouTube. Answer the following questions on this technology:

1. Analyse the potential social or environmental costs and/or benefits of Augmented Reality (AR) to shop for clothes.
2. Discuss possible modifications that would allow this technology to assist the wider community. How and where could it be used?
3. Consider the ethical implications if systems such as these could be 'hacked' or the data misused. Weigh up the pros and cons of privacy versus safety and productivity.

IMPACT ON THE ENVIRONMENT

The environment may be viewed as both our natural and manufactured surroundings. The environmental impact could affect a macro-environment (the world, its air and water) or a micro-environment like a bedroom or classroom. We impact on the environment continually, taking what nature produces and returning waste in the form of air and water pollution and landfill. Many students will conduct a life-cycle assessment (LCA) of the resources used in the production of their MDP in this section. As an example, you may consider where all raw materials came from and how they were processed. Other designed solutions that have made it into the marketplace will have additional impacts such as their transport into retail stores and into the place of use, their use and, finally, their disposal. For students looking at critically analysing the LCA of their MDP, you will need to make assumptions about its transportation, use and disposal. To begin, examine the impact on the physical environment by considering all inputs (resources), the production and life of the design, and all outputs (wastage and pollution).

Consider the environmental impacts of your MDP as it is being used. In some cases, the impacts are not all negative, and your design may enhance the environment. For example, the Seabin (see Case Study 21.1) functions to improve water environments but also has a number of other positive impacts; alternatively, a piece of timber furniture could impact positively on the space for which it is intended. When evaluating your project, consider if it will blend in with the surrounding decor and colour scheme. Will it enhance the space and make life easier and more enjoyable for those interacting with it and using that space? Will it create a focal piece or conversation starter as people interact with the piece?

Most importantly, remember to photograph your MDP displayed in the environment or performing the task for which it was designed. The impact of a dance costume on its surrounding environment, for example, cannot be seen if only displayed on a mannequin. Make sure you provide photographic evidence or video footage of it in use on stage or in a dance studio.

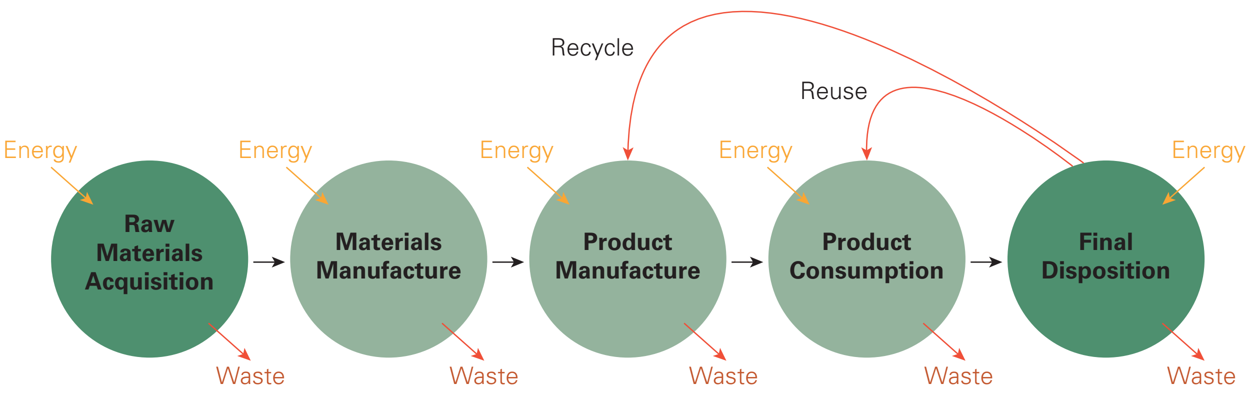

Figure 21.6 An example of an LCA. Note there are inputs (energy) and outputs (by-products) at each stage.

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CASE STUDY 21.1

The Seabin Project

Video

As we have learned in Chapter 19, plastic debris in our oceans and waterways is threatening not only marine life, but human life as a result of microplastics entering our food chain.

For the majority of us who only experience the ocean along certain shorelines, the extent of pollution and plastic debris in the ocean is only now being realised through photographic and video evidence of the 'Pacific trash vortex', also known as the 'Great Pacific Garbage Patch', and the decrease in water quality from increasing agricultural and industrial activity run-off.

It is undeniable that careless disposal of products and by-products are finding their way into the waterways and oceans. Rather than succumb to the enormity of the problem, some people are actively looking to develop innovative ways in which the negative impact on the environment can be mitigated. One such example is the innovative Seabin Projects developed by Andrew 'Turtle' Turton and Pete Ceglinski.

Both Turtle and Pete invest a lot of their time in and around the water, and as such have shared values of the importance of keeping our oceans and waterways healthy. For Pete, it was due to a seemingly familiar Australian upbringing of spending time fishing, surfing, swimming and diving, as well as a career in product design and boat building. Turtle, while also a boat builder, was a sailor who spent years travelling around the world. It was these experiences and their love for the ocean that motivated them to do something about the problem.

Based on this experience, the Seabin idea was initiated from an exploration of Turtle's simple question, 'if we can have rubbish bins on land, then why not have them in the water?'. After teaming up with product designer Pete Ceglinski in 2015, Seabin Pty Ltd was founded.

How does the Seabin work? Well, it is the simplicity of this design that makes it a success. We are all familiar with rubbish bins, and the ones in our homes are usually lined with a bag to capture our waste. The Seabin is exactly the same, but rather than being placed in our house, the bin (being the container) housing a 'catch-bag' is attached to a floating dock.

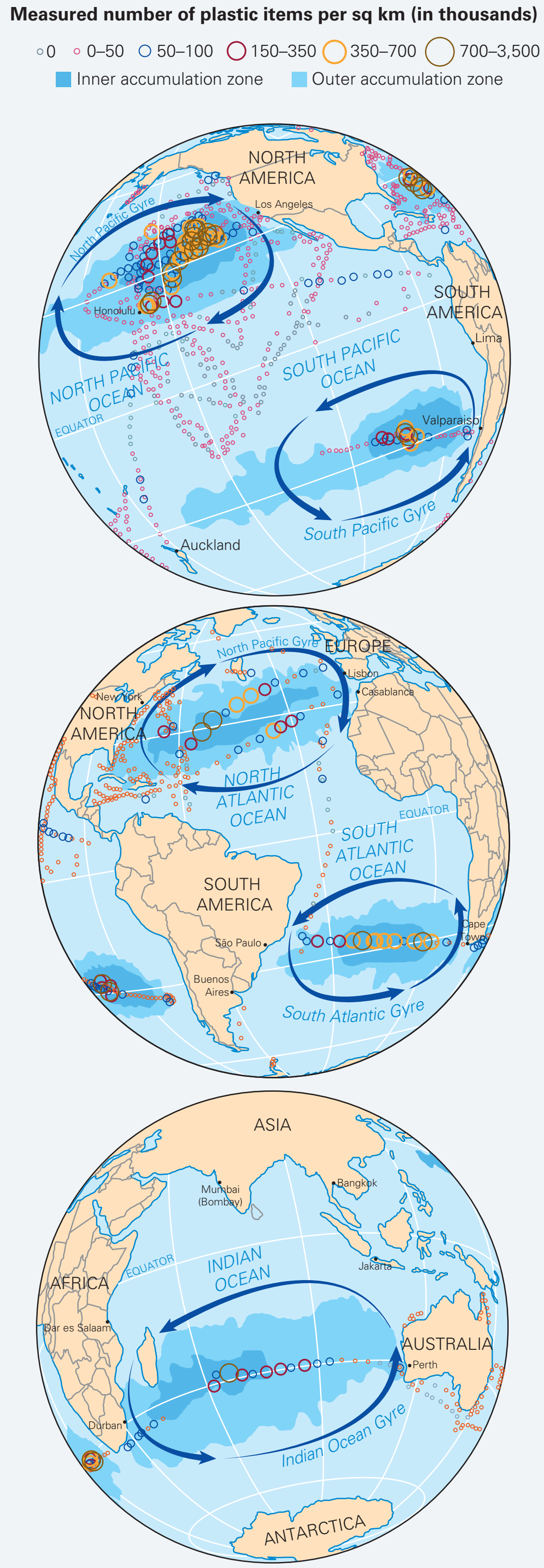

Figure 21.7 Ocean trash vortexes

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The development of this innovation is an evolving process, as the design refines over time with different versions. The first prototypes, shown in their Indiegogo campaign, with a pump mounted on land has evolved to a submersible pump mounted under the main body of the bin. The Seabin Project has been growing since 2015, with one Seabin being estimated to catch over one tonne of debris each year. As the popularity and success of the Seabin Project increases, the positive impact is not just environmental or financial, but also in other ways too.

In the Caribbean, the tropical islands and clear waters that surround them have a large dependency on water-related industries such as tourism. Butterfield Bank have sponsored the installation of Seabin technology in Bermuda, as well as assisting (funding) in the introduction of research and education programs on the plastic pollution in Bermuda. As such they support initiatives such as the Seabin Project, due to the positive impact that it can make on the local economy.

Not only has the Seabin Project been impacting on marinas worldwide where they have been installed, their focus has also been to educate people as to the source of the litter. An interesting quote from Pete in a story published by Dezeen in 2016 talks about the visibility of where the Seabin is installed in local marinas. He said that 'people can see what we're catching and what they're swimming in'. This provided an interesting insight in how this innovation may have a psychological impact on the community. To extend the reach of the Seabin Project from an educative perspective, the Global Ambassador Program (GAP) has invited school students and environmental groups to work with the Seabin Project, and as of 2017 more than 2300 students had been involved. Using other human resources such as researchers, the Seabin Project is aiming to extend their impact through continuing to improve their product addressing a broader range of issues including oil pollution, plastic fibres and micro-plastics.

In some cases, impacts, both positive and negative, are not always obvious, and in other cases are unintended. Apart from the positive impact on the marine environment, what are some other positive impacts that the Seabin Project is making?

Figure 21.8 A Seabin in action

21.5 Final evaluation with respect to the project proposal

Testhub

Above all else, remember that your MDP was the solution to a problem in response to an identified need or opportunity. Clearly analyse how your MDP solves the problem or meets that need. The criteria were established to help guide your decisions, to help you stay on track and make sure the problem was solved. Analyse what went well and where problems were encountered; consider what could have been done better or what you would do if you had the chance to do it all again. Evaluate your role as the designer, manager and manufacturer of your project, always referring back to the identified need or opportunity, and the criteria used to measure your success.

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CHAPTER SUMMARY

- Functional criteria and aesthetic criteria are separate but related to each other. For the MDP, functional and aesthetic criteria will need to be carefully identified.
- In order for designers to develop their ideas, primary research, as well as practical research in the form of testing, needs to take place.
- The production of models or prototypes enables designers to determine whether the solution may be appropriate from both a functional and an aesthetic point of view.
- A good design folio will tell the story while documenting how the designer arrived at their decisions. Continual and visual ongoing evaluation will ensure you stay on task to meet your identified need or opportunity.
- Plan how you will present your ongoing evaluation before you start your project. Make sure it is easy for the markers to find and read your evaluation.
- When evaluating, you need to check what you have done against both the criteria to evaluate success and the identified need.
- The Deming cycle is a valuable tool for ongoing evaluation so as to keep the project on track.
- When assessing the impact of the MDP on the individual, it is important to consider both the positive and negative ways in which the project may impact on the user.
- The impact on society may look at a product, system or environment's affect on a group of people with a common interest.
- The environmental impact could affect a macro-environment or a micro-environment. Consider the positive as well as the negative aspects too!

CHAPTER SUMMARY TASKS

1. For a previous project you have completed, describe one functional and one aesthetic criterion that determined the success and/or shortcomings of the project. In your current MDP project, how do the functional and aesthetics requirements impact on the design?
2. Describe the testing that you conducted in your MDP. What was the result of this testing? Explain the direction that this testing has given to the development of your design.
3. Explain why ongoing evaluation is essential when developing a successful MDP.
4. Suggest three ways you can present ongoing evaluation in your design folio.
5. Identify three products that have had a positive impact on society. Using critical details, explain how these products have impacted positively.
6. Consider the impact of your MDP on the environment and suggest how you could reduce its negative environmental impact.
7. 'You should evaluate the impact of your MDP on the environment in which it is to be used.' What does this statement mean? How does it apply to the evaluation of your MDP?

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8 Why is the development of models and prototypes an important part of the design process?

9 What are design solutions? How and when should they be evaluated and tested?

10 Discuss why it is important to be realistic and honest when evaluating your project.

EXTENSION TASKS

1 Refer to Case Study 21.1. Make a list of all the impacts that the Seabin Project could have on the individual, on society and on the environment. Consider how this technology could have wider benefits for society. Where else could it be adopted? How could it be used in other situations?

2 Conduct a life-cycle analysis of the resources that you will use for the construction of your MDP and elaborate with critical details regarding how your MDP has an impact on the environment. To add value to a cradle-to-grave approach, make realistic suggestions about how you could modify your project in line with a cradle-to-cradle design approach.

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22 Managing the development of a quality major design project

This chapter explores the management of the development of a quality major design project. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H5.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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22.1 Planning, organising, directing and controlling

Most real-world design situations rely on a team of designers to work collaboratively in the development of a design solution. A design team typically consists of a group that possess a complementary set of skills and a balance of open-minded, creative and diverse perspectives that can work towards a common goal.

To ensure productivity, a design lead will offer experience and guidance to a project, while enabling the other team members to utilise their diverse range of talents and insights to develop the best possible design solution. Taking a role that balances between leadership and management, as they are responsible for the quality, creativity and delivery of the project, the design lead will call upon other human resources such as engineers, material specialists, industrial designers, accountants, marketing representatives and stakeholders to contribute to the project at different points.

Video

In the management of your Major Design Project (MDP), where your individually developed project is presented as the practical component of the HSC examination, there is no team of designers, no collaborative effort, no sharing of expertise. It is just you, or is it?

SWOT analysis an analysis of the strengths, weaknesses, opportunities and threats associated with an idea or a product

In most cases, you are the design lead as well as the researcher. You also undertake the market research, construct the models and prototypes, run the testing sessions as well as determine the finances and develop the marketing strategy, among other things. In some cases, you may even be the client and end-user. With all of these roles in mind, you are definitely not alone, and you have the added benefit of being able to build a team around you to help you manage the project. Human resources such as your teacher, subject-matter experts, appropriate stakeholders and target market users can all assist you to make the most appropriate decisions in your MDP journey.

You plan what needs to be done, organise the work to be carried out, direct the progress of your project and control the outcome of all of your hard work. Careful planning will assist you to present a quality project and portfolio. With a carefully developed plan, a well-organised workflow, flexibility to direct the project when you get off track, and thorough ongoing evaluation to control the development of the project, you will manage to do what you set out to do within the available time. When developing your management plans, always remember that while time, money and resources are essential to the success of your MDP, your greatest asset is you.

The MDP may be the first major project that you have undertaken. As a result, there may be aspects to the management of the project that you could manage quite easily, and there are other aspects that you would find very challenging. In project management situations such as these, you do learn what your strengths and weaknesses are. On that note, recognising weaknesses is not a flaw as not everyone is excellent at everything, and this is why there are design teams! Consider conducting a **SWOT analysis**. A SWOT analysis can help us recognise our personal strengths and weaknesses as well as make us aware of opportunities and threats that may impact on the successful management of a project.

The strengths and weaknesses that you list will reflect personal traits and qualities such as skills, experience, things you do well and areas you find challenging. Opportunities and threats refer to external conditions that may impact on the success of your project, such as competition, emerging technologies, expert opinion, and accident or illness. Considering all factors that could have an impact, either positive or negative, on the successful completion of the MDP allows us to think about options, make the most of what is available and be prepared if things go wrong.

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Before you embark on the management of your MDP journey, ask yourself the following questions as they relate to the three key areas of project management required in the portfolio:

- What do I need to do? (Action Plan)
- How much time do I really have? (Time Plan)
- How much will it cost, and can I afford it? (Finance Plan)

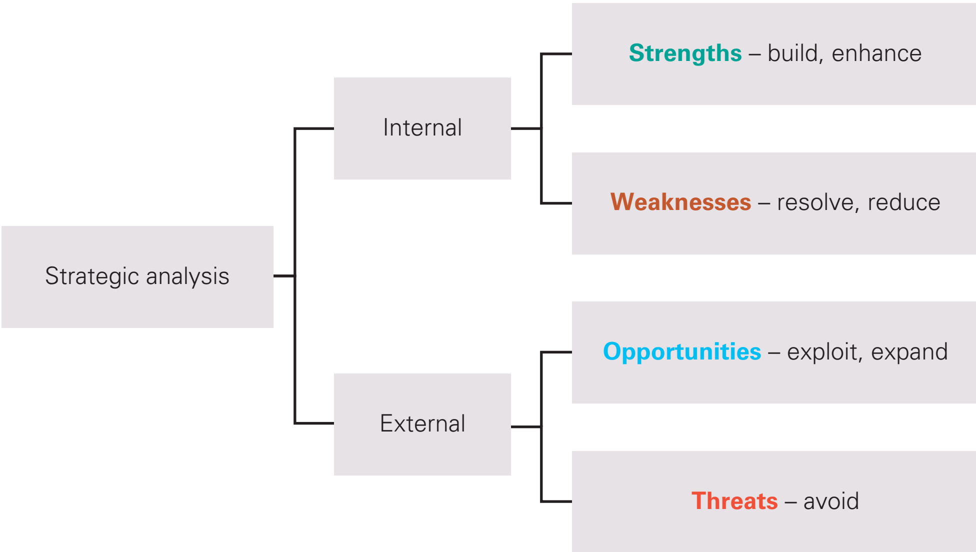

Figure 22.1 A SWOT analysis

If you look at both their label and what is required in the portfolio, they are plans. This means that you are assuming and projecting these activities forward.

As a result, you are first asked to '**formulate**' then to 'evaluate' these plans at a later stage.

formulate to develop a plan

22.2 Action planning

The process of good planning will make your MDP journey less stressful and will ensure the quality of your project is not compromised due to a lack of time. In this action planning process, what you are formulating is small achievable goals that in combination will help you meet specific milestones, such as completing your idea generation or your testing.

To begin you will first document the series of actions that you can expand upon later as some of the specific activities become clearer. To assist you in your documentation, you can use the marking criteria components and present this as a flow chart or mind map to get you started. Consider all of the possible actions that may be required from what you may have already undertaken in your identification and exploration of the need to the presentation of your MDP and portfolio for marking.

Initially these actions may be broad such as 'carry out testing to determine the most appropriate material'. The precise tests may not be clear in the early stages and some areas that need to be tested will only become evident as the process unfolds. As such, this is why many students present a Gantt chart with two sections (rows) for each action, labelling them as proposed actions and 'actual' actions. Any differences between what is proposed and what eventuates in terms of actions is good, as this will provide you with opportunities to evaluate and discuss the differences.

If designing for a client, listen carefully and remain flexible so that ideas can be discussed, possible solutions considered and a clear direction for the development of the project established that you both agree upon. Record discussions, noting client feedback and how this may modify the action plan and the MDP. The designer must take on board the wishes of the client, but the designer also has a responsibility to guide the client away from possible problems that may result from lack

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Figure 22.2 Discussions with the clients help reach design outcomes.

dependency relationship between preceding and succeeding tasks

of knowledge or ideas that are not suitable, practical or achievable. For example, if a client has selected fabric for a garment that will not perform as desired, the designer should guide the client to consider a more appropriate fabric. In your MDP documentation, you can justify why you did not take the advice of the client.

One suggestion to elaborate on your action planning is to revisit the Areas of Investigation you developed. In this section you have already determined a number of actions that you will undertake. Using the actions described in this section will help you to be more accurate in the proposed actions that you plan for.

ACTIVITY 22.1

You have been elected to the committee given the task of organising the after-party for your Year 12 formal.

1. Brainstorm all the things you will need to do and create a list of all the actions, in no particular order.
2. Write each action on a separate line. Cut up your list into separate actions.
3. Organise the actions into the order in which they need to take place. Some actions will have task **dependencies** on specific actions that need to be carried out before a successor task can occur; for example, you cannot send out the invitations before you make or purchase invitations. Some actions will need to be refined; for example, 'Organising the food' is far too broad and will need to be broken down into smaller, more achievable stages, such as 'Buy the non-perishables one week before', 'Make a cake', 'Order the pizzas', 'Pick up the drinks'.
4. Write your action plan incorporating the new refined steps.

Another strategy is to learn from what you have uncovered in your SWOT analysis. If there are any specific weaknesses, opportunities and threats, these may enable you to seek the advice of human resources, such as subject-matter experts, to help you to anticipate additional actions.

22.3 Time planning

Time management is about using your time effectively. Time management is a learned skill that requires attention to detail when developing, and motivation and persistence when applying. Listen to the advice given by your teacher, as they are aware of the time constraints and have the experience of guiding students through their MDP every year. Knowing what you have to do, knowing how long you have to do it and planning how best to sequence actions will help you complete a quality MDP within the given time frame. It is easy to be overwhelmed with the number of actions when formulating your time plan. To avoid this, break the project down into smaller sections. This will give you the confidence to continue on your journey. Considering the three sections of the folio may be an obvious starting point (see Table 22.1).

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Table 22.1 Drafting an initial time plan for the three sections of the design folio. How much time will you allocate for each?

PROJECT PROPOSAL AND PROJECT MANAGEMENT	Identifies and explores genuine needs and opportunities, justifying final selection for the development of the MDP
	Describes relevant areas of investigation which relate clearly to the need, and provides direction for further action
	Establishes and analyses appropriate criteria to evaluate the success of the product, system or environment (PSE)
	Formulates and evaluates well-documented action, time and finance plans with clear evidence of their application to the PSE
PROJECT DEVELOPMENT AND REALISATION	Demonstrates the substantial application of creativity in the development of the MDP
	Analyses a range of design factors relevant to the PSE and applies them
	Undertakes, evaluates and applies a range of appropriate research experimentation and design solution testing in the development of the MDP
	Applies conclusions drawn from research and experimentation and design solution testing to the MDP
	Justifies the selection and use of ideas and resources used for the PSE
	Demonstrates succinctly a range of appropriate quality communication and presentation techniques
	Applies a range of high-quality practical skills in the development of the PSE
PROJECT EVALUATION	Critically evaluates aspects of the PSE throughout its entire development
	Analyses and critically evaluates the functional and aesthetic aspects of the PSE
	Critically evaluates the impact of the PSE on the individual, society and the environment
	Analyses the relationship of the PSE to the criteria for success identified in the project proposal

As discussed in the 22.2 Action Planning section, while the above example may guide your action planning by helping you think about the steps you will need to work through, try not to use only the folio headings in your action plan. Assume other relevant actions and include these as actions when allocating your time.

As you begin your project management, your action and time planning will change from being a *proposed* time/action plan to the documentation of an *actual* time/action plan. As more clarity regarding the different actions comes to light, document the actual steps such as 'researched methods of silver soldering for my pendants' or 'tested different oils and waxes as possible finishes for my table'. Aligning your actions to the marking criteria will help ensure that you are addressing each part of the marking guidelines. Just remember to also include evaluation and the practical hands-on development and application of skills that occurred throughout the process.

CREATING A TIME/ACTION PLAN

Often the action and time plans are presented together in an MDP portfolio. Using graphs, such as Gantt charts, students can provide quick, effective communication on what they propose to do and when. Unlike many other sections of the portfolio, the time/management and finance plans are 'dynamic' sections of the portfolio that are constantly adjusted as more detail comes to light. As an example, cutting up one type of material was planned to take only one week; however, because the machine broke, the actual time to complete this task was three weeks. Sometimes unplanned events are not welcome. In the previous example, what impact would a two-week delay have on the rest of the project?

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Once you have developed an action plan of the steps to be completed in a logical, sequential order, you need to start allocating time to each task. Examine each task and make an educated guess as to how long that step will take to complete. If you are unsure, discuss this with your human resources, such as subject-matter experts, to determine how long a particular task may take. Write the allocated time in days or weeks beside each step. For your time/action plan to be effective, you need to develop a time scale and method for displaying your time/ action plan that is meaningful to you, that will help you re-organise (where required) and achieve your goals, and that communicates this easily to the markers.

In the organisation of your Gantt chart, you may create separate time/action plans for each term, you may choose to document time/actions needed to complete different parts of your project or you may work in weeks showing the development of your project from start to finish. The most important thing is to allocate a realistic amount of time to a task and to record the actual time taken to complete the task. If there is a difference in the proposed and actual plans, justify why there is a difference between the two. This will ensure you know exactly how much time you have remaining at each step and will allow you to take remedial action to catch up if you start to fall behind schedule. The last thing you want to happen is to run out of time. A shortage of time usually results in a change to the quality and ability of the MDP to satisfy the need.

deviate to move away from an established route

Figure 22.3 Time/action plans should be clear and open to change.

Most actions in projects are sequential and dependant on each other. As an example, you cannot start to build the roof of the house if the walls are not up, as the walls are an 'upstream dependency' or a predecessor for the roof to be constructed. As a result, a delay in one action may impact on all other downstream dependent or succeeding actions to follow. Upstream dependant actions require preceding steps or pre-work before they can occur. For example, you cannot cut out the fabric for your garment until you have determined the most suitable material and purchased it. Other steps may occur concurrently, which means that more than one action may be taking place at the same time. For example, you can develop your initial design ideas at the same time as you conduct initial research – one may help generate the other.

Just like your planning of the MDPs actions, or your anticipation of the time to complete scheduled tasks, your time/action plan should be a working document showing refinement and modification as problems are encountered and solved. It should not be a record of what you did and how long it took, written after the project is completed. Your time/action plan is a comparison between planned stages with estimated times and what actually occurred. It is expected that you will **deviate** from your time plan and make changes along the way. Some things will take longer than expected, some unforeseen actions will be required, or some steps may be eliminated because you may have discovered a more effective way of doing something. Sometimes illness, breakages and workload from other HSC subjects or exams will also get in the way of your progress.

Problems encountered that result in changes to your time/action plan are seen as an opportunity to demonstrate your managerial skills. By responding to new information or solving a difficult situation, you are actively working through the design process. Show modifications on your time/action plan and use ongoing evaluation to explain how and why they

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have occurred. This is why the marking criteria asks you to both formulate and evaluate your plans.

The method used to document your time/action plan is up to you. Many lead designers and project managers use a Gantt chart to show the sequence of actions against an established time scale. Bars are used to indicate when an action commenced and finished. Gantt charts provide a good visual representation of the steps undertaken and allow for variations to be recorded using different coloured bars. They also allow quick comparison of the time allocated to tasks and the proportion of the entire project dedicated to different steps.

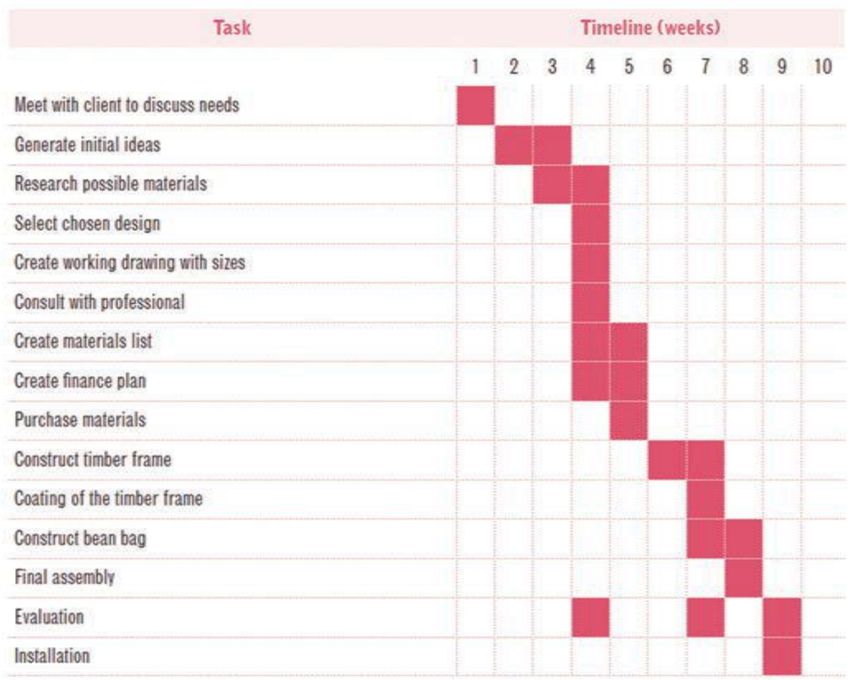

Figure 22.4 An overview time/action plan presented as a Gantt chart. An effective plan will show the relationship between preceding and succeeding actions.

ACTIVITY 22.2

Using the actions that you established in Activity 22.1, where you planned the after-party, create a Gantt chart to use as a project (event) management tool. First, determine the length of time available to plan the party – 10 weeks may be an appropriate time frame. Create a table and list the actions down the left column. Create a time scale in weeks across the top – one column for each week. Draw in bars or colour in cells to represent when the action was commenced, how long it took and when it should be completed.

Remember the following points must be considered:

1. The actions must be listed in an assumed logical, sequential order.
2. Some actions can occur at the same time as others (concurrent).
3. Some actions cannot occur until a previous step has been completed (dependent).

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22.4 Finance planning

All designers work within a budget or some kind of financial constraint. This may be established by the client, who does not want to exceed a certain amount and sets monetary limits. This may impact on process and material choices as well as the time the designer spends on design development. The budget may also be set by the designer, who is developing a product for commercial sale and wishes to achieve a competitive market price point against any competitor's existing designs.

Your MDP is no different. Looking at the retail prices of existing designs, considering all projected costs, setting financial goals to meet these costs and sourcing materials to stay within your budget is all part of the MDP. In the commercial world, cost is one of the main factors contributing to the success and quality of product design, as products must be priced so that they are affordable and therefore desirable to the consumer while achieving maximum profit for the company or designer. When formulating a finance plan, the following steps need to be considered:

- Discuss the project budget with the client or determine how much you can afford to spend on the development of your MDP.
- Investigate how the money to develop the project will be sourced.
- Source materials that are of good quality but also realistically priced.
- Keep all purchase receipts for documentation.
- Set up a spreadsheet to enter all financial data.
- Update the finance plan regularly to ensure you keep within the budget constraints.
- Review ongoing costs with the client and discuss options if the costs look like exceeding the budget. Compromises may need to be made.
- Conduct ongoing evaluation to weigh-up options, document choices and justify decisions. Changes may result from tough financial decisions.

As the finance plan falls into the project management section of the folio, you need to demonstrate the ability to manage the resources available to you – in this case, money. A budget or recommended amount of money to be spent on the project should be established in the early stages of the project and adhered to throughout the development and realisation phases. The budget should not be a random amount that you hope will cover the cost of your MDP. Many students will say, 'I have a budget of $500 and Mum and Dad are happy to pay for it.' Avoid this generalised approach and instead come up with a realistic figure based on preliminary research. The budget should be a total costing of all of the resources you expect to use throughout all phases of testing, development and construction of your project. Make a list of all the resources you think you will use, estimate the quantity of each you will require and then approach retailers and suppliers to find out how much each item may cost. The initial costing of your project in this way can be colloquially called making a 'guesstimate' and may be accompanied by an initial rough sketch to show resources you expect to use.

Your first financial evaluation should occur at this point. You need to evaluate the total cost of your project. Is the cost reasonable? Can you afford it? How does it compare with similar products on the market? Do you need to source less expensive materials and/or processes? Should you proceed with the project? Make adjustments where necessary, but it is important to justify and record them in your ongoing evaluation.

Remember, your role is to be seen to manage your financial resources proactively or to acknowledge how it could have been managed better retrospectively in your evaluation. There will be changes along the way. See these variations as an opportunity to demonstrate your project management skills by evaluating the situation and making informed decisions that will benefit the development of your project. Remember that you

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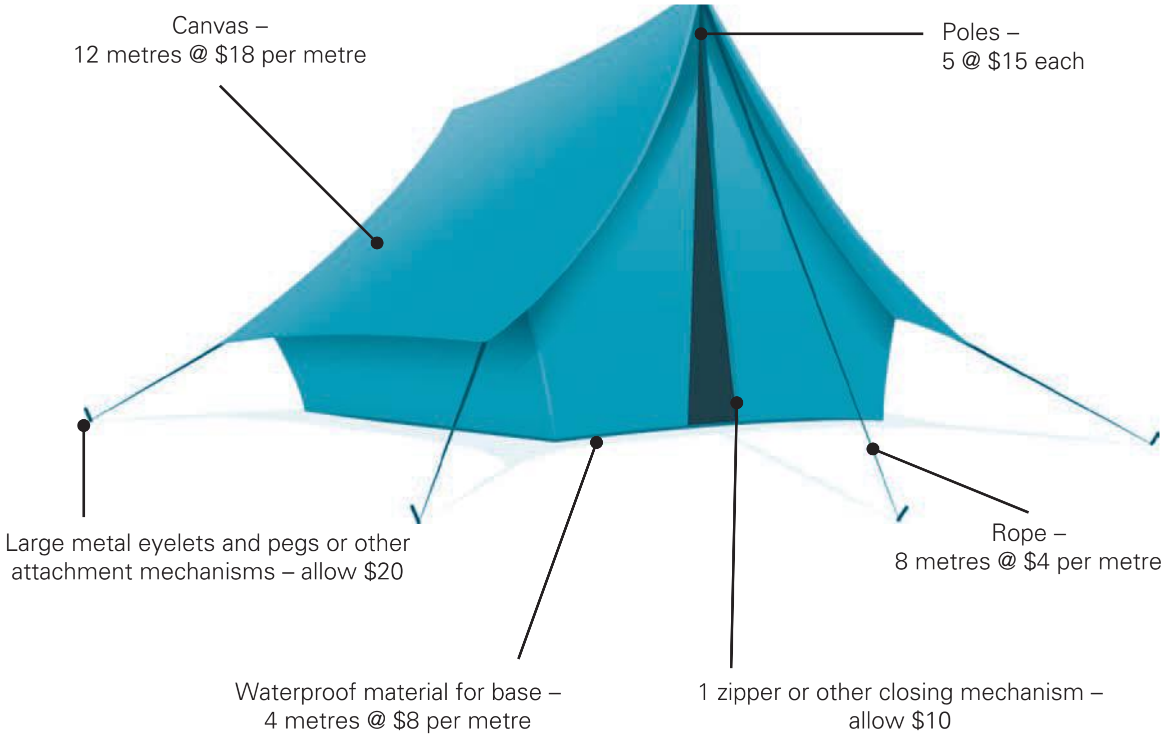
Figure 22.5 An initial 'guesstimate' may not account for additional costs that will increase the total amount.



must be effective in your communication of this in your portfolio. As an example, changes to your financial planning may be a result of:

- A price increase from when you initially investigated the costs to when you purchase resources.
- A material may be out of stock and you may need to source it from a different supplier.
- A material may no longer be available, and you may need to find an alternative.
- A retailer may offer you a student discount.
- You may obtain some resources free of charge from friends, relatives, recycling or generous suppliers.
- You may find a material you had initially chosen is unsuitable as a result of research and/or testing.
- You may discover a new material, tool or technique as a result of research that you had not previously considered.

DEVELOPING THE FINANCE PLAN

The finance plan must be clear and easy to understand and should align with the development of your project. The marking criteria asks for 'clear evidence of their application to the PSE'. It is important to label the key parts of the finance plan, including:

1. the budget allocated to the project and all expenses
2. receipts and tax invoices
3. a total cost for the project
4. a final evaluation comparing the total cost of the project with the initial budget to determine the success of financial management of the project
5. evidence of their application in the PSE (some students use photographs).

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Table 22.2 Possible headings for your finance plan

MATERIAL/ RESOURCE	SUPPLIER	QUANTITY	UNIT COST	PROJECTED TOTAL COST	ACTUAL TOTAL COST	REASON FOR DIFFERENCE	CUMULATIVE TOTAL	EVIDENCE OF APPLICATION IN THE PSE

A spreadsheet or table in a word-processing software that accepts formulas in tables should be set up to standard conventions. Entering numerical data in a table isn't as efficient: it is time-consuming and there is a risk to input incorrect data. The formulas are **dynamic** and can calculate **cumulative** costs and display remaining funds with each entry. Table 22.2 shows possible column headings.

Your finance plan will not only help you manage your money and stick to your budget, it will also allow you to highlight your managerial skills. The column headed 'Reason for difference' allows you to explain why some costs have changed along the way. Hopefully, some of these changes will be because of modifications resulting from research and testing and will reflect your flexibility to cope with change by responding to new information, materials or processes to produce the best possible solution. Some students will show a cumulative total that will increase as purchases are made. Others will start with the budget amount, which decreases as money is spent. Both are acceptable as long as a thorough evaluation of the total spending compared with the amount budgeted is conducted at the conclusion of practical work.

dynamic able to adjust and change in response to changes
cumulative increasing by a series of additions

ACTIVITY 22.3

Develop a finance plan to help you manage your Christmas shopping.

1. Set a budget. List all the people you need to buy presents for, estimate how much you will spend on each and add up the amounts to form a total cost for your Christmas shopping.
2. Evaluate your Christmas shopping budget. Is it realistic? Can you afford it? Do you need to modify it?
3. Create a spreadsheet to manage your spending.
4. List the people for whom you will buy presents down the left column. Have additional columns for suggested gift, place of purchase, estimated price, actual price and total.
5. Insert a formula to show an ongoing tally of money spent.
6. Use your Christmas shopping finance plan as an ongoing management tool.

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22.5 Establishing your milestones

A managerial technique that may be applied after establishing your time, action and finance plans is the setting of milestones. These are significant developmental stages or points determined by the designer and allocated a specific date for completion. For example, a builder may set the following milestones for the construction of a house:

- completion of foundation work
- laying of cement slab
- erection of framework
- completion to lock-up stage
- hand over keys to owner.

Milestones are non-negotiable completion dates for major stages of the MDP. Limit milestones to two or three and make them significant events. Realistic, achievable dates for completion should be set and clearly indicated on the time/action plan, along with dates blocked out for events such as exams, excursions, and public holidays. The sense of achievement you will feel by achieving a milestone will not only help keep your project on track but will also provide you with valuable motivation to continue on to the next stage.

Video

Now that well-developed time, action and finance plans are established, the next phase is to implement and evaluate them.

1 Once your project is underway, begin by regularly evaluating your initial time, action and finance plans by referring back to the project proposal.

- Will they achieve the expected outcome?
- Will they allow you to meet the identified need in the time available?
- Are they realistic and achievable?
- Do you have enough time to do what you have planned?
- Can you afford to complete the MDP?

At this stage, you are evaluating what you have planned to do. This evaluation is essential as the marking guidelines state that to achieve top-band marks you must 'Formulate and evaluate well-documented action, time and finance plans with clear evidence of their application to the product, system or environment'.

2 Secondly, evaluate your implementation of the time, action and finance plans.

- Did you do what you set out to achieve?
- Did you stick to the plans?
- How did you cope with problems?
- Did you complete your MDP in line with your criteria for success within the given time?
- Did you stay within budget?

This can be done as both ongoing evaluations throughout the project and as a final written evaluation after completing the project. At this stage, you are evaluating what you actually did against what you proposed. Draw comparisons between the planned steps and those achieved, always relating achievements back to the identified need and the criteria for success.

Formulating a good management plan is the key to a successful project. However, the most thoroughly planned and documented time, action and finance plans will only be of benefit if you refer to them regularly, adhere to them as much as possible and continually evaluate your progress in relation to what you planned to achieve. Schedule a specific time each week to attend to this task.

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Managing the realisation of a successful MDP means completing a project that is:

- on time
- on budget
- meets the identified need or opportunity established in the project proposal and achieves the criteria for success to the desired standard.

There is no point in finishing on time and under budget yet producing a product that does not meet the identified need. A client will not be satisfied if a designer delivers by the due date within the set budget but hands over a product that does not function, look, or exhibit the level of quality as expected.

Project management requires more than just balancing the budget and finishing on time. While these two aspects are important, designing and creating a project that demonstrates quality and innovation, and responds to the identified need or opportunity must always be our primary goal. So when developing your time/action plan, allow time to apply a sufficient number of coats of good quality paint or appropriate finish, make sure the appropriate hem finish is neatly and securely applied, ensure jewellery is highly polished or surface finished as desired. Finishing is carried out right at the end of the project near the deadline, so students often rush this final stage, and this impacts on the quality and the market appeal of a product. Make sure you finish off your MDP to a standard and quality that you can be proud of, and that you know others would be willing to pay money to purchase.

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CHAPTER SUMMARY

- Formulating a good management plan is one of the keys to a successful project.
- Creating action, time and finance plans for a project will enable it to be well managed and stay on schedule if the plan is adhered to.
- It is important to clearly identify what you have to do, realistically how much time you have to do it, and how much money you plan to spend in the development of the project.
- Ongoing evaluation of a project is a requirement and must be regularly documented throughout the development of the MDP.
- Discuss all project requirements with your client to ensure that all needs are met.
- Obtain a copy of the syllabus marking guidelines and use it as a checklist for your MDP.
- Be realistic when developing your time/action plan and ensure that you block out all days when you cannot work on your MDP.
- Keep all receipts for purchases related to the project and update your spreadsheet regularly.
- Set milestones to identify major developmental stages and maintain motivation.
- Use your human resources to guide you to manage your time better.

CHAPTER SUMMARY TASKS

1. Explain the function of an action plan, a time plan and a finance plan in the MDP.
2. What is a Gantt chart?
3. In a draft of your time and action plan, are there any tasks that are dependent on others being completed? If so, describe the relationship between these tasks.
4. Explain why it is important to evaluate your MDP throughout the project.
5. What is a guesstimate? How can a guesstimate be used when establishing a budget?
6. Why is it important to involve the client in decision-making during the project?
7. Why is it important to keep all receipts of purchases made during the project?
8. Why is using a spreadsheet or table that accepts formulas preferable to listing expenses in a table that does not accept formulas?
9. Explain what formulas would be used in the setting up of a spreadsheet.
10. Why are quality and innovation important factors to consider with the management of your MDP?

EXTENSION TASKS

1. Explain the importance of project management to the successful completion of the MDP. Analyse the impact that poor management could have on your MDP.
2. Why is documentation of all stages of the development of the MDP important? Investigate what types of documentation occur in industry and explain the importance of such documentation. Try to choose an industry related to your MDP and draw comparisons between the documentation that is recorded and that which is required in your design folio.

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23 Selecting and using appropriate research methods and communication techniques

This chapter explores the selection and use of appropriate research methods and communication techniques. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H5.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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23.1 Research and investigative reports

In your Design and Technology course, you are required to study an innovation and complete an investigative report on the innovation you have chosen. Choose an innovative product, system or environment that interests you and one about which you can obtain information.

The investigative report should answer the following questions:

- What is the innovation?
- When was it first introduced and by whom?
- What needs does the product/system/environment meet?
- Is it a new product/system/environment or a development of an existing one?
- How has the product/system/environment changed since it was first introduced?
- What factors have impacted on its development – timing; available and emerging technologies; historical and cultural influences; political, economic and legal factors; and marketing strategies?
- How has the innovation impacted on society?
- What do you see as the future for this innovation?

Choosing an innovation can be difficult. Do some research into current events when considering a topic for your report. The world of transport, for example, is going through tremendous change and innovation as petrol prices rise and the raw material for fuels (a finite resource) is depleted. New hybrid cars that run on a combination of petrol and electricity are being developed, as well as cars that are able to run on hydrogen or solar power. Energy is another area with a great deal of innovation as the need for more sustainable energy practices is increasing dramatically. Medical research is another area of constant innovation. Crisis can be a source of innovation. For instance, bushfire devastation has led to the development of safer materials and building designs and more recently, the COVID-19 pandemic has lead to numerous innovations, such as 3D-printed ventilators. You may be particularly interested in mountain bike riding or sailing or textiles. You can investigate these areas to find innovative developments.

Video

Once you have selected the innovation, you must begin your research. The internet will be a good place to start, as you will want current information. Media websites will often have current reports on innovations. The company that developed the innovation will also have a website. Often, government funding is involved so government websites will provide information. The Powerhouse Museum and the CSIRO have sections devoted to innovation. Start-ups often respond to innovations or create new ideas, so some research into such businesses may provide a new avenue of thought. Remember to record all your sources and the date you accessed them. You may also be able to interview the designer or project manager to get first-hand information.

Video

Once you have collected your data, you will need to collate it. You could develop a list of key points as subheadings and then write a paragraph about each one, or you could use a list of questions to answer. Recording all this information will not be enough. You will need to analyse. To do this, study the key points or questions you developed and then discuss the relationship between them to show a depth of knowledge. For example, you may have recorded that the innovation was developed during the political debate about carbon emissions and that the innovation received funding from government and private industry. To demonstrate analysis, you will need to show how each of these points impacted on the success of the innovation and how they are interrelated. In interpreting these findings, you will discuss how they impact on the innovation.

Your report should demonstrate thorough research into the topic and the ability to interpret your findings and justify your conclusions. In presenting your

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report, you will need to use clear language and technical terms where necessary. Images, charts and diagrams will enhance the communication of your findings.

23.2 Research and the major design project

It is important to fully research the design area that you choose for your major design project (MDP). By using a range of sources, you will be able to better understand the requirements of the project and be equipped with the tools you need to complete your MDP. A common **misconception** is that you simply create one design, set about making your finished product and hopefully it satisfies the need and design criteria. But if you spend time carefully identifying a need and following all the stages of a design process, you are much more likely to end up with a successful project and a better mark.

It is important for a designer to use as many research methods as possible in order to gather information. Depending on the project, some are better or more useful than others. You can use libraries, the internet, retail outlets, other designers, friends and family, and the client (if you have one) as sources for research.

Gathering information at the start of an MDP can be time-consuming and many students will be tempted to skip this stage. But they are only cheating themselves and will miss vital opportunities to gather information and let ideas develop. If you set out to design a storage system for the home – for example, an item of furniture that stores multimedia devices, screens and sound systems in the living room – you should at the very least research similar products in the major furniture outlets.

misconception an incorrect idea or assumption

Figure 23.1 Furniture retailers are a good source of inspiration.

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These contemporary and mass-produced items of furniture may give the designer valuable ideas and inspiration that could be incorporated into their personal design. Items such as furniture do not usually carry patents or trademarks, so a designer can use whatever components they like in their own designs without infringing any laws of copyright.

It may be a good idea to revisit Chapter 10 and revise the process of researching.

23.3 Justifying decisions

The design process involves much decision making and problem solving. Just gathering information that relates to your design project is not enough to produce a successful outcome. You also need to analyse and justify the information gathered before using relevant information to inform your decision making. When considering materials for a fashion garment, fabrics such as cotton, polyester, wool, hessian, bamboo, Lycra or silk may be researched and considered before the most appropriate one is selected. You may wish to consider using eco-textiles like EthCo® wool or recycled polyester. When making decisions about the material, you may consider the following questions.

- What is the garment intended to be used for? Will it be used for casual daywear, a cocktail party or formal evening wear?

Figure 23.2 Colour and fabric choice is an integral part of the design process.

- What is the cost limitation?
- What is the availability of the material?
- Does the material need to be durable?
- Does the fabric need to stretch or drape?
- What colour or colours does the fabric need to be?
- Will the garment be worn in cold or warm venues?
- What is the environmental impact of the material?
- Are there any ethical issues surrounding the harvesting or manufacture or transport of the material?

When these and many more questions have been answered, the designer can use the information to choose the most appropriate fabric for the task. For a casual outfit intended to be worn on holiday, or informally during the day, the designer may well choose cotton, as it is light, strong, soft and breathable, can be colourful, is easy to wash, and would be an appropriate choice for the garment. These positive factors will be balanced against the fact that it may shrink and is known to fade more quickly than other fabrics, and the environmental impact of using a fabric that requires much water in its production.

If you have done a thorough analysis of your research, you should be able to clearly justify your decisions. Remember to refer to both the positive and negative aspects of the decisions you make.

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23.4 Appropriate communication techniques

The skill of the designer to use a range of communication tools and resources to describe and justify their ideas and decisions is very important. For the MDP, this is even more important because you need to show and explain your whole process to the markers. You will need to think about information design, how best to visualise complex data and how to communicate the research message effectively. Your project will be grounded in sound research, and you will need to determine the most effective ways to communicate your findings, using design principles to develop visualisations that capture the nuances of the research and tell the story of your MDP.

Some of the skills you will need are:

- the ability to evaluate a design project and communicate effectively with those involved in the project
- the ability to work in a design team, if required
- the ability to be a good listener – when seeking advice from experienced designers and craftspeople, and when discussing the client's needs
- the ability to practise and develop practical skills needed to see the design proposal through to completion
- the ability to communicate well with the client, both verbally and in writing, such as emails, proposals and reports
- visual communication skills – sketching initial ideas and design proposals.

These techniques are also important for designers:

- brainstorming techniques that allow the designer to put down as many ideas as possible in a short time
- the ability to action-plan and manage a project to completion
- the use of audio and visual equipment to record ideas and thoughts
- the use of graphical techniques to display formal design proposals
- the use of orthographic drawings when appropriate
- the use of computers to collect data and present information
- the use of computer modelling software to present design proposals and make communication more effective.

The examiners will only know about these skills and techniques if you effectively communicate them in your design folio. You should ensure that examples are included, or you can use text to describe them, or you may include photos or diagrams.

You may like to revisit Chapter 9 and revise communication methodology.

The teacher or examiner is assessing the design process that was followed to solve an identified need, problem or opportunity, and how well the solution is developed and realised. When looking at the finished product, system or environment and the design folio for the HSC, they will be looking at the marking guidelines and asking questions like:

- What was the intended design need?
- Have you identified and explored a possible need?
- Have you identified criteria to evaluate its success?
- Have you completed action, time and finance plans and applied them to the project?
- Have you displayed creativity in your work?
- Have you considered a range of relevant design factors?

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- Have you documented a range of experimentation and testing and applied conclusions?
- Have you shown evidence of the testing of the design solutions?
- Have you succinctly used a range of communication and presentation techniques?
- Have you used high-quality practical skills?
- Have you recorded evaluation procedures throughout the project?
- Have you analysed the functional and aesthetic aspects of the design?
- Have you completed a final evaluation with respect to the project proposal and its impact on the individual, society and the environment?
- Have you described the relationship of the final product, system or environment to the project proposal?

As you can see from this list, the assessment of the MDP does not take into account whether the project is a dress, a table, a CD rack, a TV cabinet or an item of jewellery. In managing the design project, the student must address each of the assessment criteria in order to achieve a good mark for the MDP. The markers are looking to see how well you have managed a design project, identified a real need, researched possible solutions and completed a successful outcome that meets the described need.

Communication techniques play an important role in sending your message to the examiners. You must select the most appropriate methods and media to deliver your message. You will not be able to speak to the examiner, so you need to rely on effective visual communication, whether it be text or graphics. Your design folio should be simple, organised, **legible**, readable, consistent and have appropriate graphics.

legible clear and easy to decipher

Visual support should highlight, clarify or condense the message. Graphics should not be used simply to decorate. Shapes, lines and colour can be used effectively to separate or highlight information. Charts and tables are useful tools to present numeric data. It is most important to be consistent.

You should ensure that you are familiar with all the requirements of the MDP. These are available through the NESA website in the assessment and reporting document. It is important to remember that your folio is limited to 80 written A4 pages or 40 written A3 pages printed on one side only. Other media-based or multimedia-based materials in your folio should not exceed six minutes of viewing time.

Visit the Powerhouse Museum website to study the presentation of projects exhibited in the Shape showcase.

Figure 23.3 A set of symbols or icons may be used to identify sections of your folio.

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CASE STUDY 23.1

Ngarandi app

Troi Ilsley, a designer at digital agency Isobar Australia; Marlee Silver, a consultant with Cox Inall Ridgeway public relations; and Aiesha Saunders, an assistant curator with Sydney Living Museums, have developed an app full of indigenous history, stories and interactive activities. The Ngarandi app (Ngarandi means 'to know' in the Indigenous language, Dharawal) is the brainchild of these three young Indigenous women who have used twenty-first century technology such as geolocation and augmented reality to tell stories up to 60 000 years old. They have looked back into objects of the past and brought it to life so people can access it now.

Research showed that visitors to Sydney wanted to know more about the indigenous culture yet there was little to help them. The app tells the story of how Barangaroo, a Cammeraygal woman of the Eora nation, defended the Aboriginal way of life. She disagreed with her husband Bennelong about whether to negotiate with the early colonial rulers. The app aims to provide easy access to indigenous culture and knowledge and share the stories in an engaging way. It tells the story of the Eora women who fished at night near Warrane – the Aboriginal name for Circular Quay – and looked like fire flies as they moved across the water. The Eora women were known to be brave and strong and would swim in the rough surf that terrified the British sailors.

The three developers hope the app will include hundreds of geo-located stories from across Australia that provide an alternate history developed from the Indigenous perspective. In future, the app could be expanded to provide a dual narrative for anyone walking around Sydney. A tourist may be able to stand next to the controversial statue of Governor Macquarie, for example, and hear the Indigenous perspective on his term.

Original article by Julie Power of Sydney Morning Herald.

Source: https://cambridge.edu.au/redirect/8946

Figure 23.4 App developers Troi Ilsley, Aiesha Saunders and Marlee Silva created the Ngarandi app to share the history and stories of Sydney's First Peoples.

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CHAPTER SUMMARY

- Data collection and careful analysis are crucial aspects of research.
- The interpretation and application of conclusions is an important step in research.
- Research should be used to justify the decisions made in the MDP.
- Research and recording resources for the innovation report and the MDP include libraries, the internet, retail outlets, experts, and friends and family.
- The communication of ideas and processes plays an important role in the presentation of the MDP.
- Visual aids can assist in effective communication.

CHAPTER SUMMARY TASKS

1. Identify five innovations that have occurred in your lifetime and explain how they have affected your life.
2. Draw a timeline of the development of music recording from the first recording to today.
3. Explain the term 'internet' to someone who is a non-computer user.
4. For any innovation that you have studied, describe how that innovation has impacted on society and the environment.
5. Create a survey to find out what actions your classmates take to lessen their ecological footprint.
6. Conduct this survey and present your findings in a chart.
7. Describe three methods of recording research carried out for your innovation report or MDP.
8. Describe three ways of presenting research findings in your folio. Justify the methods chosen.
9. Create a simple graphic that could be used to indicate ongoing evaluation throughout your folio.
10. Discuss why visual communication is so important in your folio.

EXTENSION TASKS

1. Research the case for electric cars. Write an investigative report on this innovation.
2. Use presentation software to present your MDP to your classmates. Evaluate the visual communication techniques you used in your presentation.

Figure 23.5 An electric vehicle charging station

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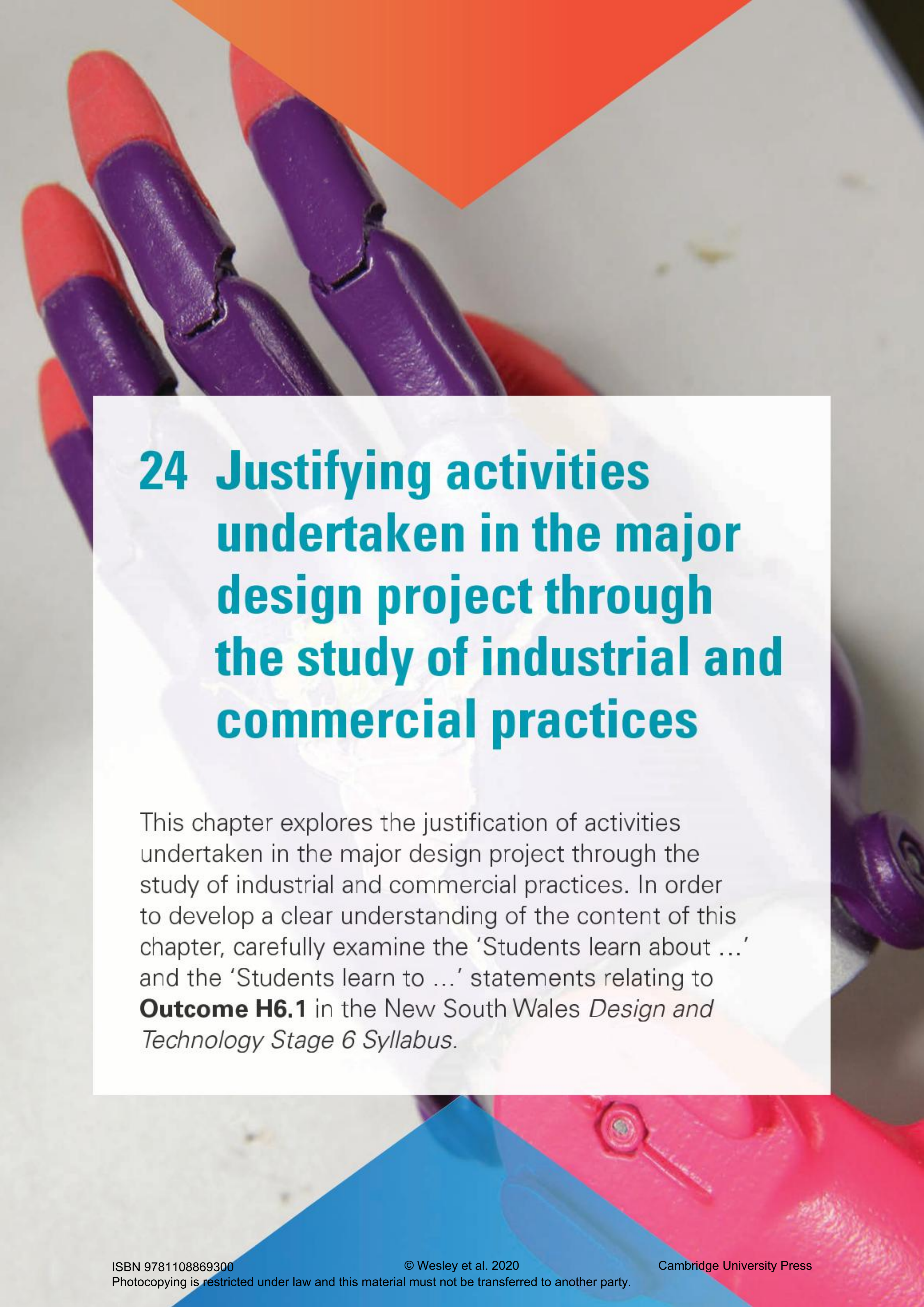

24 Justifying activities undertaken in the major design project through the study of industrial and commercial practices

This chapter explores the justification of activities undertaken in the major design project through the study of industrial and commercial practices. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H6.1** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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24.1 Processes used in design and production

Successful Design and Technology students use their skill and expertise in school and home environments, as well as an understanding of commercial and industrial practices and other individuals' expertise, to inform their decision making. The end result of this process is an appropriate mix of techniques that efficiently produces the desired result.

Figure 24.1 Combining modern practises with traditional ones

CASE STUDY 24.1

Comparing practices and processes

Major design project versus industrial and commercial settings

In this case study, a student discusses the practices adopted in the MDP and those in an industrial or commercial setting.

In an industrial or commercial setting there could be hundreds, thousands or even up to tens of thousands of the one component or project being made. This is called mass production. Comparing the methods by which these would be produced against the processes I went through to produce my project, there are obviously many major differences.

In an industrial setting, components would probably be cut out using computer-controlled laser profile cutting technology, because it is extremely quick this way and more economical. By using a CAD drawing to drive a computer-controlled machine, the process is very accurate – every component is exactly the same and the finish is extremely smooth, reducing the amount of sanding required.

All the wood turning (there are about 60–70 components requiring lathe work) – for example, arbors, all the pillars, caps, dials and pulleys – would be completed on a computer-run lathe because of its accuracy, the fast speeds at which it completes each component, and it is a lot more economical.

I spent hours manually turning components like the arbors to absolute accuracy and then sanding them up to a fine finish, whereas a computerised lathe (programmed with the required measurements) would do thousands of pieces in the same time it took me to do just one.

The finishing process that would be adopted in an industrial or commercial setting would be fairly similar to the way in which I finished my project. This is a quick and efficient process in which a sealant and stain is sprayed on using a spray gun. This is then rubbed back with steel wool and a last coat of buffing oil is applied. The only difference in an industry setting would be that the final oiling stage would be sprayed on instead of being applied with a cloth like I did.

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The first situation the student describes in Case Study 24.1 is that the industrial or commercial processes are very different from those used in the MDP. The comparison is made by explaining the processes used in industry and why the student has chosen to use a different process. Often the reason to not use industrial or commercial practices is purely practical; you do not have access to the equipment to perform the task or the method that industry uses to produce large numbers of items.

In Case Study 24.1, the student needed to use a lathe to manufacture parts for an MDP. Each part was unique and took time to turn because the equipment available was not automated. The cost of accessing machinery for producing a single part would have been **prohibitive**. It is important that the student justified the choice that was made after identifying the different possibilities for production. The same would be true in any project where access to expensive, but efficient, commercial equipment was unavailable.

The second aspect the student describes is that the industrial or commercial process is similar to the methods used in the realisation of the MDP. Again, the student identified the industrial or commercial practice used (to apply a finish to the product) and compared it to the equivalent process used in the MDP, finding that they were almost identical. The student explained only the differences instead of describing the same process twice.

The situation where a student uses a combination of some industrial or commercial processes and some non-industrial or non-commercial processes, as in this example, is very common. Some industries use processes that are easily adapted for use in MDPs. The food and fashion industries offer examples of this. Most of the processes used to produce food commercially are easily adapted for a wide range of food-related design projects. If the project relates to mass-produced processed food, however, the range of techniques available for the student to use would be reduced severely. Food that is canned or frozen is made using processes that are not readily available in school kitchens.

Different types of producers in the fashion industry have two distinctly different styles of production. When comparing the realisation of a clothing design project that is a one-off creation to the mass-produced garments available in department and chain stores, students may recognise that industry production techniques are very different from their own. Large-scale production and specialised machines used in industry are usually not an option for students. However, exclusive designers often use very similar methods to students when manufacturing their products in smaller numbers.

Processes in all major design projects relate to industry in some way. It could be that all processes are identical, they could have no similarities, or they could (and probably will) lie somewhere between these two extremes. As part of a design process, students should identify relevant production practices in industry and compare them to the practices available to them to allow a better selection of the most appropriate method to use in the MDP.

prohibitive of a price high enough to prevent something being used or purchased

Figure 24.2 Any product that is handcrafted may be considered as using small-scale production techniques.

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CASE STUDY 24.2

Bimota

Gallery

This case study was conducted in 2014 to highlight a global manufacturer who utilised very specific technologies that were very traditional in manufacturing, combined with some technological highlights that made their products very special and sought after. Due to their exclusivity and exceptional quality they were able to be accepted into the market at a premium price in comparison to other mainstream motorcycle manufacturers.

However, they are also an example of how the commercialisation of an enterprise can fail when it is unable to meet the challenges that the global market was presenting. Significantly the Global Financial Crisis of 2007–2009 and the changing of emission standards around the world presented a challenge for Bimota that it could not financially survive. From all reports the factory closed its doors at the end of 2017 in Rimini Italy, and little has been heard since about its future.

The reasons for the closure are speculative; however, the ability for a small specialist manufacture to meet the changing integrations of technology, safety standards, legal and environmental requirements for its products with a limited budget seem to be contributing factors. To compete in the expensive market of high technology performance motorcycles, designers require resources to design, produce and sell the product that people want and can afford. The financial markets across the globe took some time to adjust and the spending habits of consumers also changed. Many stopped spending on luxury items and chose cheaper options to fill their needs in many consumer goods (televisions, mobile phones, etc. all had changes in market activities during the last decade). Price became an issue for the company when cheaper mass-produced products from competitors were more attractive to customers during the last five years and their customer dollars going into sales did not continue. Thus an example of good designing not keeping pace with technology and the changing market needs resulted in a failed commercialisation of the business.

Bimota

This case study consists of an interview with the Italian motorcycle company Bimota which was conducted in 2014.

Q. Please explain the design processes used by Bimota.

A. When we seek approval for a new model, we study the competitors and the requests that come from our customers, then we define the style following the tradition of the brand. All aspects of the design are studied and engineered in Bimota, produced by our selected supplier, then assembled in our Rimini factory from the first prototype to the entire production.

Q. Please explain the manufacturing processes for Bimota motorcycles.

A. All metal parts of a Bimota motorcycle are made from high-grade billet machining. We adopt carbon fibre for fairing and all the commercial parts are selected from the best supplier. (When possible, we prefer Italian technology.) During the process of production, we don't use robotics or automation, just the most experienced mechanics and craftsmen.

Q. Please explain the technology that is used in Bimota motorcycle design and manufacturing.

A. Since the 1970s, Bimota has produced distinct sport motorcycles with innovative solutions to motorcycle design, construction and chassis dynamics, most notably that of advanced hybrid-trellis frame, development of hub-centre steering and extreme attention to hand-crafted detail.

Q. What makes Bimota special?

A. Bimota believes in the experience of its mechanics, the love they have for their work and the passion they give to their job. One mechanic builds a single bike from the beginning to the end. We know for each bike the personnel who took care of the entire vehicle.

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Everything in Bimota is passion; the people who live Bimota daily are moved by an incredible passion for this brand. The creation of each vehicle relies on an overwhelming passion that moves between the technicians, designers and engineers. At the same time, the incredible professionalism of these guys allows Bimota to create motorcycles that generate emotions every time that the bike is turned on, used, or simply admired by the owner.

Q. Please describe the role of motorcycle racing in developing and testing your product.

A. The races are part of the DNA of Bimota. When Bimota began producing motorcycles, for the first few years, we produced only racing motorcycles. Consequently, the track and races are the ideal environment for development of a new Bimota, which blends perfectly with the thousands of kilometres on the road and the test bench that every motorcycle has to travel before it can be put into final production.

Figure 24.3 Developing new models based on customer demand leads to designs that blend technology with aesthetically pleasing engineering and showcase the craftsmanship.

More about Bimota

Bimota is unique for many reasons and was highly valued by its clients. Every Bimota motorcycle was completely constructed by a single mechanic. In 2012, an Australian customer purchased a DB8 Oronero. While the bike was in construction, the parents of this customer, who were on holiday in Italy, visited the Bimota factory in Rimini and were photographed with the mechanic who was working on the bike for their son. In 2013, the customer himself went to Italy to meet the mechanic who had created his dream bike. He spent the whole day at the Bimota factory, having lunch with the people in the production department and enjoying every moment of an incredible day.

Bimota's story includes anecdotes and moments that have changed the history of motorcycling. Motorcycle designer and Bimota co-founder Massimo Tamburini constructed the first Bimota motorcycle in 1972 using components recovered from his Honda CB750, which he had crashed at Misano. The HB1 had an innovative frame and was immediately faster than other motorcycles. Its creation marks the start of Bimota's history.

One day Giancarlo Falappa, a mechanic and truck driver with Team Bimota, put on a leather suit and helmet to take to the track for the first time in a World Superbike Championship at Donington Park in England. He won the race, with pole position and fastest lap.

Every corner of the Bimota factory resonated with history and emotion.

ACTIVITY 24.1

Identify two production tasks that you undertook in Year 11 and compare how the processes you performed would have been carried out in an appropriate industrial or commercial setting.

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24.2 Collaborative designing

Video

One process that often occurs in commercial and industrial settings, but is not part of your MDP, is that of collaborative designing and working in teams. A company such as Billabong will have access to many resources when it decides to develop a new range of beachwear. There will be a team of graphic designers to design the fabric, a team of specialists to design the garment itself, a production team to organise the making of the garment, a marketing team to develop a campaign to promote the product and a team of salespeople to ensure the product is sold to the stores. All of these groups will be carefully managed to ensure cooperation and collaboration.

bionic artificial, typically electronic, body parts

The sharing of ideas and expertise is a positive aspect of teamwork. Designers may consult with other designers or colleagues to gain inspiration or research ideas. Other professionals and tradespeople often work alongside designers, offering their specialised skills and expertise with installation and production, as well as providing services in the areas of technology, materials, assembly and mass production. Collaboration will often lead to a better result for the client. As a Design and Technology student, you have to perform all these aspects of your MDP, although you will consult with experts and in some cases have some aspect of your project completed by an outside expert.

According to an October 2019 article in Science Daily, scientists helped three amputees merge with their bionic prosthetic legs as they climbed over various obstacles without having to look. The amputees reported using and feeling their bionic leg as part of their own body, thanks to sensory feedback from the prosthetic leg delivered to nerves in the leg's stump.

Scientists from a European consortium led by Swiss Institutions, ETH Zurich and EPFL spin-off SensArs Neuroprosthetics, with clinical trials in collaboration with institutions in Belgrade, Serbia, successfully characterised and implemented **bionic** leg technology with three amputees.

According to Francesco Petrini, CEO and co-founder of SensArs Neuroprosethetics, they developed the sensory feedback technology to augment prosthetic devices. 'An investigation longer than 3 months, with more subjects, and with in-home assessment, should be executed to provide more robust data to draw clinically significant conclusions about an improvement of the health and quality of life of patients.'

24.3 Implementing safe work practices

One of the most important aspects of any design and production process is safety. In our society, we have a right to expect to be able to live safely without fear of illness or injury resulting from the actions of others. In the past, products, processes and workplaces were more dangerous and caused suffering or death to many thousands of Australians. Recent changes in safety laws and improvements in attitude have brought about many changes in our culture and in the expectations placed on designers and those who produce and sell goods to the public.

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Design and Technology is a practical course and students are required to develop a theoretical knowledge of design processes and production techniques and then put their theoretical knowledge into practice in their design tasks. This places a responsibility on the student as a designer to be aware of safety aspects of their design in all phases of its life cycle, from design through manufacture and use to disposal.

The concept of safety is one that needs to be considered from the outset and addressed at all stages of the design process. The safety of a design needs to be considered from a range of viewpoints, including:

- ethical, moral and professional perspectives
- legal responsibilities
- environmental issues
- production and disposal concerns.

The Australian Competition & Consumer Commission (ACCC) publishes a list of product recalls. Read about some of these products on the ACCC website.

Each year, thousands of students' MDPs are marked throughout the state. They are the end products of a design and production process that should emphasise safety at all stages. Trying to develop one list of simple guidelines to ensure safety in all cases is not possible and many students rely on the expertise of their teacher or other professionals to avoid dangerous mistakes. However, the following suggestions will be a good starting point in the development of safe designs.

Figure 24.4 Special consideration needs to be taken when dealing with children.

When considering a design project, think of the end-user and any special needs they might have. The younger or less able the user, the more care you must take to protect them. This is reflected in the laws regarding the safety of many products. For example, clothing has a variety of specific health and safety related regulations. The regulations are very strict for baby and toddler clothing and more generalised for adults. In 2014 various retailers had to recall 120 000 items of clothing and bedding after they were found to be tainted with a hazardous azo dye containing carcinogenic chemicals. You must also consider the health and safety measures taken during the production processes. Would the machinists involved in the manufacture of the tainted products also be contaminated with the hazardous dye? Safety considerations should be an essential part of all our actions.

ACTIVITY 24.2

Collect an assortment of four products from your home or school and examine each for potential hazards. Suggest design solutions that might suitably address the problems you may find.

ACTIVITY 24.3

Develop a list of potential health and safety hazards that need to be considered in the realisation and use of your MDP. Identify ways to avoid the potential hazards through better design and better production planning.

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THE WORK HEALTH AND SAFETY LAWS

In New South Wales, laws are now part of the national work health and safety (WHS) legislation and associated regulations are the legal basis for setting and enforcing rules in workplaces to protect the health and safety of all people in the workplace, including visitors.

Everyone in our society has the right to be safe and the laws of our society are designed to protect us. Many unsafe work practices existed in the past that have caused death or injury to many workers. Whether through ignorance, negligence or deliberately ignoring warnings about danger, employers and employees have worked and continue to work with unsafe materials, practices and environments.

One of the main points of WHS laws is that everyone in a business premises is responsible for the safety of each other: employees and employers as well as visitors. Employees now have the right to action if they identify a potential hazard and employers have the right to insist that employees follow safety rules.

ACTIVITY 24.4

1 Find out the rules regarding general safety in your school. Discuss these with your teacher to make sure you understand why they exist.
2 Evaluate the rules for safe work in your Design and Technology workspace. Discuss these with your class and identify, if you can, potential improvements to the current policy.

Students in schools have the same rights and responsibilities as employees at their workplaces. It is your responsibility to be aware of the health and safety of others, comply with the safety procedures of the school and to maintain safe working practices and safe use of materials and equipment. It is the responsibility of your school to provide a safe working environment and safe work practices as well as appropriate training and supervision to make your work as safe as possible.

The WHS laws are policed by SafeWork NSW. SafeWork NSW responds to complaints, investigates

Figure 24.5 A workplace that is easy to navigate will result in fewer accidents.

Figure 24.6 Signs are one way in which workers are reminded of the real impact of workplace injuries as each one of these numbers is a work mate and a friend.

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accidents or near misses and, if necessary, issues compliance orders for repair or shutdown of dangerous workplaces, and issues fines for breaches of the *Work Health and Safety Act 2011.* Another part of the SafeWork NSW role is the administration of workers' compensation and rehabilitation, and coordination of testing and accreditation for dangerous operations such as using explosives or operating heavy machinery.

The *Work Health and Safety Act 2011* and Work Health and Safety Regulations 2011 have the concept of consultation as one of their central principles. The Act encourages workplaces to engage in consultation as a means of improving safety and avoiding potential health and safety problems. The mechanism for consultation is the WHS committee, which is made up of both employer and employee representatives. The committee's role is to:

- develop WHS and related policies
- establish a hazard identification and workplace assessment strategy
- develop and implement risk-control procedures
- set up a consultation mechanism
- carry out workplace inspections.

The workplace committee is the first point of contact in most consultation processes. Its role is to look at potential problems and attempt to address them. Often the consultation process results in very real improvements in workplace safety.

RISK ASSESSMENT AND HAZARD REDUCTION

A hazard is anything that can potentially cause harm or loss. A hazard could be as obvious as an unguarded blade that could kill instantly or as subtle as a chemical that could take years to cause death or noise from a machine that will, over time, cause hearing loss.

SafeWork NSW categorises hazards as:

- physical (e.g. noise, machinery, working at heights, lifting or trips and falls)
- chemical (e.g. inhalation, skin contact with chemicals, swallowing chemicals)
- biological (e.g. infections, bacteria from plant and animal matter, biological waste, needle-stick injury)
- mechanical/electrical (e.g. electrocution, crush injuries from mechanical plant)
- radiation (e.g. UV light, lasers, welding)
- psychological (e.g. human behaviour, violence, traumatic stress).

It is a legal requirement for employers to identify hazards, assess risks and eliminate or control risks to health and safety at work. If a hazard is found, a judgement must be made about how dangerous it is: how seriously someone could be affected and how likely this is to happen. This is called risk assessment.

Find the highest priorities

For each hazard, think about:

1. How severely could it hurt someone or how ill could it make someone?
2. What is the probability that it will occur?
3. How many people is it likely to affect?

The law says that all employers are responsible for identifying, assessing, eliminating or controlling any risks to health or safety. If a hazard is identified, it must be removed or steps taken to reduce potential harm created by the hazard. There is a hierarchy of controls for the removal and reduction of potential hazards (see Table 24.2).

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Figure 24.7 HAZCHEM signs

Figure 24.8 A slippery floor is considered a hazard.

When working through the risk assessment and hazard-reduction process, keep in mind that you are protecting your own health and safety as well as the health and safety of your peers and your teacher.

Risk assessment is a continual process. At any time, work methods, equipment and materials could change and introduce new risks into the workplace. Be active and regularly revise risk assessments and monitor the effectiveness of your risk-control strategies.

Table 24.1 Risk assessment of potential hazards

	++ VERY LIKELY (COULD HAPPEN ANY TIME)	+ LIKELY (COULD HAPPEN SOMETIME)	– UNLIKELY (COULD HAPPEN, BUT VERY RARELY)	– – VERY UNLIKELY (COULD HAPPEN, BUT PROBABLY NEVER WILL)
!!!! Kill or cause permanent disability or ill health	1	1	2	3
!!! Long-term illness or serious injury	1	2	3	4
!! Medical attention and several days off work	2	3	4	5
! First aid needed	3	4	5	6

The numbers show how important it is to do something:

1 – It is extremely important to do something about this hazard as soon as possible.

6 – This hazard may not need your immediate attention.

Source: Work Safe NSW 2015

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ACTIVITY 24.5

1 Using the risk assessment and hazard-reduction tools in Tables 24.1 and 24.2, investigate the work being carried out by another student in your class and identify potential hazards. Work with them to develop strategies to reduce potential risks.
2 Complete the same process for work being carried out on your own MDP.

SAFE WORK PRINCIPLES

- Make sure the things you purchase are safe.
- Maintain equipment to keep it safe.
- Do not use dangerous, damaged or malfunctioning equipment.
- Use things only for the purpose for which they were designed.
- Make sure people are properly trained and supervised.
- Use safe systems of work (like lock-out systems, danger tags and specified procedures for dangerous tasks) so that both work and maintenance are done safely.
- Maintain and use safety warning devices and protection.
- Make sure everyone understands the dangers of the tools and materials they use.
- Label things properly.
- Provide personal protective equipment where needed.

Table 24.2 Hierarchy of controls for the removal and reduction of potential hazards

1 ELIMINATE THE RISK	This can be done by removing the hazard, by stopping the hazardous procedure or removing the hazardous plant or material.
2 SUBSTITUTION	If you cannot eliminate the risk entirely, substitute the hazard creating the risk with one that presents a smaller risk. • Use a less dangerous piece of equipment. • Use safer materials or chemicals.
3 ISOLATE THE HAZARD	If you cannot substitute for a less dangerous hazard, try isolating the hazard. This separates the person from the source of the problem. This can be effective where certain work processes produce excessive noise. In schools the use of fume cupboards is a good way of isolating dangerous chemicals from the students using them.
4 MINIMISE (REMOVE OR REDUCE) THE RISK THROUGH ENGINEERING MEANS	There are many ways to implement engineering controls to address workplace risks. Usually, these are physical changes to equipment or the environment, and could include such measures as adding machine guards or lock-out devices, changing lighting to reduce glare or installing exhaust fans. It could also include the purchase of specialised equipment.
5 IMPLEMENT CHANGE THROUGH ADMINISTRATIVE MEANS	Think about ways the work could be done differently. Changing your work methods can help to reduce injuries and incidents. Consider working in a different way – think about things like: • following written work procedures • changing routines, such as recommending that working with difficult machinery is only done for short stints.
6 USE PERSONAL PROTECTIVE EQUIPMENT (PPE)	You may have to use PPE for some tasks or while you find better ways of dealing with the hazard. PPE is only useful when it is in good condition and worn correctly.

Source: Work Safe NSW 2015

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CHAPTER SUMMARY

- Design and Technology students use an understanding of industrial practices as well as individual expertise to inform their decision making.
- The decision to use or not to use industrial or commercial-type practices or production techniques is often purely practical. Perhaps you cannot access the resources to perform the task or the industrial or commercial method is inefficient for producing only one or two items.
- One of the most important aspects of any design and production process is safety.
- When you begin to develop design ideas, the concept of safety needs to be considered from the outset and addressed at all stages of the design and realisation process.
- As a designer, you must identify hazards, assess risks and eliminate or control risks to health and safety, and you must take all reasonable steps to reduce the risk.
- Working collaboratively can widen the range of knowledge available to you and enhance the final design.

CHAPTER SUMMARY TASKS

1 Consider a design project in which you have been involved and compare the process you followed with those that would be used in a comparable commercial or industrial setting.

2 In a table like the one below, assess the safety of equipment or materials you commonly use.

MATERIAL OR EQUIPMENT	POTENTIAL HAZARD	SAFETY PROTOCOL

3 Locate the material safety data sheet (MSDS) for a material you have used.

- **a** Write a summary of the potential hazards and any precautions that should be taken when using the material.
- **b** Use the MSDS to identify first aid procedures relating to the material.

4 As a collaborative exercise in your class, analyse a design project with which you are familiar and conduct a risk assessment of the design for production and use. Describe how you could change the design, production or use of the design to minimise risk.

5 Safety in the school workshop is dependent on everyone understanding safe working procedures. How could you make everyone aware of these procedures?

6 Develop a work method statement to describe how you have safely completed a practical task by identifying and controlling hazards.

7 List 10 practical tasks that may be involved in the realisation of your MDP. In a table, compare your work methods with those adapted in industry.

8 Using the table completed in Question 7, conduct a risk assessment on each of the practical tasks.

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9 Identify a common industrial or commercial practice that relates to your MDP. Research the practice and produce a summary of relevant technical points and a diagram or flow chart to explain the process.

10 Using the WorkCover website determine the level of fines applied to breaches of the *Work Health and Safety Act*.

EXTENSION TASKS

1 Compare the design and production process used in your MDP with those used in an industrial or commercial setting. Present your findings in a table format.

WORK METHOD	MDP	INDUSTRIAL OR COMMERCIAL

2 Carry out a life-cycle analysis or cradle-to-grave analysis of your MDP, identifying all potential risks relating to its complete life cycle. After conducting a risk analysis, determine whether there are any hazards that can be eliminated or controlled. Check to see whether there are any specific laws, regulations or codes of practice that relate to your MDP.

Figure 24.9 Safety is everyone's responsibility. Be sure to check those around you are also being safe.

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25 The emergence and impact of new technologies, and the factors affecting their development

This chapter explores the emergence and impact of new technologies, and the factors affecting their development. In order to develop a clear understanding of the content of this chapter, carefully examine the 'Students learn about …' and the 'Students learn to …' statements relating to **Outcome H6.2** in the New South Wales *Design and Technology Stage 6 Syllabus*.

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25.1 Emerging technologies

Technologies are the processes that humans use to increase their control over and understanding of the environment in which they operate. The term 'emerging technology' refers to a field of technology that broaches new territory in some significant way. Often an emerging technological development involves the **convergence** of previously separate technologies. For example, voice, data and video technologies converge to enable the sharing of resources and new levels of interaction. Nanotechnology, biotechnology, cognitive science, robotics, artificial intelligence, information technology and educational technology would be considered fields of emerging technological development.

Many factors affect the development of emerging technologies. The move to sustainability, for example, has led to many new technologies and improvements on already existing technologies. Systems for recycling, renewable energy such as solar power, and materials to replace plastic are emerging technologies that support sustainability. Global warming is another factor that has inspired the development of new technologies that will lessen our carbon emissions. Carbon capture technology and biomass energy are technologies that will lead to a greener, cleaner environment. Drought and water shortage have farmers looking for ways to improve their productivity in times of drought. At the same time, the realisation that meat-rearing is environmentally destructive has led to investment in the development of cell-based meat.

Government financial assistance has supported the development of many of these new technologies. Private enterprise is also willing to invest in promising new technologies. Financial factors impact on emerging technologies in other ways as well. Many new technologies, such as automation, robotics, management software, CNC machining and online learning, have been developed to provide an economic advantage to industry.

convergence the movement of different technologies towards a unified, common use

New technologies lead to newer technologies. The Australian consumer today expects to be able to purchase time-saving devices, and this impacts on the development of new technologies and the improvement of existing technologies. Electronic communication is crucial to business today. As an emerging technology, it has led to further developments in communication devices and systems for online shopping. Many of these emerging technologies are the stimulus for the innovations that are changing the way we live and work. They are considered critical to the future of our world, but there are also warnings about issues of equity and the distributive justice in allocating access to beneficial forms of technology.

Video

ACTIVITY 25.1

Nanotechnology is the manipulation of matter on an atomic, molecular and supramolecular scale. Visit the How Stuff Works website to find out how nanotechnology works. Visit the Nanotechnology Now website to research some of the uses for nanotechnology. Form a small group of four to five students and discuss ways you can envisage nanotechnology being used in the future. Share your ideas with the rest of the class.

Figure 25.1 Nanotechnology

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CASE STUDY 25.1

Drone technology

Drone technology is constantly evolving as new innovation and big investment are bringing more advanced drones to the market. Unmanned aerial vehicle technology covers the aerodynamics of the drone, materials in the manufacture of the physical UAV, the circuit boards, chipset and software, which are the brains of the drone. A typical unmanned aircraft is made of light composite materials to reduce weight and increase manoeuvrability. This composite material strength allows military drones to cruise at extremely high altitudes.

Drones are equipped with different state of the art technology such as infrared cameras, GPS and laser (consumer, commercial and military UAV). Drones are controlled by remote ground control stations (GCS), also referred to as a ground cockpit. The engineering materials used to build the drone are highly complex composites designed to absorb vibration, which decrease the sound produced. These materials are very lightweight.

Drones will no doubt have a huge impact on many aspects of society.

A custom-made drone, roughly the size of a washing machine, has been used to take a human kidney from a deceased person at an accident to a nearby hospital where a team of surgeons successfully transplanted the organ into a critically ill patient. It has been stated that organ drones have the potential to improve access to transplants, decrease cost and improve quality. Such success has followed years of collaboration among doctors, researchers, engineers and aviation experts. Drones are delivering medical supplies in Rwanda and other African countries, as well as in Vanuatu and other Pacific island nations.

A rescue drone, known as the Little Ripper, helped save two teenage swimmers stuck in a rip current off the NSW coast by dropping an inflatable rescue pod. It achieved in 70 seconds what would have taken a lifesaver at least 6 minutes.

Farming processes are looking to be revolutionised by the use of a robotic alternative to bees. Taking the form of a multicopter – a type of aerial vehicle that flies using two or more rotating blades – the 'bees' would use cameras and sensors to find the locations of crops where they would distribute pollen.

Military drones are not only being used to fight wars, they are also used for surveillance, to gather intelligence, to save lives and even to monitor speeding drivers on highways.

Drone technology is innovative in itself and is bound to provide access to a range of innovative practices.

Figure 25.2 Crop dusting with a drone

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25.2 The impact of emerging technologies on society and the environment

There is no doubt that emerging technologies and the innovations they spurn will impact on our society and the environment. There are so many amazing advances occurring. You are encouraged to do your own research into areas of interest, to discover the changes that are occurring.

It is important to carefully consider the consequences of any new development. Products like DDT and asbestos were once considered great technological advancements. They were commonly used before the hazards they created were discovered. DDT, an effective pesticide, led to birth defects, effects on the nervous system and increases in cancer rates.

Asbestos, widely used in building materials, and as an insulating material, affects the respiratory system and can lead to death by asbestosis and lung cancer. These products, like many others, were still produced long after the dangers were known, and little attempt was made to protect workers or consumers until the producers came under serious legal and financial threat. As responsible designers, we must always consider the potential consequences of any material, tool or technique that we introduce into our designs.

Many technologies have positive potential. These include mining metals from the desalination of seawater and super-light cars made using carbon-fibre elements. It is important to consider the capacity of the technologies we support to have a real and positive impact on the world. It is exciting to think of the uses for brain–computer interfaces, which build on existing technologies to enable us to type by monitoring our electrical activity in the brain. Disabled people are able to operate devices through their thoughts. You would be able to think about what you want to say in your assignment and have it typed for you! Can you see both positive and negative impacts for this technology?

Body-adapted wearable electronics are another emerging technology. Whether worn on the body, embedded in clothes or even under the skin, these devices can track information, such as heart rate and stress levels, giving people real-time feedback about their health. How does this innovation impact on society, particularly the sick and infirm? Could the technology be useful in a war zone to determine a soldier's injuries? Would you like to have it in the sole of your sports shoe when you are training? Are there any ethical issues that should be considered with this technology?

Traditional steel making has been changed forever because of the work of Indian-born engineer Professor Veena Sahajwalla from the University of New South Wales. She has developed a process where old rubber tyres and waste plastic replace some of the coke in the electric arc furnaces that generate power for the production of steel. The process has now been commercialised and has prevented millions of tyres from becoming landfill.

Figure 25.3 Wearable technology

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Here we have a technology that has both efficiency benefits and environmental benefits – such a good combination.

Biofuels are an emerging technology that is having an environmental impact. In order to lessen its ecological footprint, Qantas used biofuels successfully on a flight from Sydney to Adelaide. This is a far more sustainable solution to power the aircraft. Most biofuels come from a food source, but Roger Stroud and chemical engineer Earl McConchie of Algae.Tec are undertaking a project to further develop aviation biofuels. Instead of using a food to produce energy, they are using algae, grown in shipping containers, as the base for their fuel. This is an example of innovators using an emerging technology and developing it further for better environmental outcomes.

Search for haptic footwear on the internet. What impact might this technology have?

ACTIVITY 25.2

Create your own set of criteria for evaluating a new pesticide technology. Consider the technology's impact on society and the environment.

ACTIVITY 25.3

Describe the emerging technologies that have impacted on the development of prosthetics. Predict further advancements in this technology.

Video

25.3 The impact of emerging technologies on innovation

If we define innovation as 'using an existing material or technology for a completely different purpose or to develop a new material or technology', the link between innovation and emerging technologies is a very strong one.

New types of technology play an important part in the process of innovation. Without technologies that have emerged over time, we would not have most of the things we take for granted today. In 1800, Count Alessandro Volta invented the battery. How many innovations today rely on this one simple product?

The battery may even provide the answer to sustainable transport. The adaptation of common AA rechargeable NiMH (nickel metal hydride) batteries to produce fuel cells that power electric vehicles is a strong example of how existing technology might be used in a new way. The use of the batteries in this way is innovative, while the electronic package they are developing to gain efficiency is a totally new technology. Many innovations come from using existing products for new or different purposes.

Often, we really benefit from innovations where an existing technology is used in a new way.

The development of one invention has in many cases been the catalyst for the development of whole new areas of technology. The discovery of penicillin, for example, led to the development of a range of drugs to treat infections – development that still goes on today. The x-ray machine showed, for the first time, the inside of a living human body without the need for surgery. This shadowy grey image became a valuable diagnostic tool that has helped many diagnoses and saved many lives. With more technological developments and innovation, a much

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wider range of scanning technology, such as MRI, CAT and PET scanners, has become available, each with its own specific application in health care.

As designers and consumers of the future, you should consider the impact of any new technological developments. Think carefully about the type of world in which you want your children and grandchildren to live, and carefully analyse how the rapid advancements in technology may impact on that world. There are many technological developments that we might not have accepted in our society if we had been able to predict the consequences. Evaluate how your own solutions, and those of others, affect users, equity, sustainability, ethics and personal and social values. In creating solutions and responding to the designed world in a considered manner, you can contribute to the sustainable patterns of living and moral principles we desire for the future.

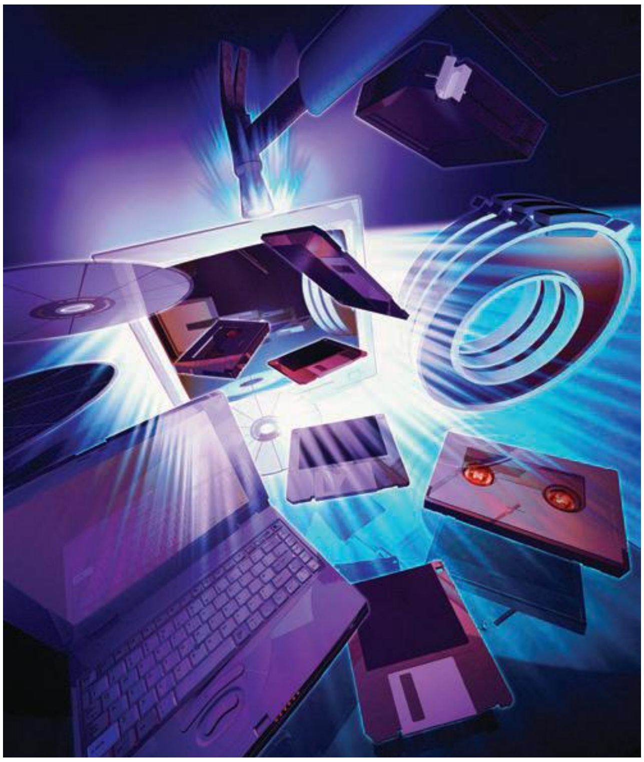

Figure 25.4 Each of these technologies was an emerging technology at one time.

ACTIVITY 25.4

1. Discuss some of the innovations that led to the range of apps available today.
2. Photography has changed considerably since 1814. What were some of the innovations or new technologies that led to these changes?
3. Choose an emerging technology from the present time and discuss how it may impact on society and the environment in the future. Comment on how the technology may develop.

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CASE STUDY 25.2

Modern medicine

Technology and medicine often combine to bring about innovative advances in the pharmaceutical and medical field. Monique Ellis, the Content Marketing Executive at Pro-Clinic, lists the following medical technologies on her blog. See the blog at Proclinical under Monique Ellis.

Smart inhalers

Bluetooth smart inhalers help asthmatics better manage their condition. The date and time of each dose and whether it was correctly administered is recorded on a small device attached to the inhaler. This data is sent to the patient's smartphone to enable them to monitor the medication.

Robotic surgery

The precision, control and flexibility of this technology enables the surgeon to perform complex procedures that are otherwise very difficult or impossible. It is anticpated that it will be combined with augmented reality to allow surgeons to view important additional patient information in real time while still operating.

3D printing

These printers can be used to create implants and joints to be used during surgery. The digital functionalities enable 3D-printed prosthetics to match an individual's measurements down to the millimetre.

Artificial organs

Taking 3D-printing to another level, bio-printing is also an emerging medical technology. It was groundbreaking to regenerate skin cells for skin draughts for burn victims. Taking this technology further, scientists have been able to create blood vessels, synthetic ovaries and even a pancreas. These artificial organs grow within the patient's body to replace the faulty one.

CRISPR

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) is an advanced gene-editing technology. It allows researchers to easily alter DNA sequences and modify gene function. Its many potential applications include correcting genetic defects, treating and preventing the spread of diseases and improving crops.

These are some of the myriad of medical innovations. Research one of these and one other of your choice. Consider the ethical concerns that may be associated with its use.

Figure 25.5 Modern surgery

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CHAPTER SUMMARY

- New and emerging technologies are those that have recently been developed or are in the process of development.
- Innovation has driven our invention and human development from the beginning of time. It has been constantly at the forefront of technological, social and artistic development.
- With each new technological development, people become more sophisticated and demanding of new products. Designers need to strive constantly to satisfy the needs and desires of society while, at the same time, produce products that are safe and more environmentally friendly.
- Any new technology in the early stages of development or acceptance in the marketplace is an emerging technology. It may be hard to believe, but everything we take for granted today was once an emerging technology.
- The development of a new (emerging) technology has in many cases been the catalyst for the creation of whole new areas of human endeavour.

CHAPTER SUMMARY TASKS

1. Define the terms 'emerging technology' and 'innovation'. Describe the relationship between these terms.
2. Read Case Study 25.1. Make a list of future uses you can see for drone technology.
3. Describe a technology that has been developed specifically to provide an advantage to a particular industry.
4. Develop a case study on one current innovation and one innovation from history.
5. Describe and analyse the innovation in your MDP.
6. Compare your current lifestyle with the life your grandparents would have lived when they were your age.
7. Identify and describe two emerging technologies in medicine. How will they assist people who are ill? What are the ethical issues related to the technologies?
8. New technologies often bring with them challenges to traditional ways of doing things. How has the introduction of online multimedia applications challenged our expectations of music and movies, and the laws that protect the intellectual property of their creators?
9. Some materials and products initially thought safe when introduced have been found to be very dangerous. What steps are taken today to ensure new products will not be found to be dangerous in the future?
10. New technologies and new products should make life in our society better, safer or easier. Compile a list of new products that have achieved or could achieve this goal for you.

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EXTENSION TASKS

1 Describe the effect a new technology has had on these areas of human life:
   - **a** food
   - **b** music
   - **c** manufacturing
   - **d** fashion
   - **e** transport

2 The shift to agriculture, the Industrial Revolution and now the computer age have irrevocably changed our society. Describe some significant inventions or innovations that have led to these changes. What do you see as the next big thing in technology to shape our world?

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GLOSSARY

3D printing the building of physical models directly from computer-aided design (CAD) data

action plan a list of tasks to be completed as part of a project

aesthetics how something looks, particularly how visually pleasing it is

algorithm a set of steps used to solve a calculation or problem

anneal to make metal or glass soft by heating and then cooling slowly

appropriate suitable for an occasion or use

Australian Standard detailed technical documents developed by Standards Australia to ensure quality and common understanding

automation mechanical controlling of machinery for speed and accuracy

biodegradable able to decay naturally and harmlessly

biofuel fuel derived from biomass (recently living organisms or their metabolic by-products such as manure)

bionic artificial, typically electronic, body parts

blog a regularly updated website used to cover a single subject

chassis the base frame of a car

collaboration working together with others on a project for a common goal

computer-aided design (CAD) an automated system for the design, drafting and display of graphic information

computer-aided manufacturing (CAM) a computer program that makes manufacturing data from CAD drawings to automate the manufacture of a product by a computer-controlled machine

computer numerical control (CNC) the computer control of machine tools for the purpose of (repetitively) manufacturing complex parts for a product

concept board a cognitive organiser used to clarify the aspects of the concept that will be important to the final design

constraint a limitation or control that must be followed

control measures a set of guidelines or rules to maintain certain standards and consistency

convergence the movement of different technologies towards a unified, common use

copyright legal rights of artistic ownership and integrity, represented by the symbol ©

cradle-to-cradle analysis design of products that do not generate waste or landfill at the end of their useful life, but that can be reused and recycled into new products

credible valid and reliable

criteria (singular: criterion) a list of requirements and specifications

cumulative increasing by a series of additions

custom product product produced manually by an experienced, highly skilled and qualified labourer

demographic a section of the population grouped according to common characteristics such as age, income or gender

dependency relationship between preceding and succeeding tasks

design for disassembly design for products that can easily be disassembled, separated and sorted for reuse or recycling at the end of their useable life

deviate to move away from an established route

drone an unmanned aerial vehicle (UAV)

durability the ability of a product to repeatedly perform its designed function for an acceptable period of time without failure; to be long-lasting

dynamic able to adjust and change in response to changes

efficiency ratio of output or work done to energy used or input supplied

empathy our ability as designers to understand the different perspectives of users regarding what they may say, do, think, feel and experience

emulate attempt to equal or surpass through imitation

entrepreneur a person who sets up and manages new commercial enterprises to make a profit

entrepreneurial activity making ideas for products or businesses into productive and profitable businesses

environment the total of surrounding things, conditions or influences; especially the combination of external physical conditions that affect and influence our growth, development and survival

environmental sustainability the practice of making responsible decisions that will reduce negative impact on the environment

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ergonomics the science of designing machines, products and systems to maximise the safety, comfort and efficiency of the people who use them (and minimise harm or physical damage)

ethics a system of accepted beliefs that control behaviour, especially one based on morals

finance plan a detailed report of the resources used in a project with costs applied

formulate to develop a plan

function the action or use for which something has been designed

Gantt chart a detailed grid that displays the tasks to be undertaken and time allocated, and maps these on a specified timeline

global warming increases in the average land and sea temperatures on Earth

globalisation the ongoing process of integrating economies, societies and cultures through global networks

graphical relating to visual art

greenhouse effect the gradual warming of the Earth's surface caused by an increase in gases in the atmosphere (caused by human activity)

greenhouse gases gases that trap and emit heat in the atmosphere causing a greenhouse effect on the planet

hazard anything that can potentially cause harm or loss

holistic an approach that emphasises the importance of the whole

hypothesis a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation

iconic represented as worthy of celebration and great respect

Industrial Revolution the transition to new large-scale manufacturing; paved the way for mass production

innovation using an existing material or technology for a completely different purpose or to develop a new material or technology; something new or unprecedented in a market or society

intellectual property recognises ownership of a product of the intellect that has commercial value including copyrighted property such as literary or artistic works, patents, business methods and industrial processes

iterative/cyclical process a process where activities occur again and again until a desired state is achieved

lateral thinking using creative or unexpected thinking to solve problems

lathe a machine used for cutting and working wood or metal that spins the material against a cutting tool

legible clear and easy to decipher

legislate to create, provide or enact laws

mass production the manufacture of goods on a large scale, usually on an assembly line

material safety data sheet (MSDS) describes the identity, relevant hazard information, precautions for use and safe handling of a hazardous substance

measureable something that can be quantified, or is able to be measured

milestone a significant developmental stage or point determined by the designer and allocated a specific date for completion

misconception an incorrect idea or assumption

needs analysis in-depth exploration of the needs and wants of the target market; used to establish a genuine need or opportunity and ensure that the design solution is in response to that need

niche a gap in the market; a small, specialised group of consumers for whom no adequate product exists

occupational overuse syndrome a range of conditions, including injury to, or discomfort or pain in, muscles or soft tissue

orthographic the drawing technique of representing lines, surfaces or solids in one or more imaginary planes that are at right angles to one another

parameter a limit or boundary that defines work

patent a legal document granted by the government that gives an inventor exclusive rights to make, use and sell an invention (for a specified period)

personal protective equipment (PPE) a device or appliance designed to be worn individually to protect the user against potential hazards

podcast a digital audio file available to download from the internet

powertrain the mechanism that transmits the drive from the engine of a vehicle to its axle

primary function the main purpose for which a product is selected by a customer

primary research research conducted by going directly to the source, such as interviewing, experimenting, and collecting and analysing statistics

proficiency a high degree of skill or expertise

prohibitive of a price high enough to prevent something being used or purchased

prosthesis an artificial device used to replace a missing body part

prototype the preliminary version of a product or design from which other versions are developed

secondary function additional features that make a product different and preferred to competition products

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secondary research facts or data obtained from sources other than the original source, such as books, other people's reports or the internet

sequential happening in a logical order or sequence

specification detailed instructions on how something should be done or produced

standardisation the process of establishing a technical standard to ensure compatibility of production assemblies

statutory authority an organisation established under an Act for a public purpose

sustainable causing little or no damage to the environment or not using finite resources; therefore, able to continue for a long time

SWOT analysis an analysis of the strengths, weaknesses, opportunities and threats associated with an idea or a product

target market the sector of a market that a product is being produced for and marketed to

testing a process of trying something to see if it works or is appropriate

trademark the name or other symbol used by a manufacturer to distinguish its products from those of competitors

unambiguous clear meaning that can only be interpreted in one way

Work Health and Safety Act 2011 an Act relating to health and safety within the workplace; the Act sets the framework for duties designed to promote health and safety, and workplaces must comply with these duties

wiki a collaborative website or database that allows all users to update and edit the content

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