

Design and Technology: Stage 6

Arna Wesley
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Michael McLean

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Foreword

Today, 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. This subject has a strong focus on innovation and the development of innovative ideas, and provides the opportunity for you to apply technologies to solve problems and create ideas and solutions.

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.

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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. Since retiring as Technological and Applied Studies (TAS) Co-ordinator at Loreto Kirribilli in 2006, Arna has been working on a sessional basis with pre-service teachers at Australian Catholic University as Lecturer-in-charge of Technology Curriculum and Teaching and leading ICT workshops.

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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.

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How to use this textbook



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

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



Case studies extend on information, explore innovative designs and their designers and provide detailed accounts of industry practice.

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

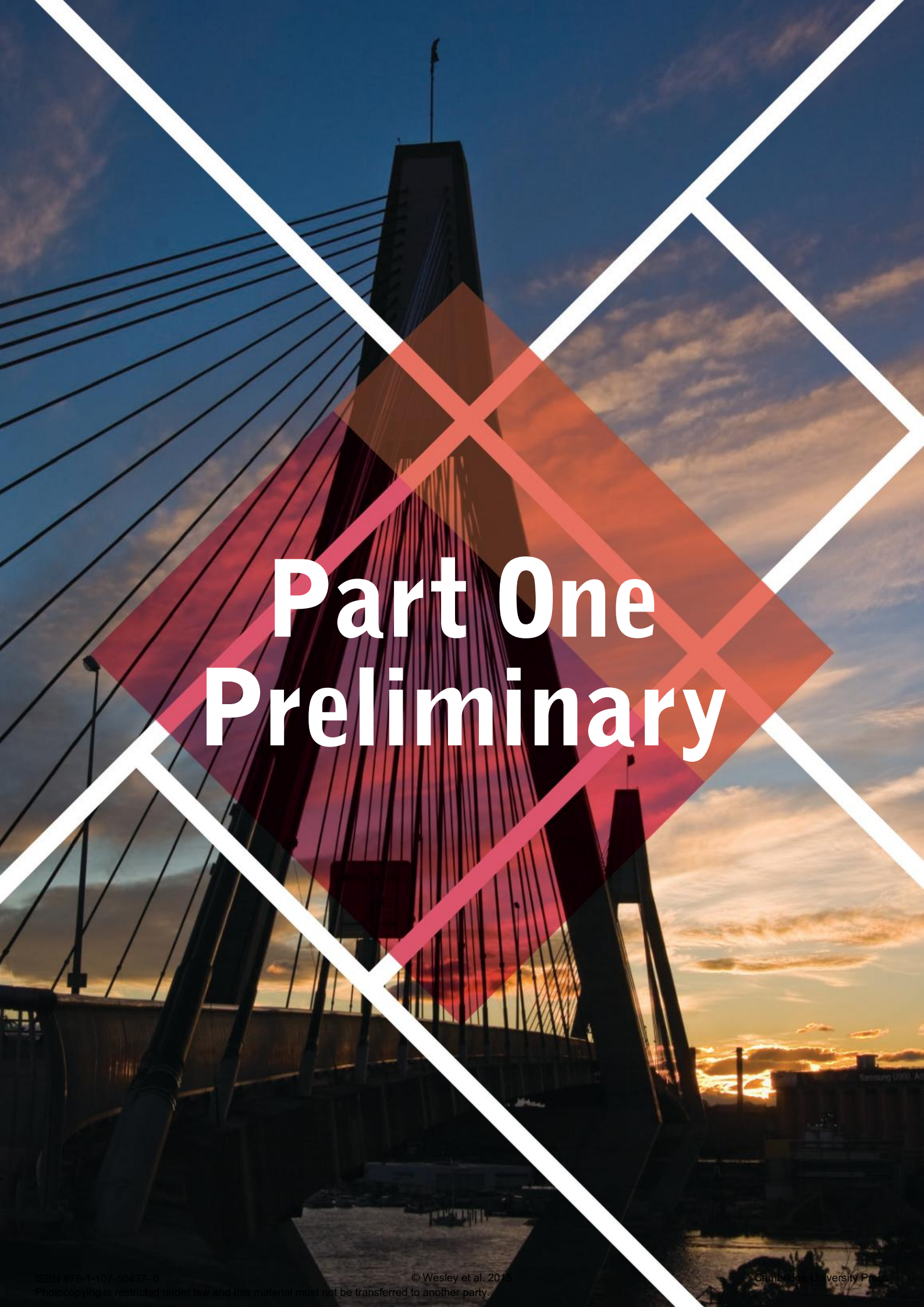
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End of chapter material includes chapter summaries, chapter summary tasks and extension tasks to test your knowledge through the reinforcement of key outcomes and application of skills.

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Part One Preliminary

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1 Design theory and practice

This chapter explores design theory and practice and considers the factors that affect 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 P1.1** in the New South Wales *Design and Technology Stage 6 Syllabus.*



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1.1 Design is everywhere

Why is the Sydney Opera House the shape it is?

How do solar panels work?

What is 'the cloud'?

Who decides this season's fashion colours?

I'm organising the Year 12 farewell – where do I begin?

Who designed Sydney's Wet'n'Wild?

function
the action or use for which something has been designed

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. 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!

So just how much design *is* involved in Wet'n'Wild?

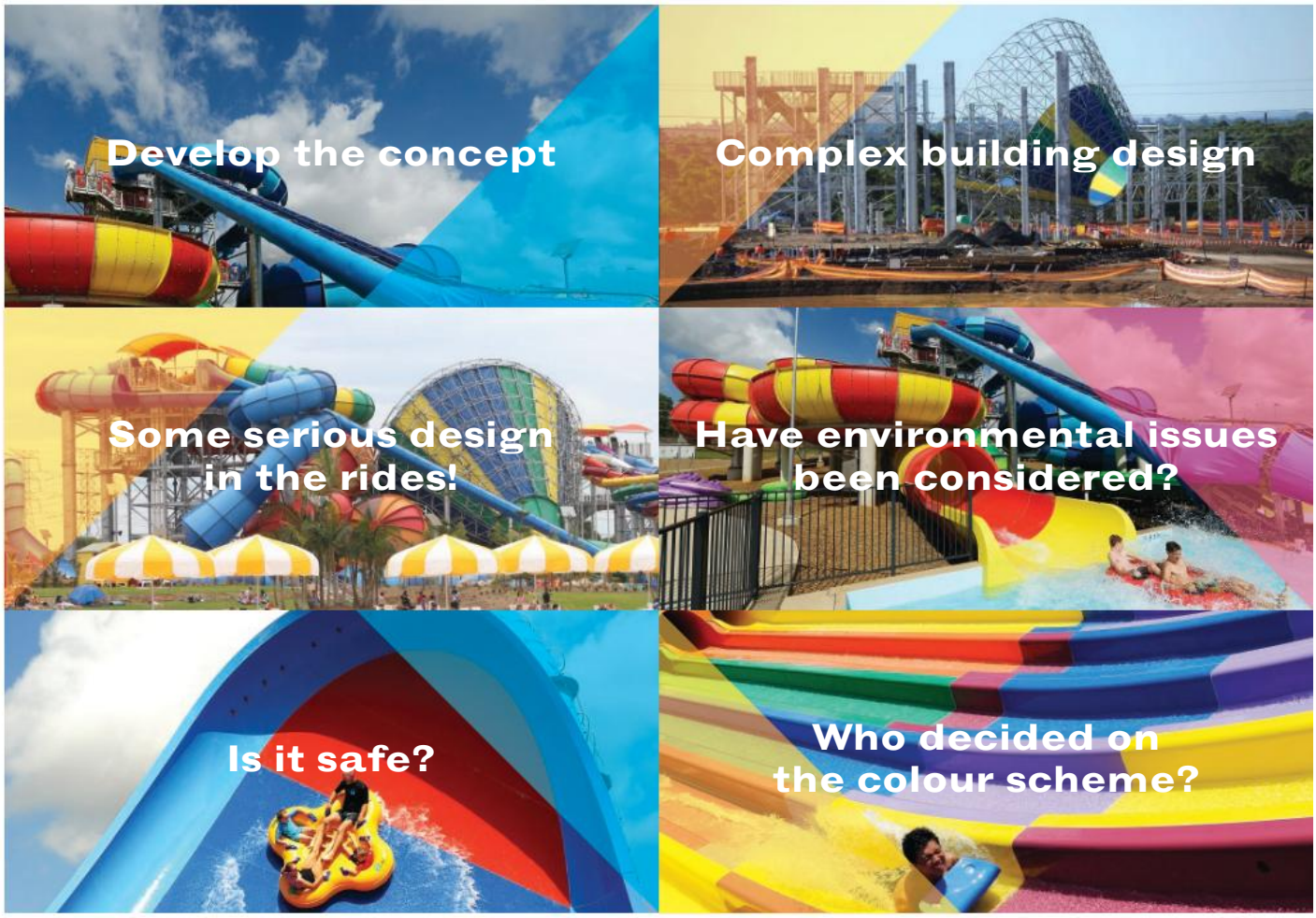


Figure 1.1 How much design is involved in Wet'n'Wild?

aesthetics
how something looks, particularly how visually pleasing it is

There are many concepts to reflect on – a lot more than are mentioned here. Each of these images promotes 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 theme park.

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1.2 Investigating designers and the nature of their work

CASE STUDY 1.1

Lenko

Dana Lenko's career as a fashion designer began with the creation of witty T-shirts when she was still a teenager. It has grown over the years to a full collection of clothing under the label Lenko. Her work is available around Australia, in the UK and in Asia, and Dana up until recently ran a boutique in Melbourne's Flinders Lane.

Dana studied film and art and to her the design process is another creative expression. She has a quirky personality that is expressed in her designs, and is inspired by colours and textures and beautiful fabrics, with a penchant for unique patterns. It takes Dana about three months to develop a collection from sketch pad through to the shop floor. Her random sketches and scribbles form the basis of many of her designs. Concept sketches are scanned into the computer for manipulation.

Dana's T-shirt range is very popular. It is fun and reflects her sense of humour. She often designs T-shirts for specific clients and purposes like promotions and corporate events. Clients will meet with Dana at her shop to discuss the brief. Here she can show the client examples of her work and explain her printing techniques and illustration style, as well as discuss the message the client wishes to convey to the audience. Dana will take notes during this interview and agree on the time frame, the design concepts and when she and the client will next meet. The budget is also discussed, as this will impact on the number of colours used. Sometimes Dana may use collage techniques, as this enables an impressive design without so many colours. Screen printing is another technique used, as are embroidery and appliqué. Dana presents her design to the client as a mock-up photographic image so the client can visualise how the product will look when worn.

Dana's design process for a dress begins with the sketch and computer printout of the design she has created. Fabric, colours and patterns she can visualise in the style often inspire the design. Her design is handed to the pattern maker, who makes it into sizes before passing it to the production crew. At this stage it is given to an embroidery specialist, a silk-screen specialist, a dye house, or a combination of these processes. The garment is then pressed, tagged and packaged.



Figure 1.2 Dana Lenko is known for her quirky designs.

The Lenko Boutique in Flinders Lane in Melbourne was recently closed, to allow Dana to focus on the online business and other art projects. Dana supports a creative community rather than making mainstream mass-produced items, and promotes a social conscience, stocking designers who have good business morals.

All of the in-house label, Lenko clothing, is made locally.

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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. This multi-talented and versatile duo are known for their unconventional creations. They work on props making, illustration, photography, motion graphics, installation, sculpture, and any kooky project that arises in the design scene. They have the ability to be wacky and unique but take the process of design seriously with their highly imaginative use of a range of media. Much of their work has been with advertising agencies and consequently for companies such as Nike, MTV, Visa and American Express.

Tin and Ed are often challenged to work in unfamiliar areas, resolving problems as they go along. The concept and the process are most important to these designers. They like to work in different media, using different processes, seeing having to learn something as a challenge and not a problem.

> Our work tries to communicate with people on a more subconscious level, we don't want people to understand everything right away.
>
> *Source: The Design Files, 1 July 2010, http://thedesignfiles.net/2010/07/interview-tin-ed*

Tin&Ed work as a team; however, others are involved when needed. The Visa Go installation was a large project that involved other designers like Miles Jeffreys, who was responsible for the art direction, and Julian Wolkenstein, who was responsible for the photography. The project was a giant sculpture made from hundreds of computer parts that was suspended with heavy fishing wire from the ceiling of a warehouse. Photographs of the sculpture were used in the Visa Go advertising campaign.



Figure 1.3 An installation by Tin&Ed made from computer parts for the Visa Go campaign

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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.

Architect

This is a classic design job where the balance of aesthetics and functionality needs to be in harmony. An architect needs to know virtually all facets of building design, from load-bearing and concrete strength through to 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.

Furniture designer/maker

This job 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.

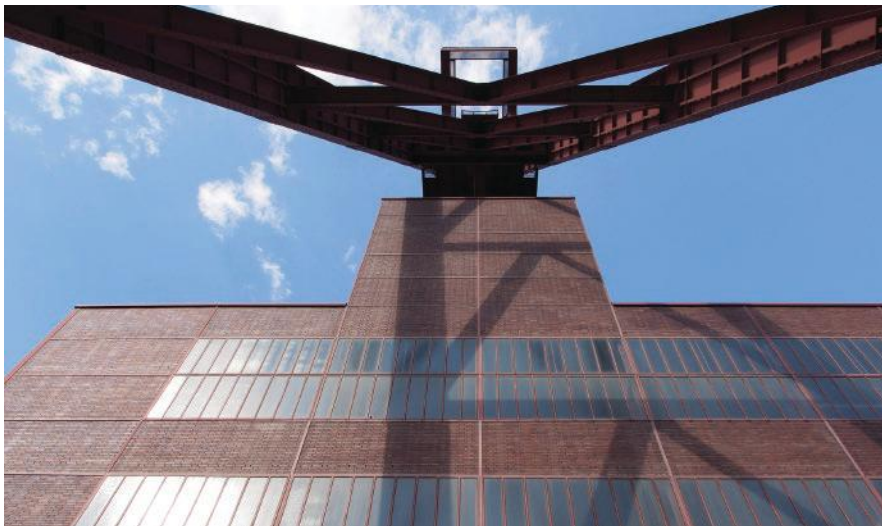


Figure 1.4 Architects need to combine design and function.

Industrial designer

This profession 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 in this profession 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.

Web designer

This job involves producing interesting, functional and diverse internet 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.

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

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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

Electrician

Design of installation is something an electrician undertakes before every job. This ranges from power loadings and load balancing through to 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, the plans of ongoing care and layout need careful consideration.



Figure 1.5 Well-designed retail spaces engage customers.

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.

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.

ACTIVITY 1.1

1. Visit websites such as CareerOne (see http://cambridge.edu.au/redirect/?id=119), JobSearch (see http://cambridge.edu.au/redirect/?id=120) and JobSeeker (see http://cambridge.edu.au/redirect/?id=121) or use the latest job guide publication 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 they are doing it.)
5. Write a list of the design-related jobs that would have been involved in the development of Wet'n'Wild.

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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, while an industrial project may draw upon massive resources and teams of people. The processes you use may depend on the availability of resources at your school.



Figure 1.6 Industrial projects require a lot of planning.

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 completely 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.

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

specifications detailed instructions on how something should be done or produced

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

> Design a car that drives for 20 kilometres on 1 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. The vehicle must have a ticket price no greater than $35 500. The design should be completed by 21 January 2018. The design budget is not to exceed $550 000.

This statement now guides the designer on a more specific and achievable path. It 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.

constraint
a limitation or control that must be followed

The constraints

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

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.

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, there would be several teams of people, each working on a particular area. Positions and teams involved in such an investigation could include:

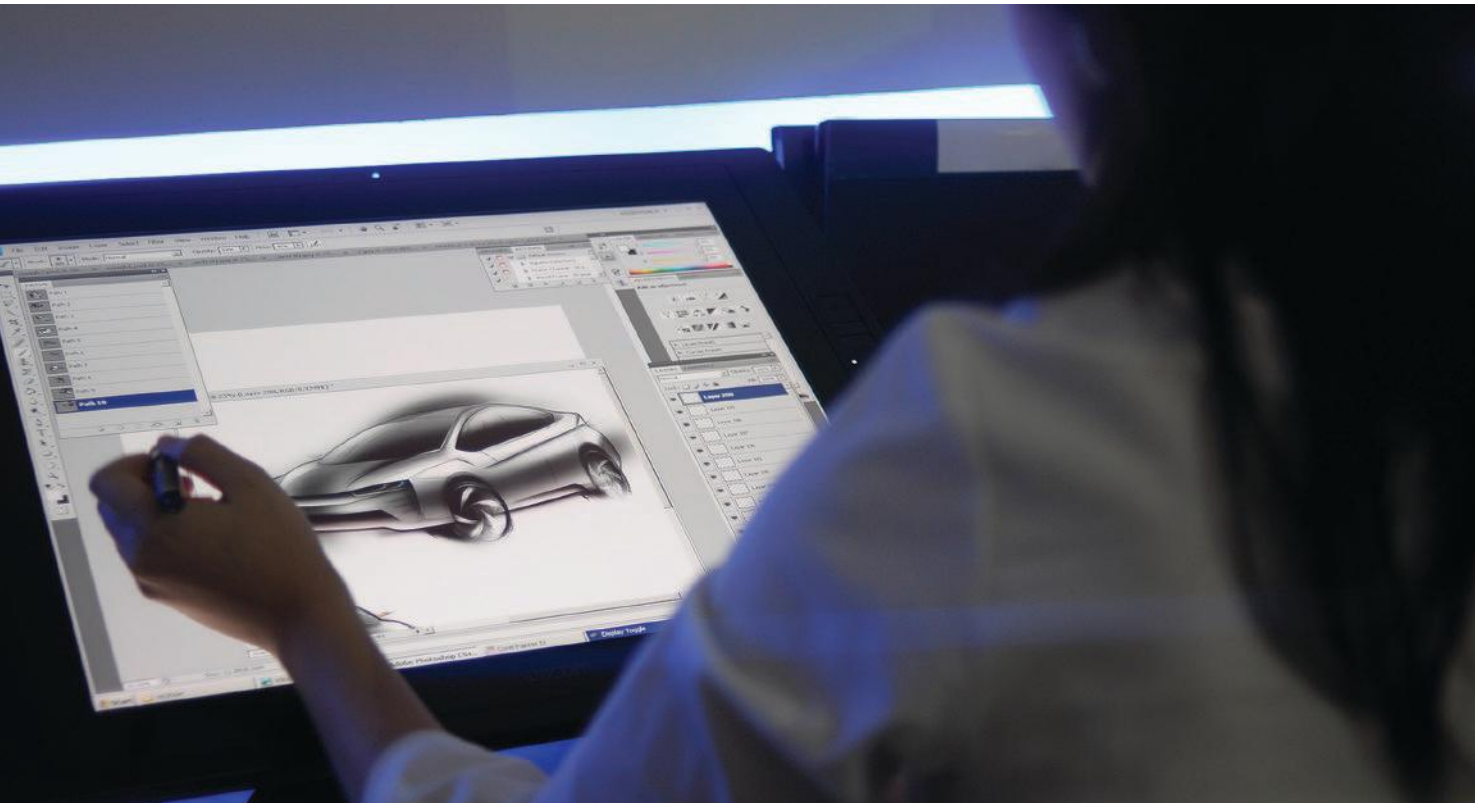


Figure 1.7 Will the car's design meet the elements of the design brief?

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

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 constraints are related to the design process. They are: time, budget and quality of resources.
- Design criteria are specifically related to the outcome; that is, quality of outcome, user behaviour, user benefit, maintenance, safety, purpose, aesthetics, **ergonomics** and so on.

Design inspiration

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

Initial design ideas

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

This 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.

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.

criteria
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)

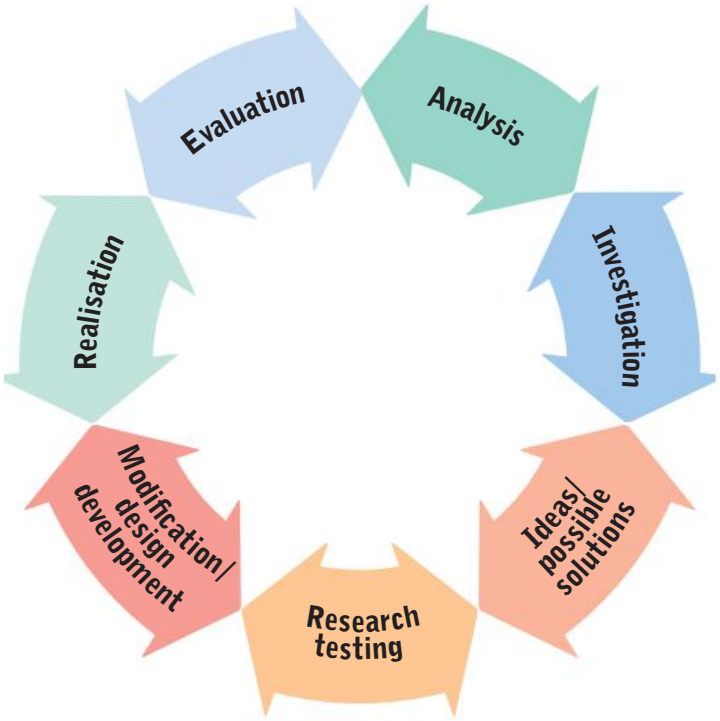


Figure 1.8 A design process wheel

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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.



Figure 1.9 A barbecue design

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.

ACTIVITY 1.3

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

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.

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CASE STUDY 1.3

Design processes used by HSV to design a car

The HSV product group is a team of senior HSV management who create the design direction for future car model programs. The CEO, head of styling, head of sales, head of engineering and the future product planner are all members of the product group. The future product planner liaises with Holden to provide the group with Holden's direction for their models. Decisions made by this group include styling of body, wheels, interior, equipment levels and power levels. Through a process of continual feedback and evaluation between engineering, styling and product group, a base direction for the future model is created. This base direction is usually settled on approximately three years prior to production and can continually evolve as the program progresses.

Body design

Holden will usually supply HSV with a body in white (new model body shell) and all 3D CAD models for use in designing body and interior components. The head of styling creates sketches of designs to be reviewed by the product group. Several sketched designs are usually chosen to go forward to clay modelling. HSV has its own clay modelling studio with four staff. The studio staff take the design sketches and create a full-size clay model. Usually two designs are built at once and are constantly reviewed and finessed by the product group. During this design phase, all applicable Australian Design Rules, such as body height, ramp angles and tyre coverage, have to be considered. When the acceptable clay design has been settled on by the product group, the HSV components of the clay model are digitised and converted to a 3D CAD model suitable for working with Unigraphics modelling software. This model is then handed over to the HSV engineering department. The engineer works with a CAD operator to design mounts, hardware, etc. to secure each body component to the Holden core body of the 3D model. Once these designs are completed, the HSV purchasing department locates a source for a limited run of pilot parts. The supplier uses the HSV CAD models and drawings to create the pilot components and supplies them to the HSV engineer. The engineer uses these pilot parts to assess their functionality and make any necessary changes via the 3D model. In some cases, a second or third set of pilot parts may be required before a final design is settled on. When the final design is settled on, a prior production approved part (PPAP) is ordered from the supplier. If the PPAP is entirely correct, the engineer signs off on it as the final design. This part is stored at HSV for use as the guide to which ongoing supplies of the part can be compared, to ensure all received parts are the same as the original.



Figure 1.10 An HSV

Chassis design

HSV's direction for **chassis** design is to have performance nature well-mannered enough to be driven daily under all types of conditions. Chassis testing usually starts out with fitting new evaluation parts to the current model as the new model cannot be tested in public. Holden will give HSV engineering access to new model pilot vehicles at the Holden proving ground for test purposes. Many different combinations of components and settings are trialled until a set of components complementary to each model is settled upon. During this process, the engineer has to consider any impacts on the Australian Design Rules ground clearance and braking performance. Aesthetics also play a part, as the design intent is to have an aggressive stance. After the hardware selections have been made, calibrations for features such as ESC, traction control and ABS have to be developed. HSV does not have the ability to develop these calibrations by itself and will use the assistance of companies such as Bosch and Delphi. In some cases vehicles need to be

chassis
the base frame of a car

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sent to Europe for testing and evaluation. Once all calibrations and hardware development have been settled, extensive proving ground testing is required to ensure the vehicle meets HSV's intent and its customers' expectations for characteristics such as handling, braking, and tyre and brake wear.

Powertrain design

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

Many different factors are involved in **powertrain** development, such as performance, fuel consumption and emissions, driveability and even exhaust sound. As HSV's product is a GM-based product, HSV's powertrain engineering group usually looks at what combinations have been successful and popular performance-wise in the United States. In many cases, HSV **drivelines** are derived from GM's performance brands. Direction is given by the product group on power and torque levels deemed necessary to be competitive in the performance market. Once the expected power levels are settled upon, it is then up to the powertrain engineers to select a cost-effective means to achieve this goal. The engineer will assess what is available within the market and evaluate whether it will package into the future model structure via CAD. Once these **parameters** are met, several drivelines will be ordered and fitted to the current model chassis for evaluation. To do this, components such as mounts, exhaust systems and cooling systems all need to be developed.

drivelines
everything in the powertrain excluding the engine and transmission

parameter
a limit or boundary that defines work

Once developed as far as possible in the current chassis, these drivelines are then transferred into the future model pilot vehicles for extensive proving ground testing. In conjunction with this, a program of dyno engine development is undertaken, creating base engine calibrations. As these calibrations are completed, they are applied to the pilot vehicles and further refined to reflect power and torque levels and fuel consumption emission levels required. Many different types of air intake and exhaust are tested, all requiring differing calibrations, until the final combination of components and calibrations is settled upon. Once the correct driveline is settled upon, HSV will then liaise with Holden to have the selected drivelines and components fitted at the Holden vehicle assembly plant.

Electrical design

The product group informs the electrical engineer of the features and options required by the model. Some of these features may be Holden features that HSV wants to integrate into its models. In this case, the engineer will need to liaise with Holden to ensure these are fitted during the Holden assembly phase. Dedicated HSV electrical features will need to be designed and fitted by HSV. The engineer takes the concepts proposed by the product group and conducts feasibility studies on whether they will be compatible and cost-effective. After passing these parameters, the concept is taken to the design phase. The engineer will work with a CAD designer to design mounting hardware for modules, harness routing, etc. The engineer will also liaise with Holden to integrate as much of the wiring into the Holden harnesses as possible so HSV production do not have to intervene into the wiring system too much. Most components fitted at the HSV plant will have a plug on the harness ready to go. Again, much time is spent on calibrations for park sensors, side blind zone sensors and reverse cameras by the engineer and supplier.

Interior design

The interior engineer receives direction from the product group and head of styling in regard to style, materials and colours. The engineer will liaise with the supplier on seat foam design to ensure the design intent of a sport-type seat is met. Materials and designs need to be assessed for **durability**, etc. Once designs and materials are settled upon, the engineer will liaise with Holden to have the HSV interior trim fitted by the Holden assembly plant. Another responsibility of this engineer is interior and exterior badging. Again, direction from the product group and styling are required.

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

Source: Andrew Purcell, HSV

ACTIVITY 1.4

Consider the number of different designers involved in the process described above. 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 Find three organisations that support designers.
4 Write a design brief that you think may have been given to 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 Volkswagen Beetle.

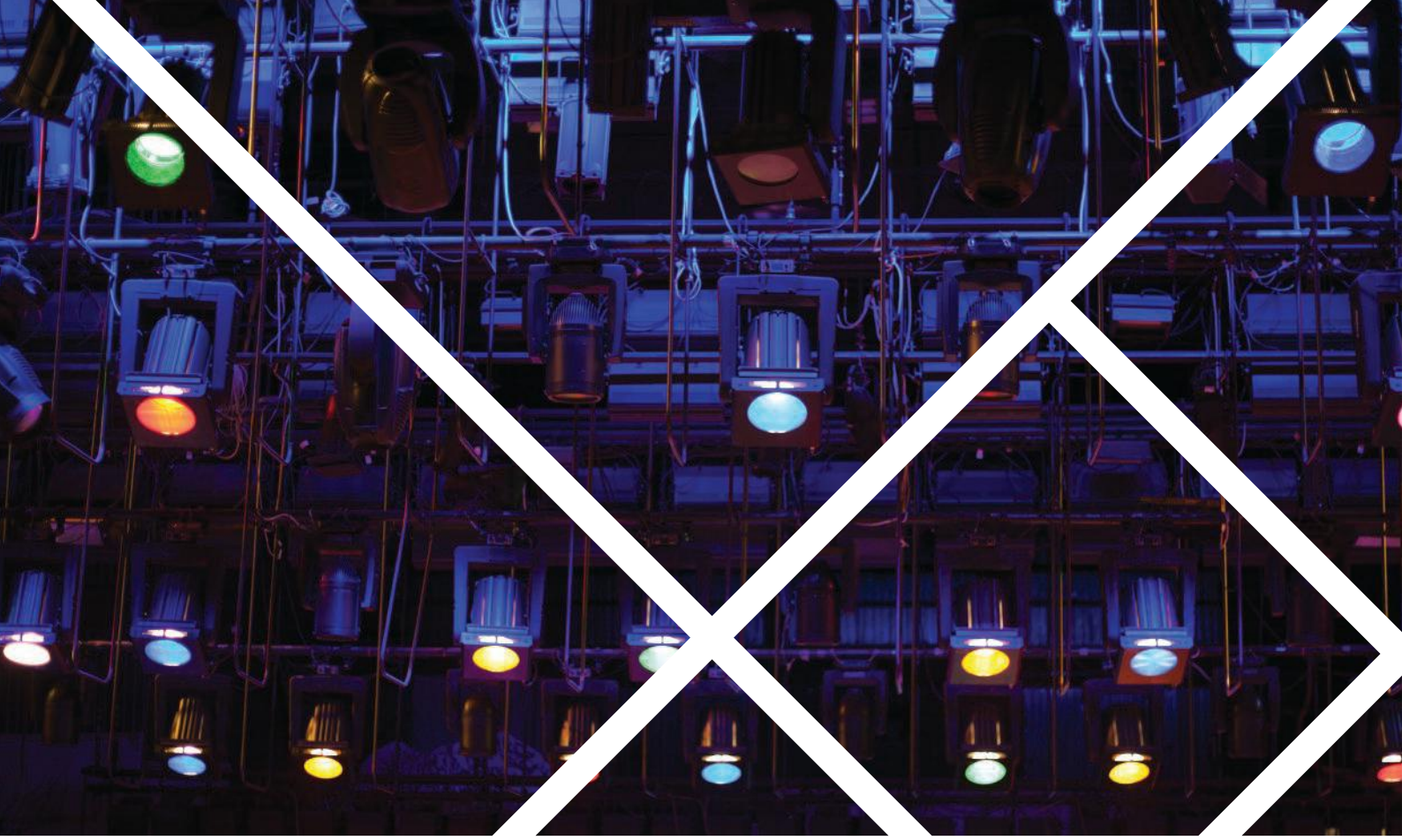
Extension tasks

1 Consider your bedroom. Appraise its functional and aesthetic qualities. Use sketches to show how you would improve these aspects of your bedroom.
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 1.11

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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 and industrial 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 be born 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.

Generally speaking, 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.

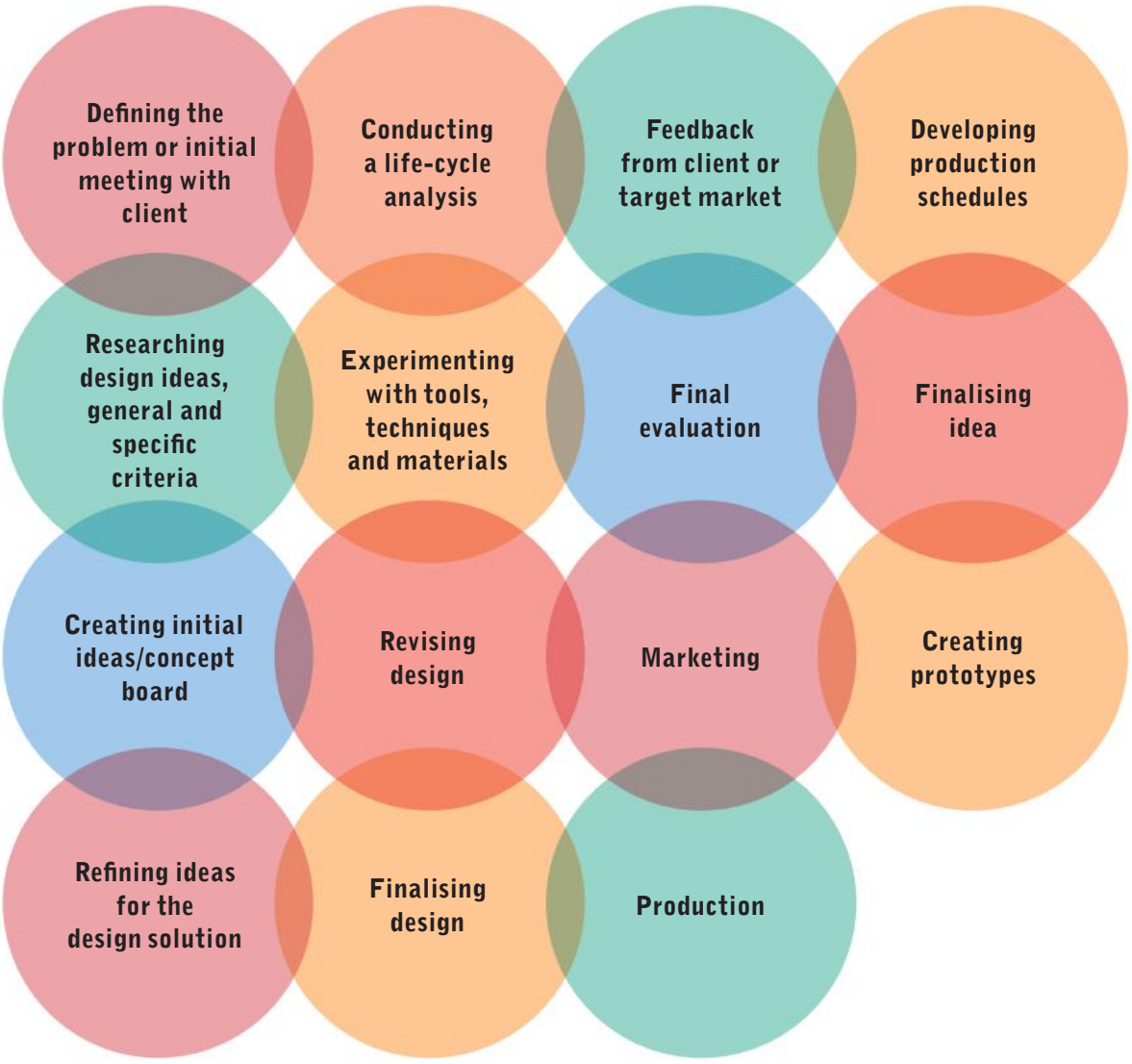


Figure 2.1 Stages of the design process

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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



Figure 2.2 Community gardens are becoming more popular.

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 quite basic and suited to a domestic setting. For example, Jessica Mckenzie, director of Pretty in Pink, which produces retro-inspired clothing and accessories, began her production from home. Initially she was able to meet client demand working independently. However, successful sales at Paddington and Bondi markets in Sydney have led to the expansion of her business and she has had to employ others to assist in the production of her bags. Dinosaur Designs began in a similar manner, working from home and selling the products in the local markets (see http://cambridge.edu.au/redirect/?id=122).

Community settings

'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.

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.

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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.
- Project management: Software, including project-management tools, spreadsheets, databases.
- Marketing: Media such as TV, radio, print and the internet.



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

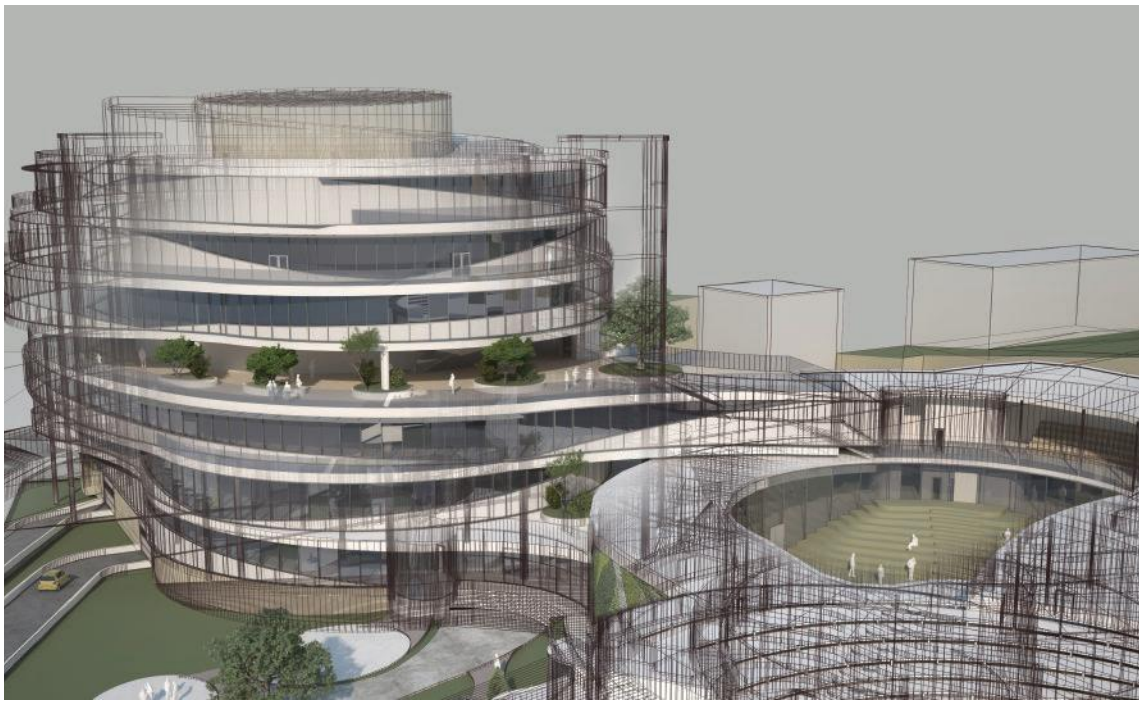


Figure 2.4 Architects use wireframe modelling.

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

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

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

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

Technology used in production processes

Different design projects employ different machinery. Machinery is critical in developing designs; it allows for efficient and effective production (e.g. a wood-turning **lathe** or an industrial sewing machine).

Using the designs produced in **computer-aided design (CAD)**, rapid prototyping scans sketches and produces a 3D **prototype** of a product based on the measurements and coordinates 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.

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.

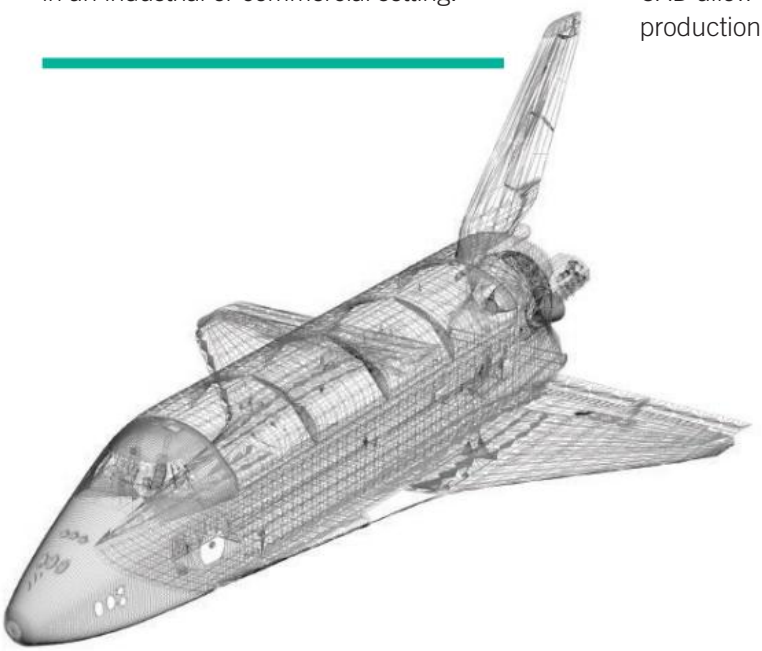


Figure 2.5 CAD allows for elaborate drawings.

Benefits of using technology in design and production

Technologies benefit the design process in numerous ways.

Project management has simplified considerably the storage and transmission of information since earlier days. Such information may include supplier and client records, inventory and financial records; that is, a budget, time and **action plan**. Project management has allowed this information to be readily accessible, and faster and easier to work with. Relevant information is immediately available to all people involved in the project.

Developments in communication technologies have impacted enormously on the potential for instant 24-hour contact between designers and clients, breaking down barriers of distance and time. This allows for collaborative work across different continents, 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.

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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 devices that monitor internet users. Many businesses today operate entirely online.

A further consideration of the benefit of technology in the design process is 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, 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 (RSI), also called **occupational overuse syndrome (OOS)**. 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 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.

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.

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

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

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



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The design process in a commercial setting

CASE STUDY 2.1

Lighting design for theatre: *The Dissolving Self*

Alexander Berlage is a young emerging freelance lighting designer from Sydney. He shares with us the processes that were undertaken in the design and production of the lighting for the play *The Dissolving Self* at Carriageworks, Sydney.

Development of the need

Brink Productions, along with Carriageworks and the National Institute of Dramatic Art, commissioned the creation of a new play to be performed at Carriageworks. The new play, called *The Dissolving Self*, was to be devised by the actors, playwright Susan Rogers and director Chris Drummond (artistic director of Brink Productions). Set in the luminal space of an airport waiting lounge in an unspecified location, the play explored the ideas of transition, reflection, change and hope.

The design team consisted of Jacqui Schofield (set designer), Becky-Dee Trevenen (costume designer), Gemma Rowe (sound designer), Tom Hogan (composer) and Alexander (lighting designer). To create the world of the play, Jacqui Schofield designed an airport waiting lounge set, which included a 6-metre-high and 12-metre-wide window made from hundreds of strands of fishing line framed by nine tall pillars, as well as a beige tiled floor, waiting-room chairs and a lone vending machine. To document and present her design, Jacqui drew numerous plans using CAD software to detail the layout, make-up and dimensions of her set as well as a fully rendered 1:25 scale model (see Figure 2.6).



Figure 2.6 1:25 scale model for *The Dissolving Self*. Set design by Jacqui Schofield. Photograph by Becky-Dee Trevenen.

As the set had already been designed by Jacqui Schofield – following her own process of research, idea generation, experimentation, evaluation and refinement – the next stage was the creation of a lighting design. The purpose of a lighting design for a play is not only to illuminate the set and the actors inhabiting the set, but also to work in harmony with the set design to create mood, movement and further establish the world and its time and place.

The design brief

To create a lighting design for the production of *The Dissolving Self* at Bay 20, Carriageworks, Sydney.

Constraints

When designing the lighting for this production, Alexander had to always keep in mind the many constraints that would affect the realisation of the end product. These included factors such as the budget, the available resources and equipment, time and labour.

First of all, there are the constraints of what is logistically and technically possible in the venue. One of the first actions Alexander took when he started considering his design for this play was to examine the technical specifications for the theatre at Carriageworks. Every theatre normally produces a technical specifications document that details the constraints of the venue. This includes what equipment is available, how much power is able to be used, guidelines for rigging any lighting or set elements in the theatre, as well as any other information that is deemed relevant. From looking over this document, visiting the theatre and speaking with the venue technical manager, Alexander was able to establish the parameters for design.

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The venue had a fairly small stock of lamps for the size of the theatre, let alone the scale of the set for the play, yet it had the power available to be able to cope with a greater number of lights. It became quite clear, early on, that hiring additional lamps would be necessary. Another constraint to be considered therefore was the budget available for hiring and purchasing extra lighting equipment (such as additional lamps, dimmer racks, 240-volt cable and coloured gels) to realise the design. After further testing, experimentation and idea generation, the design team would then have to spend time negotiating with suppliers such as lighting hire companies to work out what the production could afford and what cheaper alternatives could be substituted to achieve the desired effect.

Time was also a major concern when it came to planning the realisation of the lighting design. There is no point designing a lighting rig that is impossible to install with the available time and crew. A large factor for consideration was that as soon as the team had access to the venue, known as bump in, there was very limited time until the deadline of opening night. With the limited days in the venue also came the constraints of the time and hours that the team was allowed to be in the venue each day. The installation crew had to keep within the restrictions of the Media, Entertainment and Arts Alliance (MEAA) Award.

Research and design inspiration

One of the earliest stages of the design process for a lighting designer is to start discussions with the director to find out what their motivation and vision are for the show. Alexander spoke at great lengths with the director, Chris Drummond, about how he envisioned the setting of the play and how it would flow over the duration of the piece. It was established that the play was best set in the transition from night to sunrise, to emphasise the themes of change, transition and hope.

With the launch pad of the play, the set design and his discussions with Chris, it was time for Alexander to start doing his own research to find inspiration for the lighting design. As the play was set in an airport waiting lounge, Alexander started his research by visiting an airport one night. He sat and examined both the architectural lighting and the natural light that made its way through the many windows of the terminal. He took a lot of photos of various locations in the terminal and small elements that he discovered, constantly evaluating what it was that he found interesting about them. He was particularly drawn to the beauty of the lights of the runways and opposite terminal blinking and shining in the distance.

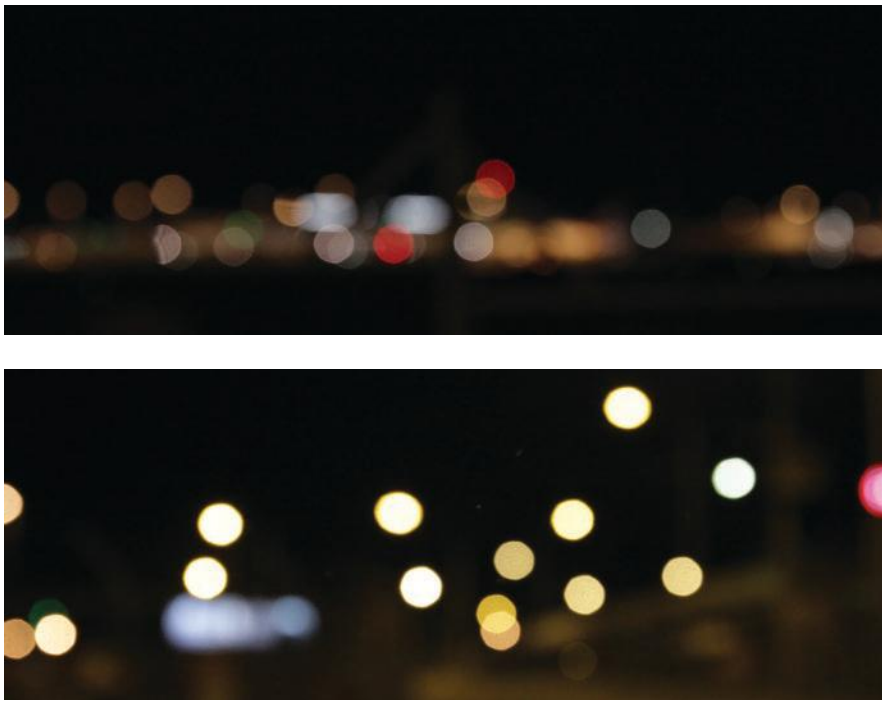


Figure 2.7 Reference images for *The Dissolving Self*. Photographs by Alexander Berlage.

Following this trip to the airport, and visits to a few other airports, Alexander started to collate a folder of reference images, annotating those that he found the most interesting or relevant to the play (see Figure 2.7).

Testing and experimentation

After spending time researching airport lighting and considering the themes and world of the play, Alexander started to workshop the idea of the distant runway and terminal lights further. He set up some tests in a theatre with various types of lights and different coloured gels. Through the testing process he came to the conclusion that the best way to achieve the look of the distant lights was to set up a structure constructed out of scaffolding pipe with numerous PAR 64 lamps gelled in various different shades of yellow, amber, red and green (see Figure 2.8). The team also found that if they used a material called black wrap they could vary the size of each light source by creating a smaller hole for the light to come out of the front of the lamp.

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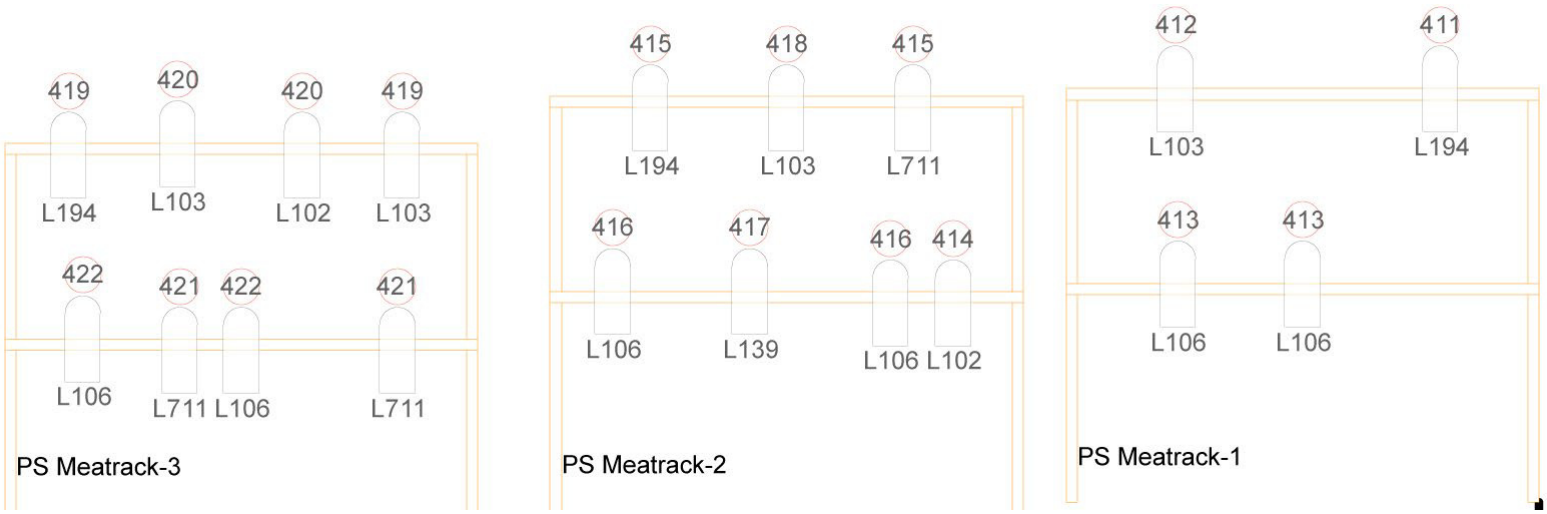


Figure 2.8 Preliminary drawing of airport light structure

Alexander also took time to conduct some tests with coloured gels to see which ones looked the best on the scenic samples of the set that Jacqui had created and some samples of the costumes that Becky had designed.

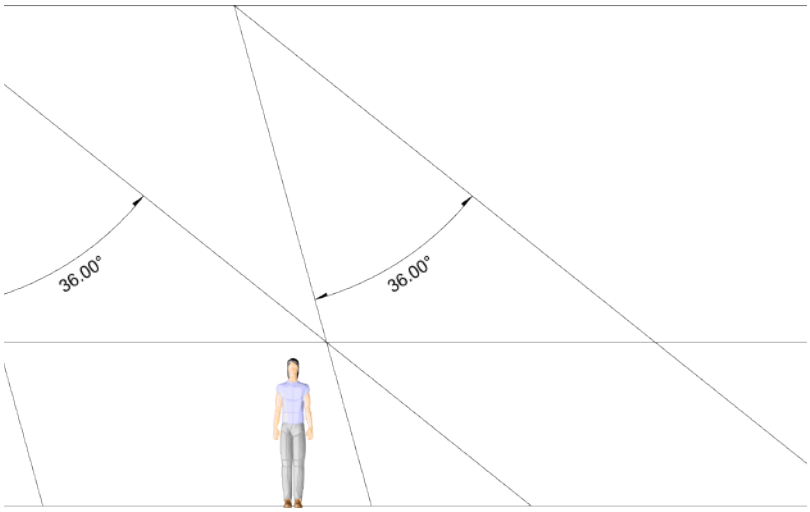
As well as experimenting with creating images such as the exterior airport lights, watching rehearsals for the play also helped further educate the progression of the design. From observing rehearsals he was able to find more information about the world of the play and the movement that happens within the play (the blocking). Lighting design for theatre is very much responsive to what happens in the rehearsal room.

Another key stage of the testing and experimentation phase was working out the possible positions and angles of lamps in the grid. Alexander drew up a range of sections and elevations to help him figure out what beam angle was best for each focus as well as working out where each lamp needed to be positioned in the lighting grid to be able to achieve a consistent light wash across the stage with no dark spots (see Figure 2.9).

tungsten lamp a lamp in which light is produced by a tungsten filament heated by an electric current

As the team reached the final weeks of rehearsals, they drew closer to being able to finalise the equipment order. Final negotiations with the hire company took place to see what they could do within the budget. Because the lighting grid was not easily accessible, and the work was still constantly evolving and changing, it became clear early on that there would need to be a certain degree of flexibility in light focus that only a light with a moving head could provide. Moving lights are more expensive than conventional **tungsten lamps** such as profiles, fresnels and PAR cans. The final design ended up using a moving lamp called the Source Four Revolution, as it provided the ability to move the position of the beam, iris in to get a smaller beam of light, shutter to create focus shapes such as squares and rectangles, and the ability to change colour. Alexander considered these factors to be the most important in selection of the cheapest moving light possible.

Figure 2.9 Example of sections and elevations used for *The Dissolving Self*



Refining the idea

Once all the idea generation, experimentation and testing were complete, Alexander was able to start drawing up the final lighting plan using a computer-aided design program called Vectorworks. Each lamp on the plan was allocated a position, a gel colour and a channel number (the number that the lighting designer references when they want to turn the light on). Alexander used the knowledge and discoveries

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that he evaluated as being suitable for the production to inform the drafting of the plan. One of the most important things in the lighting design process is good, clear and concise documentation of plans (see Figure 2.10).

Following the completion of the drawn lighting plan, the final order was placed with the hire company that prepared all of the equipment for bump in. During bump in, Alexander not only helped install the lights, but also had to oversee the realisation of the design. This included calling the focus, where the lighting designer leads the crew in pointing each lamp at its designed position for the show, and plotting the show, where the lighting designer, along with the director, sculpts the progression of the show through lighting cues, deciding and programming on the lighting console which lights turn on when and how long it takes for each cue to take place. For this production the lighting desk used the ETC Ion, as it is a very user-friendly console and has a great interface for working with moving lights.

Presentation of the final product

Skip ahead to opening night, and Alexander managed to design the lighting for the show, which not only remained within the constraints of budget, equipment and time, but also created the halfway world of the airport waiting lounge. Through constant evaluation, discussion, experimentation, testing and documentation, the lighting design for the production was realised (see Figure 2.11).

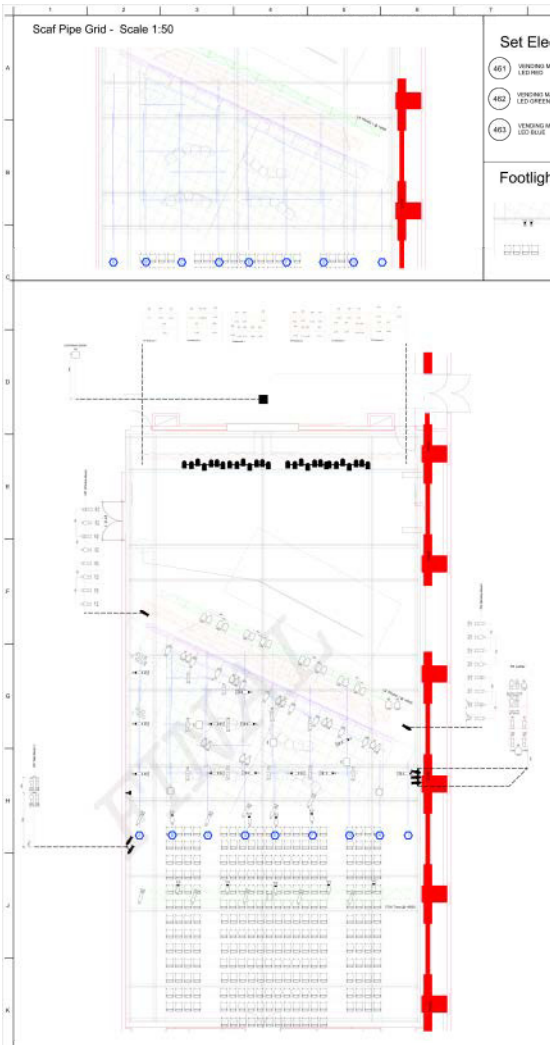


Figure 2.10 Lighting plan from *The Dissolving Self*

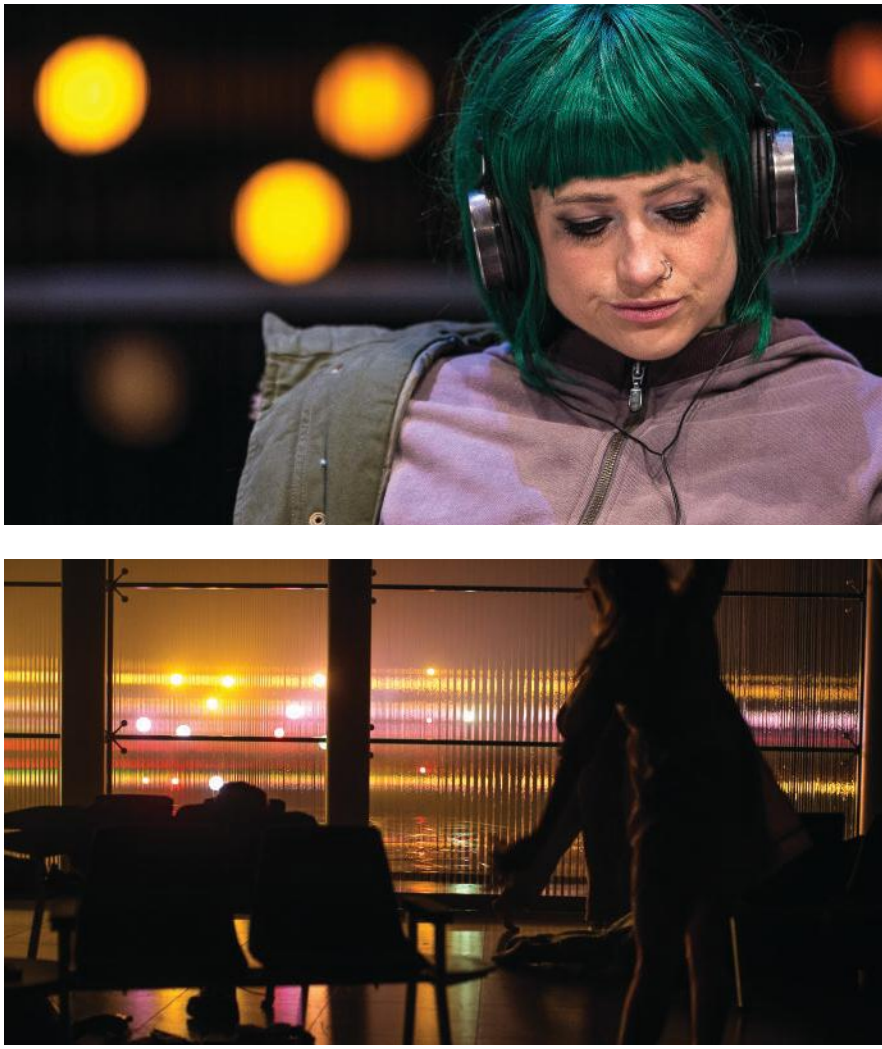


Figure 2.11 Production photographs from *The Dissolving Self*. Photographs by Mark Nolan, set design by Jacqui Schofield, costume design by Becky-Dee Trevenen.

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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 local people or interested parties within the local community.
  - Industrial settings: large-scale production, using a large number of people in the production process and a variety of manufacturing techniques and machinery.

Chapter summary tasks

1 Define the terms 'production process' and 'design process'.
2 For a design project you have undertaken and a designer you have studied, complete the following:
   a In a table like the one below, list the steps involved in the design and production processes.
   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 designer. Explain the differences.
3 Discuss the importance of effective communication between the design and production teams. Give examples to support your answer.
4 Explain how the design process would be different if a need were identified by a client and not from personal inspiration.
5 'Designers are better off using machinery instead of humans.' Discuss this statement.
6 Evaluate the role of pilot runs and prototyping. Why are they an important part of the production process? Provide examples to support your answer.
7 Describe technologies that designers can employ during the project-management stage.
8 Discuss the importance of designers documenting their idea development. Provide specific examples.
9 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.

Technologies used in the design process	Technologies used in the production process

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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

As designers, we need to be aware of the impact on an 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 an 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 social networking site like Instagram may have on an 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 Instagram

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	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. • You can group photos and videos through hashtags. • You can leave comments or like particular photos or videos.	• Other users can try to contact you 24 hours a day. • You cannot control access to some personal information and photographs that other users put on the site. • You can be exposed to undesirable people or online predators. • As certain users can see some of your activities on the site, as well as photographs, you can lose your privacy. • As you can see the activities of other users on the site, you may develop social insecurities if your messages or photos/videos are not liked. • You can develop addictive behaviour, or dependence on the site. This may lead to loss of personal time, and the replacement of face-to-face relationships. It may also detract from study and work time. • You can become a victim of online bullying. • Other users can leave negative comments, upload inappropriate material or send abusive messages. (Bullying behaviour also extends to blocking, removing and isolating users, such as creating an event to which the victim is not invited.) • 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 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 be conditioned to use Instagram, which can lead to changes in social behaviour and etiquette. 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	• Instagram 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.	• Instagram uses a range of quickly developing technologies, such as computers and smartphones, which may encourage materialism, become obsolete quickly or add to landfill.

Table 3.1 What are the advantages and disadvantages of Instagram?



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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 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. 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 artwork in graphic design, for example, may be considered taboo.

ACTIVITY 3.1

For each technology listed below, 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:

- plastic bag
- light rail
- solar power
- hearing aid
- mobile phone.

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 and try to minimise their carbon footprint, through changing production practices or replacing materials with more sustainable alternatives.

	Cause (Why did this happen?)	Effect (What has happened as a result?)
Individual		
Society		
Environment		

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ACTIVITY 3.2

1 What is sustainable design?
2 Find five examples of sustainable design and describe what makes each of them sustainable.

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 WorkCover, Standards Australia and work health and safety (WHS) guidelines. For example, use of MDF should be eliminated in schools and asbestos should not be used in building sites because of the negative health consequences of these materials.

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**.

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.

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.

Equity

Designers must strive to ensure equal accessibility to their product, system or environment. The less able, minority groups or those suffering from 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.

appropriate
suitable for an occasion or use

hazard
anything that can potentially cause harm or loss



Figure 3.2 Some materials have less of an environmental impact than others.



Figure 3.3 Designers must consider equal opportunity.

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CASE STUDY 3.1

How the fashion industry is responding to environmental concerns

sustainable fashion the movement promoting an environmentally sustainable fashion industry

As Australia's industry body for **sustainable fashion**, Clean Cut works to bring about greater awareness and celebration of the future of Australian fashion: a future that looks amazing, and is also fair, environmentally sustainable and socially aware.

Formed by a collective of ethical and environmental fashion advocates, Clean Cut provides online resources, events and industry consultations to support fashion lovers, designers and labels as they make choices towards fashion that is truly fair.

There is no doubt there is a lot of bad practice and misinformation out there. Clean Cut believes the best way to make a difference is to promote the good work being done, to celebrate the achievements of our industry and to set the sustainability standard, by example.

Source: Clean Cut Fashion, http://www.cleancutfashion.com/about-us

Clean Cut supports:

- environmentally sustainable materials
- fair trade and fair working conditions
- low or no waste production
- transparency
- directional design and systems.

Sustainable fashion is all about being able to enjoy fashion with a conscience. It is fashion that thinks about the impact it is having on the natural and social environment for the long term. This means considering everything from manufacturing processes and fabric selection to ethical working conditions for the people who help produce it.

It is all about making sure that fashion can be enjoyed into the future, while protecting the environment and respecting the many people who work to produce the garments we enjoy on a daily basis.



Figure 3.4 Clean Cut celebrates ethically designed fashion with its inaugural Designer Showcase.

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ACTIVITY 3.3

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.

ACTIVITY 3.4

Visit *Australia Innovates* on the Powerhouse Museum website (see http://cambridge.edu.au/redirect/?id=124). Choose three innovations that you think address social issues. Evaluate the design and production processes used in these innovations.

CASE STUDY 3.2

Genetic testing

The area of genetic testing continues to develop. It is expected that in the near future parents will be able to predict their child's future health, height and even eye colour before the baby is conceived. The technology creates digital embryos by mixing the DNA of a woman with possible sperm donors, simulating how two people's genes may interact during reproduction. The purpose behind this development is to prevent a baby inheriting genetic diseases. However, the technology may have ethical repercussions. It is expected that this technology will give us much information that we will not know what to do with, and perhaps would rather not have.

Read more at http://cambridge.edu.au/redirect/?id=123.



Figure 3.5 Genetic testing might let parents predict their child's appearance before birth.

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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 to show the impact that the internet has had on individuals, society and the environment.
2 '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?
3 How does the production of a plasma TV impact on society and the environment? Consider each step in the design and production processes.
4 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?
5 Develop and discuss your own strategies that industries can undertake to ensure the conservation of natural resources.
6 Outline some of the health and safety issues that impact on the design of a skateboard ramp.
7 Explain the importance of community groups.
8 Why do you think the design of a product or system should take equity into account?
9 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?

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 or e-waste? Outline possible ways to reduce e-waste.



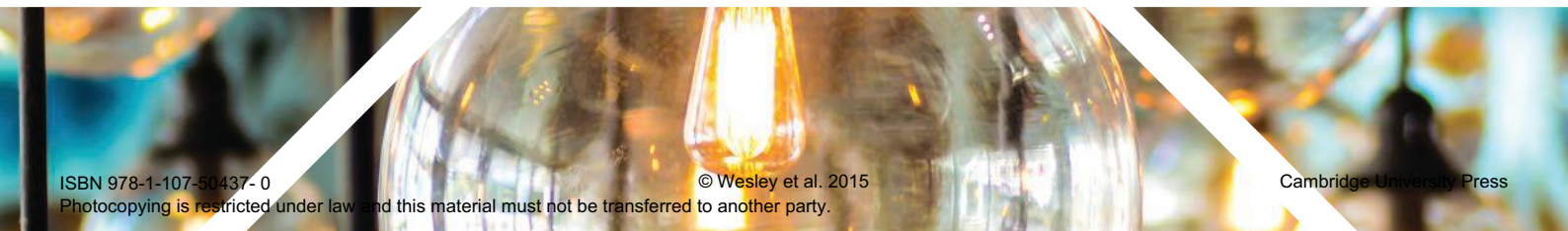
Figure 3.6

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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 involve you in quality assessment as well as the production of something different. While you are thinking creatively you will be constantly critically evaluating the validity of your ideas.

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.

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.

We aim to:

- 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.

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ACTIVITY 4.1

Compare and contrast the lists of actions for creative and critical thinking given on page 34. Why do you think there are similarities and differences? Do you consider your strength is in critical or creative thinking? Why?

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.

CASE STUDY 4.1

Designer profile: Ellie Bradley

The creative force behind the Xavier & Me products that inspire home furnishing in Australia is Ellie Bradley. She provides us with an excellent example of how a successful designer employs creative and critical thinking to solve problems. Her response to the problem of sourcing the bright bold designs she craved led to the development of a successful home furnishing company.

Ellie first worked in advertising, and here enhanced her creative flair through her association with design agencies, photographers and stylists. After the birth of her son Xavier, Ellie was able to further develop this talent as the owner, creative director and designer of her own business. She is wowing the market with her soft furnishing, textiles and rug design house. Her products reflect her passion for colour and design. She epitomises the ability to seek new ideas and not be bound by traditions or expectations.

Creative thinking about design forms the foundation for Ellie's products. She has described how she lies awake at night thinking about how she would use a pattern, imagining it as part of the furnishings in a room, what colours would enhance the impact, and how these would relate to fibre and fabric. The colours, images and materials are the crucial factors of her designs. Design development begins with a mood board, reflecting her thoughts and ideas. The designs are initially presented as paintings or vector-based artwork. With colour as the focal point, Ellie will create samples with different colours, until she is satisfied the design is ready for production.





Figure 4.1 Xavier & Me designs

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Bright, fun and bold, too; those three words, exactly, were a-going through our Creative Director & Designer Ellie Bradley's mind, when she first dreamed up the concept and theme for this, her colourfully chic interior design line. Neutrals be gone, subtracted right on out and shooed only because Ellie knew she was going to have to leave ample amounts of space and room in this design equation for the addition to fill *your* rooms, too, with nothing but the brightest and fun of bold patterns and hues. But just how would Miss E go about making this colour-drenched dream she came up with a reality? Why with the inspiration of her son, Xavier, the 'X' in this here design equation.

And where did she start proving this colour seeking theory and mission? Well, it all began with one simple cushion vision. See, Ellie just couldn't seem to find the right, bold cushion design. Looking absolutely everywhere, to no avail, she decided right then and there that she was going to design, create and make her own to sell. And that's just what she did (and is doing) oh so very well. Now designing absolutely everything on this site, from cushions to rugs, always with colours so bright; with almost every piece from Xavier & Me being made locally, here, in Sydney; with the exception of the actual making of all the rugs which are made with nothing but love from and in India.

Source: Xavier & Me, http://www.xavierandme.com

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

lateral thinking
using creative or unexpected thinking to solve problems

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

ACTIVITY 4.2

1 Conduct a PMI on each of the designs shown in Figures 4.2 and 4.3.
2 Sketch a design for a bed that you believe would be an improvement.
3 Ask a friend to do a PMI on your design.



Figure 4.2 An antique cast-iron bed frame



Figure 4.3 A modern bed design

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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.

ACTIVITY 4.3

1. Form a group of three to five students. Select a student to record the suggestions.
2. For five 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?

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.

ACTIVITY 4.4

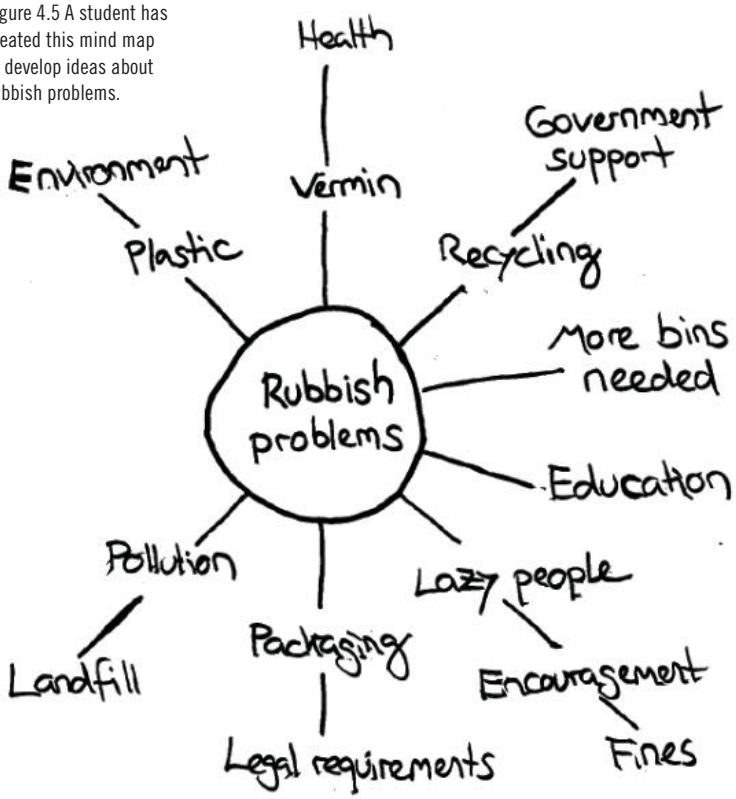
Draw a futures wheel to illustrate the consequences of using up the world's supply of crude oil.



Figure 4.4 A student has created this futures wheel to investigate the consequences of an increase in world population.

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Figure 4.5 A student has created this mind map to develop ideas about rubbish problems.



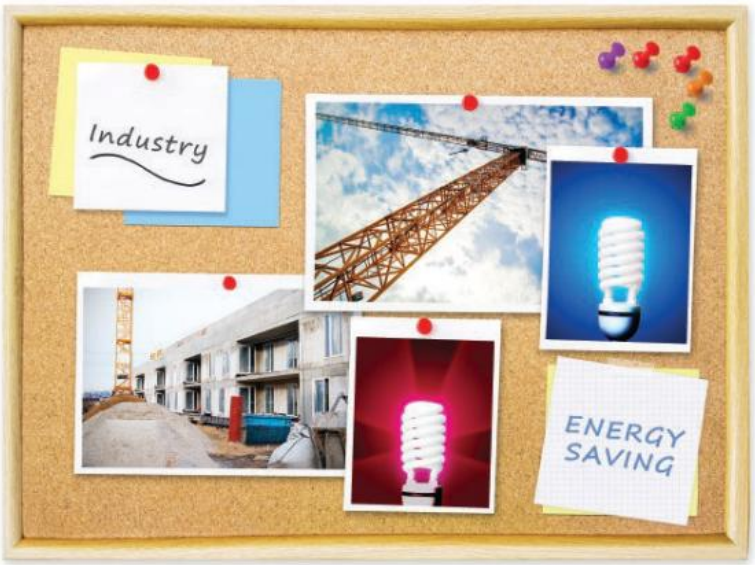


Figure 4.6 A concept board

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

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 4.5).

ACTIVITY 4.5

You have been asked to consider all the factors that affect the design shown in Figure 4.7. Draw a mind map to plan your response.



Figure 4.7 A mountain bike

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.

ACTIVITY 4.6

1. Develop a concept board to illustrate the concept of poverty.
2. Use your concept board as inspiration to design a cover for a book titled *Make Poverty History*.

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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 really 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 more 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

Designer profile: Dirt Art

Dirt Art is an Australian business specialising in all facets of recreational trail and mountain bike facility consultancy, management, design and construction. The team of experienced bike riders is dedicated to designing and constructing recreational bike trails of the highest standard – world-class trail infrastructure that is both sustainable and enjoyable for users.

Figure 4.8 Dirt Art specialises in the design of bike trails.



The design and construction of successful mountain bike trails and infrastructure relies on inspired and creative design. Dirt Art trails are designed and built by elite-level riders to suit all rider abilities from young families through to world-class athletes. Our trails 'flow', providing ultimate user enjoyment and minimum ongoing maintenance. Dirt Art pushes the boundaries of traditional design methods whilst delivering projects with the highest standards in sustainability.

Source: Dirt Art, http://www.dirtart.com.au/about

Rob Potter of Dirt Art is a keen mountain bike rider who has been involved in designing many new challenging trails in Tasmania. Rob's experience means that he has theoretical understandings of riding the rough terrain that is required to create a challenging experience for the huge customer base of mountain bike riders. The Tasmanian natural terrain is an ideal place for his work.

It is important that mountain bike trails do not damage the natural environment, so Rob will work with an expert to advise about the flora and fauna consequences of a new trail. When designing the trail at Mt Stronach in north-east Tasmania, he surveyed the area with Anna Povey, a botanical consultant. Anna advised about any threatened species that might suffer from the building of a trail. They walked the trail together and discussed any issues that might arise. Dirt Art takes natural values seriously. Not only does Rob consider the damage that a trail may do to the pristine environment but another issue is to ensure that bikes do not bring in any unwanted species. Rob also has to consider machine access for the building of the track through the steep granite.

Dirt Art has an in-house design team capable of producing a full range of 2D and 3D CAD designs for a range of pump tracks, dirt jump facilities and related infrastructure.



Figure 4.9 Hornsby Mountain Bike Trail

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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, letters and faxes.

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 4.10 Professional designers often collaborate on projects.



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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!

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, is clear on their responsibilities and that the project stays on track.

ACTIVITY 4.7

You have been asked to organise a design team to create an educational computer game suitable for children aged from five to 10 years.

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 the work of Dirt Art. List the different strategies you think the business would employ to fully develop its ideas for a new bike trail. Compare them with the strategies you think Ellie Bradley might use in developing ideas for a new product.
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.



Figure 4.11

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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 relevant 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.

One of the best ways 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 your 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.

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.

target market
the sector of a market that a product is being produced for and marketed to

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, which assist you to shape your design in a certain direction.

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.

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Figure 5.1 A table lamp

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. 'the lamp must be made of stainless steel and jarrah').

jarrah
a durable hardwood from eucalyptus trees

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

ACTIVITY 5.1

Assume the role of a designer. You have been employed to design the pool area of a client's home. The client wants furniture on which to sit around the pool and wants to adopt a Balinese theme. Draft a set of functional and aesthetic criteria that you can present to the client before progressing with your designs.

When designers start working on a design brief for a solution to a particular problem, they will also be considering the materials to be used and the processes that may be required. This is not a separate process, but one that 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 a pool? Do they have two cars?

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 following:

- 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.
- The garage should have internal access.

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 Barangaroo precinct.

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CASE STUDY 5.1

Barangaroo

In 2003 the New South Wales Government made the decision to redevelop the site now known as Barangaroo. The area's stevedoring operations were to be moved to Botany and so the East Darling Harbour would be transformed from a working harbour to a new urban precinct. In 2005 the government launched an international urban design competition to source ideas and concepts that would underpin the transformation of Barangaroo.

The criteria set by the brief was listed as:

- provide a minimum of 50% new foreshore parkland for the people of Sydney
- enhance the growth and positioning of Sydney as the premier business, cultural and living centre of the Asia-Pacific region
- activate the site with a combination of working and recreational uses
- incorporate the New South Wales Government's public foreshore 14-kilometre walkway from Woolloomooloo to Anzac Bridge.

A total of 137 entries were submitted and five finalists were selected and required to submit further designs and models at a presentation to a selected jury. Technical assessments were made on engineering, cost planning, heritage, traffic and transportation and commercial office planning. The next group of submissions were assessed on vision, contextual response, functionality and deliverability. The jury unanimously selected the proposal by Hill Thalis Architecture + Urban Projects, Paul Berkemeier Architects and Jane Irwin Landscape Architecture as the winner of the East Darling Harbour Urban Design Competition.

The winning designer's statement

This scheme will give Sydney a great new western precinct. The design will:

- bring the city back into contact with the harbour
- make a generous new public realm that completes the layout of the city, creating multiple connections and linkages

Figure 5.2
The Barangaroo site, 2014



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- form a new relationship between the city centre, a public foreshore and the water's edge, creating a vibrant new place for all Sydney
- provide new harbour-front parklands; with a multitude of places, landscapes and opportunities to engage with the water's edge
- give Sydney a great new street, that complements Macquarie Street; defining the western edge of the city and ensuring that the extensive parklands will remain as inalienable public lands in perpetuity
- create public places and public rooms, to bring vitality and equity for all the people of Sydney, as well as special intimate spaces that engage with local neighbourhoods
- generate a vibrant new city quarter, accommodating working, living, commerce and recreation within a generous and dignified public domain.

The design draws on an understanding of the site, its physicality, history and contribution to Sydney's development.

This is a sustainable project, fusing environmental, social and economic concerns to create a world-class place for Sydney. It is able to be flexibly staged and delivered, in response to changing public expectations, civic requirements, social needs and market pressures.

It is a design that will create a great public legacy for Sydney, and future generations.

Source: East Darling Harbour Urban Design Competition, Stage 2 Jury Report, March 2006, p. 6

Conduct an internet search for Barangaroo and study the development. Do you think that these ideals have been met?



Parameters and other specific criteria can offer you assistance: by helping define certain (often practical) key themes or requirements they leave you free to take them and put 'your own stamp' on the project – to use your individual creativity. When a teacher gives a class specifications to design a lamp, each design student in the class would add their own interpretation on this, their own flair. This interpretation can be classified as criteria, or factors the project must live up to.

ACTIVITY 5.2

Identify the general parameters that a toy designed for a child aged 0–3 years would incorporate.

Figure 5.3 A child playing with blocks

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5.3 Producing functionally and aesthetically appropriate design projects

Function and aesthetics are two elements that are closely associated. 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.

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.

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 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.



Figure 5.4 Umbrellas

Now let's consider aesthetics. If the umbrella is for a woman, she may want to choose a product that is fashionable or matches other items she carries, such as her handbag. If the umbrella is made to appeal to a child, it might be decorated with a cartoon character or elements children identify with as being fun.

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. Using the internet, research the Skybed and come up with three functional criteria and three aesthetic criteria for the success of the Skybed.

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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**.

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

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

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 internet, the Australian Bureau of Statistics (ABS) and chambers of commerce. Even the local phone book may prove useful for finding out what similar businesses there are on a local level.

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

Always remember to correctly source any secondary research used and obtain permission to use data and information.

Segmenting the market is essential in the identification of the **demographic** with which you will be seeking to identify your product. Examples of the different categories that might be relevant in defining the market include:

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

- 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 research is not done thoroughly and the product designed 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.

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. All these aspects need to be taken into consideration. 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.

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 they would see it as too expensive.

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 radio or press advertisements. Have you identified your target market? Will they relate to your product? For example, would you find a young adult promoting pensioners' insurance believable?

How the competition's products are distributed from place to place is an important

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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? These are some of the important questions that need to be answered.

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.

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.



Figure 5.5 A graph analysis

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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 such trends as changes in real income per capita, the changing income distribution between the classes and changes in other economic figures, such as interest rates and the cost of living.

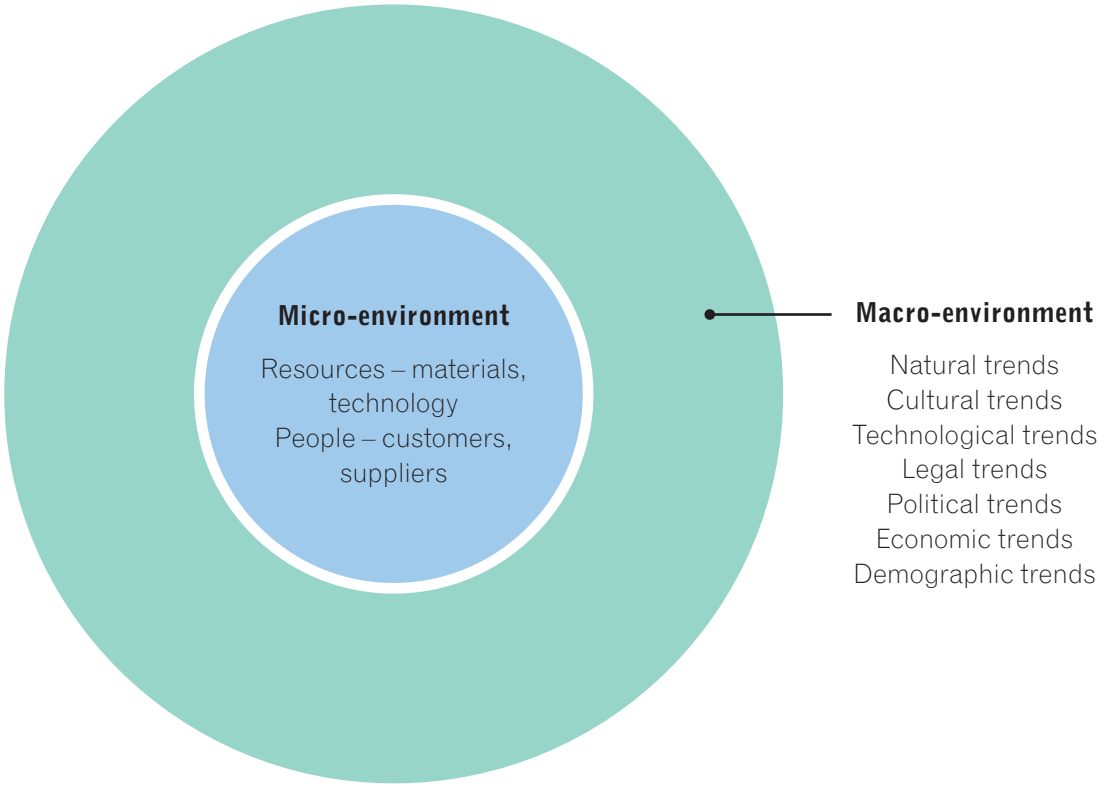
3 **Natural environment trends** include natural resources that are included in production or that are affected by marketing activities. Natural environment trends include shortages of raw materials, the increased cost of energy used in production and transport of goods, increased levels of pollution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

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 dress acceptable.

Figure 5.6 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 swimwear 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 appliances 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? Describe the marketing techniques used to promote a product that you believe is well marketed. Create a marketing strategy you would use to sell the idea of buying a trip to the moon in 2050.



Figure 5.7

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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.

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 – of the materials to be used and the processes undertaken
- availability – this can impact on timing for you and if the supplier is out of stock
- equipment and expertise needed – access may have constraints, such as time, distance and cost
- appearance – colour, texture and so on
- characteristics – strength, durability, workability and so on
- environmental issues – energy use, waste, production process, recyclability and so on.

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.

If your project is to design a new set of boardshorts, you would not look at metal finishes or the various thicknesses of acrylic sheets; you would look at fabrics, including textures, weave, colours, patterns, cuts, pockets, stitching and so on. When dealing with fashion, colours and societal trends are also factors. This is clearly an example where you can use some common sense, where your own knowledge base can assist you in narrowing down the materials you could select.

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

credible
valid and reliable

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Figure 6.1 High-grade stainless steel is the material selected for this yacht winch because it is strong and will resist corrosion.

Your research helps you refine this further. Perhaps you have checked the clothing label of your favourite pair of boardshorts and discovered they are made out of polyester. Further research on the internet and talking to manufacturers will help you discover that the majority of boardshorts are made from a similar material because it is the most appropriate (the best at achieving the result you are looking for). In this case, the fabric is lightweight, does not absorb water, is fast-drying and can be cleaned using domestic laundry detergents. (Boardshorts that had to be dry-cleaned would not appeal to the target market.) You would also need to consider how the boardshorts are used. Asking surfers what they look for in boardshorts will enhance the chances of selecting the right materials. Choosing the right fasteners and fittings is just as important in developing a design. Using a steel buckle instead of Velcro might be an unwise choice. This might be common sense, but little details like this can turn a good design into a not-so-successful one.

The same approach can be applied to tools and techniques. If you are designing a pair of boardshorts, you would examine sewing machines and overlockers, not electric drills, and sewing techniques, not welding skills.

ACTIVITY 6.1

You have been commissioned to design a range of outdoor furniture suitable for use in a domestic backyard. What characteristics will need to be considered when selecting materials? Remember that you will need both resistant and non-resistant materials for this project. How would the materials change if the environment in which the furniture was to be used was different; for example, the beach, pool or in a public park? Would the methods of construction be the same? Establish criteria for each of these settings and discuss from your own knowledge what might be suitable materials. What testing might be needed?

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. They also need to take into consideration the most suitable technologies available.

In your project work, you will need to consider your own skills when deciding which 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

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Figure 6.2 Boardshorts generally contain polyester.



Figure 6.3 Maximum flexibility





Figure 6.4 Steel fastener vs Velcro

to your teacher in relation to this, as they can assist in helping you to develop the skills you may need.

Your production processes will be determined by the available technologies. In industry this may influence the design and production of a designer, as they do not have unlimited resources at their disposal either. 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.

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 respects their **intellectual property** as well. This is important in your role as an ethical designer.

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.

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

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6.2 Justifying and explaining the selection and use of resources

ACTIVITY 6.2

Do a PMI (plus, minus, interesting) on the choice of colour for each of the children's life jackets shown in Figures 6.5 and 6.6. From this PMI, suggest what colour changes or design enhancements may be made to improve the safety function of the jacket. How would the life jacket's storage or location (small boat, aircraft, ocean liner) affect the colour and design? Would there be differences if the life jacket were designed for an adult? Research the changes in life jackets over the last 100 years, and describe how technological and legislative changes have influenced the designs.

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 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 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. 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.

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.

Justifying and explaining are processes that continue through the designing, 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.



Figure 6.5 An orange life jacket



Figure 6.6 A blue life jacket

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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.

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.

So how could this proficiency be achieved? Here is an example of how a student might go about developing proficiency. A student decides to design a lounge chair for a specific space. They have some ideas on what a lounge chair should look like and have conducted the research about the materials most suitable. In the early stages of design, the student has used freehand sketches, but to be more accurate they need to learn to use some drawing software. They spend some time learning to use the software and come up with some detailed drawings. These drawings require specific parts of the lounge to fit together using a timber frame and vinyl fabric stretched over the frame. This is a complex process that requires multiple new skills to be learned then applied together. The student has experience working with wood from previous years in the workshop. But the fabric seat needs to be upholstered with vinyl and the student has never before used this fabric (the material), a staple gun (the tool) or applied staples to fabric (the technique). This student spends some time working with their teacher, reading magazines and looking on the internet for information. This is invaluable, but upholstering using practice materials is proving to be frustrating. Contacting a furniture maker and asking them for some tips changes the way



Figure 6.7 A student learning to weld

proficiency
a high degree of skill or expertise

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Figure 6.8 Designers do not always possess the skills needed to make a product. Some skills, like upholstering, may need to be outsourced or learned.

in which the resources are to be used. They suggest making some jigs to assist with the processes and make it safer to use the staple gun. With the expert assistance, practising the techniques and developing confidence in using the tools, the student is able to create the lounge chair to the specifications required, thus demonstrating proficiency. The student keeps all the sample test pieces of fabric to help document how their skills have improved until they have achieved the desired quality. In this case, it means neat edges, no creases and rows of staples neatly arranged. The student also keeps the safety test sheet and operating instructions to demonstrate that they have passed their safety requirements (met the proficiency standards) to operate the staple gun. They then ask the expert to assess their work to confirm proficiency.

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.

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.

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.

Figure 6.9 What skills and knowledge would you require for these two different bags?





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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, WorkCover 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. WorkCover 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. For further information, see http://cambridge.edu.au/redirect/?id=125.

As a responsible designer, you are required to implement safe work practices when designing and producing, both to protect 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.

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 (see http://cambridge.edu.au/redirect/?id=126).

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

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

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

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

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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 6.10 The placement of signage helps create a safe working environment.

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 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.
- 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.

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Chapter summary tasks

1 Describe two ways you could research the properties of a material.
2 Investigate what materials are commonly used for boardshorts or swimsuits.
3 Where would you find information on correct sewing techniques to make the costume seen in Figure 6.11? How would the sewing techniques be different from those needed to make the boardshorts?
4 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.
5 Explain the term 'appropriate' in relation to machining techniques. Be specific for three different materials.
6 Why is colouring a design factor when developing safety equipment? Justify your answer.
7 How can we develop proficiency in the realisation of design projects?
8 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.
9 What is the difference between an Australian Standard and a code of practice?

Extension tasks

1 Earlier in the chapter, we learned that polyester is a suitable fabric for boardshorts. Investigate the properties of water-resistant fabrics used in swimming and recreation. Justify why each would be most suitable for its intended use. How have technological changes and societal needs influenced the use of these materials? Quote your sources of information.
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.

Figure 6.11 What sewing techniques have been used in the creation of this costume?



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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 (such as architects) often inherit these boundaries in the design of building 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 be blamed in the case of an accident involving the handrail.

Do not be afraid of constraints; they often guide us and 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 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 the following:

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

In the establishment of their parameters, the designer may still inherit a set of limitations, but they can then decide on what extra parameters they want to add. These specific parameters will 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.

ACTIVITY 7.1

Your client has asked you to design some packaging for a DVD. 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.

As you have learned, criteria can be identified and assessed under two headings: functional (how it operates) and aesthetic (how it looks). A simple way to decide what criteria your project must attain or live up to on completion is to write the parameters and 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. In identifying the criteria for the evaluation of a design project, you give yourself a set of rules that, together with the parameters you have established, 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 reason 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.

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Design parameters	How is this going to be evaluated?
Must use recycled timber only.	Visual check of the timber to determine whether it has been used before. Determine source of the timber.
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 colonial decor of the home where it is to be placed.	Compare the table to other furniture in the house and ensure it has the same style.

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

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

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.

Figure 7.1 A sports bag



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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 on automatic pilot. 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. 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 write down the processes you would need to use to make a chocolate cake.

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, to be expected and 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 not 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 complete 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.

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.



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Figure 7.2 Friends discussing their plans for the day

ACTIVITY 7.4

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

Briefly describe all of 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 and how much money to take. 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 of the decisions, list the criteria that may be considered when evaluating that decision.

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

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.

ACTIVITY 7.5

1. Look at the historical development of the iPod on the Apple website (see http://cambridge.edu.au/redirect/?id=127).
2. Construct a timeline showing all the design improvements in the music devices you have used over the years. You could use Dipity (see http://cambridge.edu.au/redirect/?id=128).
3. Explain why you think these changes have occurred.

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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.

Computers are one example of this. For the individual, work-related injuries from prolonged use of computers can be seen as a negative impact. Society has questioned the long-term effects of excessive computer use when it comes to obesity and antisocial behaviours. The ever-increasing amount of landfill that discarded computer hardware creates is starting to cause a real problem. Designers need to look at incorporating recyclable plastics into these products and manufacturers need to develop effective recycling programs.

ACTIVITY 7.6

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

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?

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 product that is not **biodegradable**. Could you substitute this product with a recycled material or one that will break down over time?

When assessing the impact of your designs on society and the environment, you should try to ensure that your positive column outweighs 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.



Figure 7.3 Biodegradable alternatives have less impact on the environment.

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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.

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, then 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.

CASE STUDY 7.1

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 waste water 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. The Plan is designed to encourage councils to create a more exciting and sustainable community. Its goals are designed for the suburb of Chippendale but can be adapted to other suburbs and cities. It aims to:

- cut household and business bills for participants by over 3 million dollars by 2015
- reduce council operating and capital costs for Chippendale by 5 per cent by 2012
- ensure Chippendale is at the forefront of goals to meet the objectives and targets of Sydney City Council's 2030 Vision
- trial demonstration projects for houses, units, buildings and roads
- trial vertical gardens and pop-up median strip gardens, maximising space available for planting

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- lower energy, water, transport, food and health bills and demonstrate affordable solutions which may be adapted throughout the City of Sydney and elsewhere
- trial pop-up cafes to attract business to the area and create a flexible approach to grow the birth rate and life of businesses
- cut air pollution by 2015
- cool roads, reducing the damage caused to human health and vegetation from car pollution and dangerously hot roads by 2015
- cool the suburb in summer by up to 2°C by 2020
- reach modest goals in stages over 10 years to 2020 (based on original 2011 targets)
- annually review data from trial demonstration projects and, if no longer necessary by 2020 cease to operate
- support commercial urban farms producing organic vegetables and fish
- achieve a united approach by agencies, using their pipes and wires to help cool roads
- increase practical knowledge in the community and Council about achieving sustainable communities
- make annual changes based on data reviews
- achieve a sustainable suburb by 2020
- provide a roadmap and a high benchmark for more sustainable suburbs in Sydney and across all local government areas in Australia.

Source: The Sustainable Communities Plan, http://theplan.sustainablehouse.com.au/introduction

At the time of writing, some councils have taken on the challenge. You might like to do some research and see what, if any, changes in behaviour have been influenced by The Plan.

Read Michael Mobbs' blog (see http://cambridge.edu.au/redirect/?id=129).



Figure 7.4 Michael Mobbs in his garden

ACTIVITY 7.8

You are a landscape designer. Your client, who lives in a drought-affected 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 7.5 A drought-affected lawn

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Chapter summary

- Parameters are welcome 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. This may include choice of materials, style, texture, colours and so on.
- Before undertaking the design and construction of any design project, have a look at 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 continuously as you work through your project.
- Evaluate on a continual basis. Remember you have to justify every decision you have made.



Figure 7.6

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 computers 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 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** 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. 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'.

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 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

When we embark on a project that involves the combining of 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 that it 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.

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CASE STUDY 8.1

Charity fashion show

Sometimes we are asked to organise a fundraising event for a specific charity. If you have ever been involved in such an event, you will know how crucial good management is to its success. One group of school students organised a fashion show to raise money for WWF Australia (see http://cambridge.edu.au/redirect/?id=130), a group whose mission is to halt the degradation of our planet's natural resources and preserve our life-support system – the environment.

The selected charity made it easy to decide on a theme – an environmental theme with the latest eco-fashion. A list of key personnel was made – show producer, backstage manager, publicist, model coordinator, sponsor, sales manager and so on. Some students already had some of the needed skills through drama production, others had contacts in the fashion industry, while for other students it was a steep learning curve. Job descriptions were written and the key management team decided on a timeline and designated meeting times to ensure everything was on track. A checklist and Gantt chart were developed to ensure that everything would be ready for the set date.

Once the theme was determined and the knowledgeable team developed, the venue had to be chosen. It would determine the time of the show and the crowd capacity. The students were fortunate that the school hall had the necessary features – lighting, sound and backstage area. Soliciting sponsors and clothing was done through the school newsletter, with a student creating the graphics, and the response was impressive. A fashion designer came forward to advise and local boutiques offered clothes. Hair and make-up services were offered by a group from the TAFE college. A model competition was held one lunchtime and students were selected to model the teen clothes. A parent who worked in the fashion industry offered to find five adult models to volunteer their time. The management team monitored all this. Items were ticked off on the checklist, and adjustments were made to the Gantt chart.

Four weeks before the fashion show, the sales manager organised a ticket-selling event and all tickets were sold on the first day!



Figure 8.1 Models walk the runway

Some people were invited guests, including the principal, a local member of parliament, sponsors, a representative from WWF and a local journalist.

A dry rehearsal with substitute models wearing their own clothes was held two weeks before the event and some changes were made to the time sheet and music. A full rehearsal was held the night before the event and the premier fashion show went off without a hitch, thanks to efficient planning.

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 that are needed to complete the project. A brainstorming chart or mind map should be drawn up as a visual guide to all the tasks. It is a useful technique because seeing all the tasks written down acts as a reminder and when completed at a meeting with a group, an action plan can often cover all the required tasks.

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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 if 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.

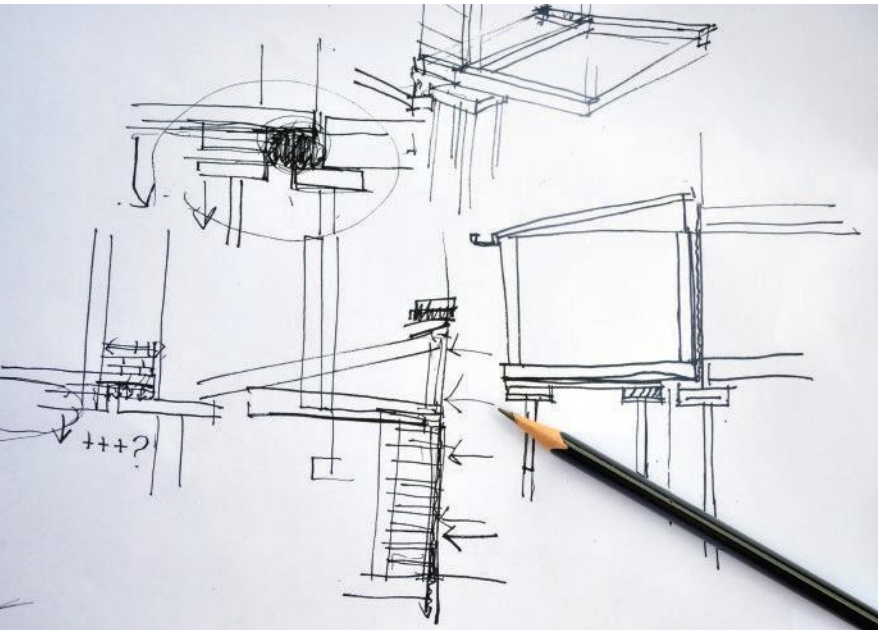


Figure 8.2 Rough sketches in a journal

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 used by a student to assist in the management of her project.

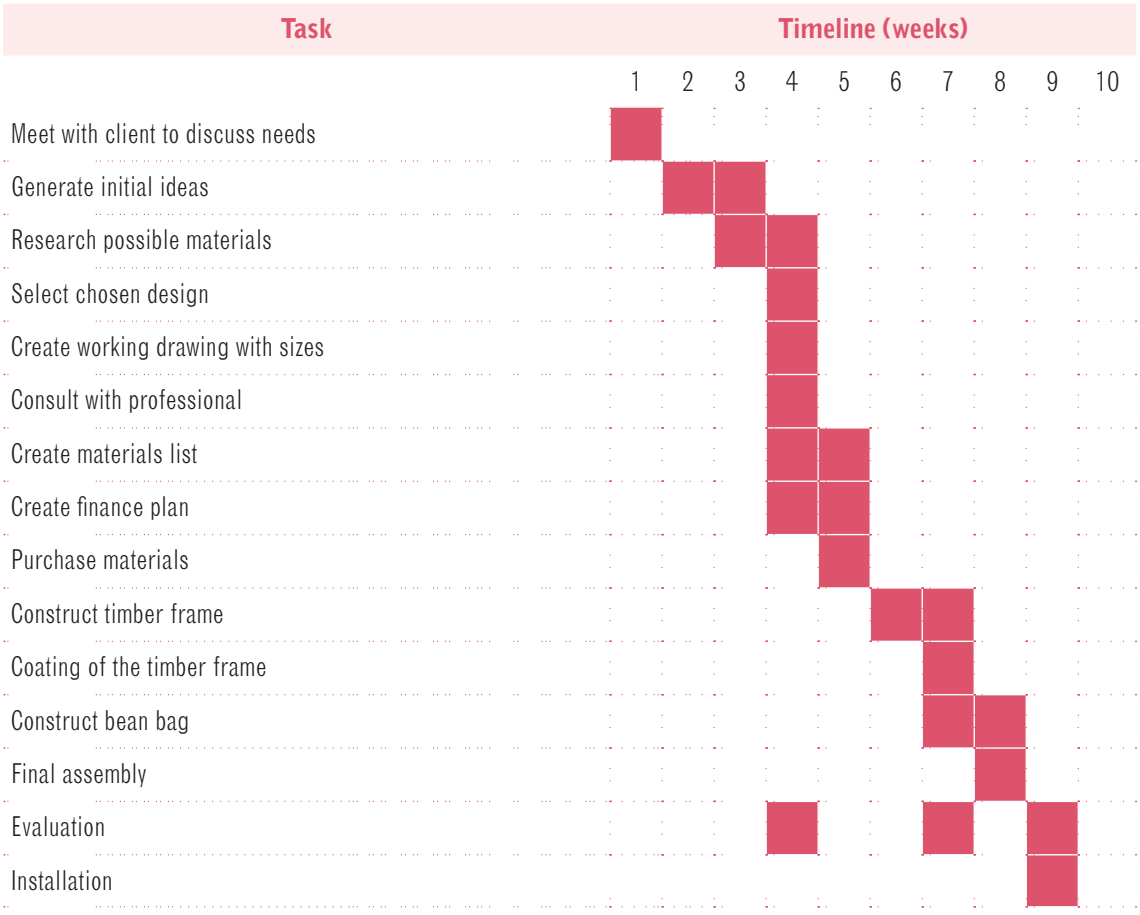


Figure 8.3
A student's Gantt chart

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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.

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, 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.

A designer must be accurate with all costing throughout the whole project 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 made. Often design projects are given a set budget and it is then up to the designer to creatively select the materials and resources needed to complete the design.

ACTIVITY 8.3

1. Set up a spreadsheet to complete the finance plan for a holiday you 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 holiday, use the spreadsheet facilities to calculate how much you will need to save each month.
4. Print out a copy of the completed spreadsheet.

Figure 8.4
Finance plan



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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 to the way 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 above to assist you in your management.

Sound 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.

automation
mechanical controlling of machinery for speed and accuracy

ACTIVITY 8.4

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

CASE STUDY 8.2

Laser Electrical Artarmon

Laser Electrical Artarmon is an electrical and communication contracting company specialising in office, data centre and warehouse fit-out. Laser Electrical Artarmon values sustainable development and design all fit-outs 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. Laser Electrical Artarmon designs and implements solutions for electrical installations; data, voice and communications systems; lighting and building **automation**; and audiovisual installations.

One client of Laser Electrical Artarmon was a listed property fund and development company that decided to create a sustainable office environment in central Sydney. Laser Electrical Artarmon management spent time with these clients to ensure that it understood their requirements before designing an effective solution. Both the client and the Laser Electrical Artarmon designers were aiming for energy efficiency and a functional and attractive workplace environment. Consultation between the client, the builder, the engineers and Laser Electrical Artarmon 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.

Figure 8.5 Laser Electrical Artarmon logo

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Figure 8.6 An engineer using CAD



Figure 8.7 An electrical engineer at work

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.

It was important that these would meet criteria for a 5 Star Green Star rating from the Green Building Council of Australia. To achieve this, the plans included extensive lighting control and energy management.

All the required resources had to be organised by the project manager, ensuring that all products were of high quality with warranty, and that manufacturers' specifications were clear to the electricians who would be building the systems. The project manager ensures that all legislative requirements are followed in accordance with the Building Code of Australia (BCA) Section J.

All decisions are documented in the notes section of the online management system and correspondence is filed physically and on the Laser Electrical Artarmon server. As the job progresses, it is 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 people in Laser Electrical Artarmon can also view the progress of any specific project. 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 fit-out was completed on time and to the satisfaction of the client, but this would not have occurred without comprehensive and capable project management.

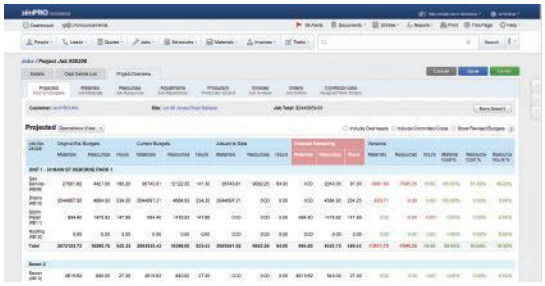


Figure 8.8 The progress of a job can be tracked using software like simPRO.



Figure 8.9 A final fit-out

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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 type 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.



Figure 8.10

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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.

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 mainly 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 20 years, there has been a revolution in the way designers present their ideas. Computers and computer-aided drawing (CAD) 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 had to become very skilled computer operators in order to use this new technology. The computer allows the designer to draw their designs on a flat two-dimensional screen and then convert them into a three-dimensional image. Computers have provided designers with the tools to produce quality drawings, and the ability to visualise designs by creating virtual models and also 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.



Figure 9.1 Pens are common drawing tools.

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

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.
- Projection lines need to 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.

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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.

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.

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 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 (see http://cambridge.edu.au/redirect/?id=131).

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.



Figure 9.2 A computer-controlled automated manufacturing process

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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. CAM links a computer to a machine tool, such as a drill or a lathe. 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 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.

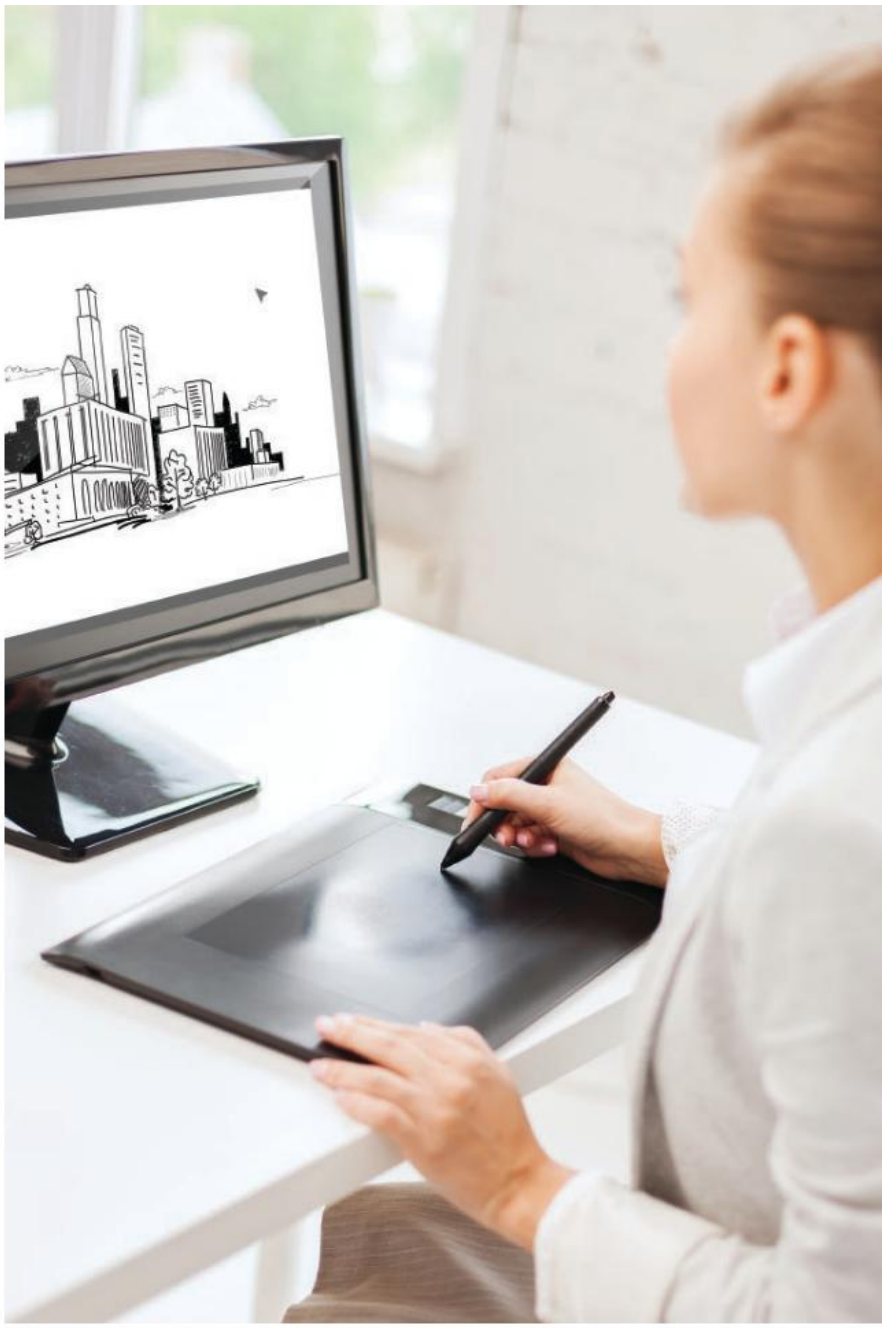


Figure 9.3 Computer-aided drawing

ACTIVITY 9.2

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

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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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.





Figure 9.4 A prototype is usually a full-scale working model and a vital part of the design process.

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 drawings as well orthographic drawings completed, the designer is equipped with sufficient 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

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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.

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 three-dimensional 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.

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?

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.

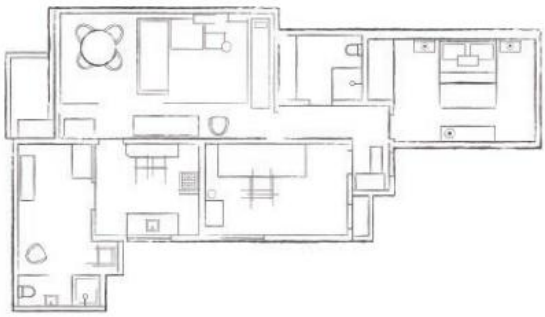


Figure 9.5 A sketch of a floor plan



Figure 9.6 A model of a floor plan



Figure 9.7 A computer-generated image of a house interior



Figure 9.8 Draft plan of a house

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CASE STUDY 9.1

Designer profile: Suzy Tuxen

As a graphic designer, being able to communicate ideas effectively in a visual format is crucial to Suzy Tuxen's work. Not only does she need to communicate her ideas to the client, but her whole aim is to communicate a message to the viewer of her products. She is known for her brilliant designs in signage, note paper, brand identity, packaging, shop fit-outs, illustration and any medium that requires an eye for design and the need for some retro aesthetics. Different techniques are employed for different projects, and the skill and variety make her designs fresh and interesting.

Suzy employs a range of methods to present her ideas, including drawing, photography, 3D handcrafting with paper, and digital processes. She is particularly creative with typography and uses it effectively in many of her designs. In every design, visual impact is key to its success.

Figure 9.9 A poster designed by Suzy Tuxen



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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 so that products can be designed in one country and manufactured in different countries.
- 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.
- Design portfolios 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. Sketch an example of one that appeals to you. Could you employ this method in your project work?
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 CAD and CAM have impacted on the way designers work today.
8. What are British and American Standards?
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. Show it to your class to get feedback on your communication techniques.
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 the light-bulb moments that make our project special and shape 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 successful designs. Getting quality information will shape your thinking and influence the final product if done well.

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)? Getting the right sort of information is part of the justification of designing, as it is often the proof that a design needs to be changed or establishes a need. (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? This will determine the types of research needed. Some suggestions are:

- At the start of the design process, to establish the needs and what is already out there, investigation of existing ideas, target market needs, technology changes and so on.
- Investigation of production techniques and resources to ensure the viability of design ideas and capacity to complete the design.
- Designing possible solutions – investigating aspects of designs, and alternatives. This is where experts and team members bring the ideas in.
- Testing of alternatives before final design is completed – ensuring changes are made prior to the design being released to the market.
- At the completion of the design, to determine design success and potential for improvement.

To provide a foundation for research processes, we will work through a scenario. In this scenario, you have identified a traffic hotspot in your area and wish to design a solution to the problem.

You have visited the local council website and downloaded data from a survey 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 problems.



Figure 10.1 A traffic hotspot in Sydney

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These three research strategies are known as secondary research, because someone else conducted the actual research.

Next you will conduct some primary research; that is, you will gather the data yourself and analyse the results. You plan to observe the intersection and count the cars at specific times of the day over a period of three weeks. You are going to interview the people who live around the intersection. The drivers who pass through the intersection on their way to the local primary school will complete a survey and local councillors will receive a questionnaire. In your interview you will use some open-ended questions, such as 'How do you think we can 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.

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

- twice a day – 40
- daily – 52
- at least three times a week – 62
- weekly – 38
- seldom – 18.

Figure 10.1 Examples of quantitative data questions

How often do you drive through the intersection?	Yes	No
Twice a day		
Daily		
At least three times a week		
Weekly		
Seldom		

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.

ACTIVITY 10.1

You have developed a nutritious snack 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.

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 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.

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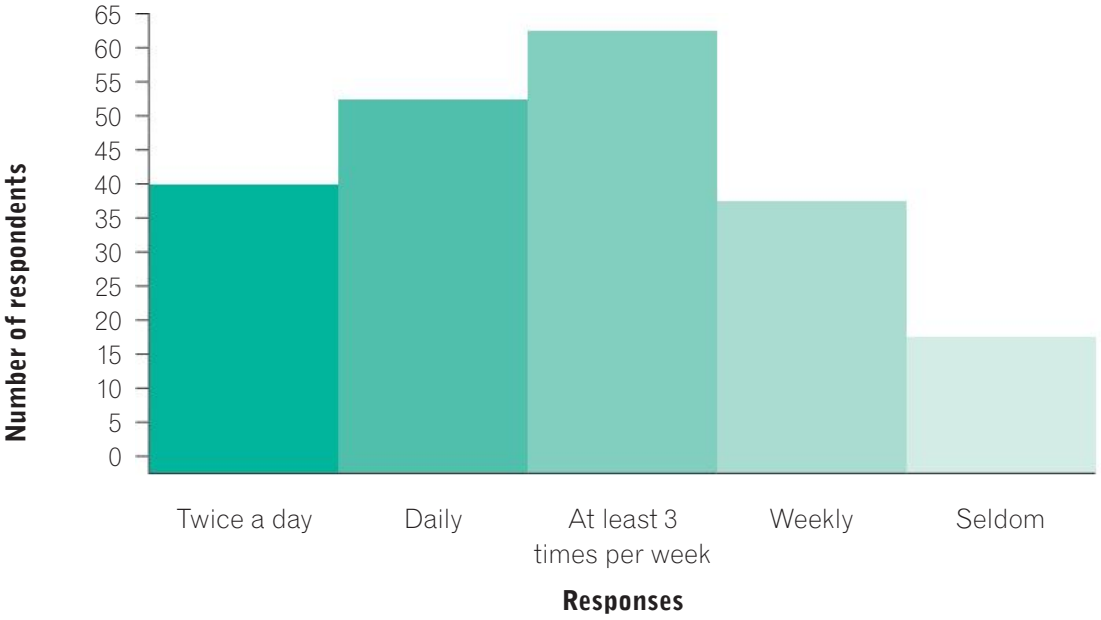


Figure 10.2 Quantitative research is often presented as a graph.

- 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 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, that 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.

ACTIVITY 10.2

You are designing a bag that will protect and provide easier transport of a mobile device. List the characteristics the materials need to have. 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.

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

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Figure 10.3 Students collecting data

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.

ACTIVITY 10.3

You have been employed to design a new social networking site aimed at the teenage market. You plan to conduct some market research with teenagers to find out their views on social networking 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.

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.

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.

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Figure 10.4 Graphs are an effective means of presenting data.

CASE STUDY 10.1

Researching to inform design

Childhood obesity is an issue that concerns Jack. He has noticed a number of overweight 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 comments without support from research.

Jack did some secondary research by visiting the Australian Institute of Health and Welfare website (see http://cambridge.edu.au/redirect/?id=132) and the National Health and Medical Research Council website (see http://cambridge.edu.au/redirect/?id=133) and looking at Australian Bureau of Statistics (ABS) survey data (*4338.0 – Profiles of Health, Australia, 2011–13*). Here he found some statistics about obesity. This is known as secondary research, as it is not his own work.

Table 10.2 Proportion of Australian children overweight and obese in 1985 and 1995 and 2011–12

Boys						
Age	7–11 (NSW)		12–15 (NSW)		8–11 (AUS)	12–15 (AUS)
BMI grade	1985	1995	1985	1995	2011–12	2011–12
Overweight	9.7	11.6	8.8	20.0		
Obese	1.5	3.7	1.9	6.1		
Overweight/obese	11.2	15.3	10.7	26.1	24.8	28.3
Girls						
Age	7–11 (NSW)		12–15 (NSW)		8–11 (AUS)	12–15 (AUS)
BMI grade	1985	1995	1985	1995	2011–12	2011–12
Overweight	11.0	17.2	10.1	14.5		
Obese	1.9	6.3	1.3	4.4		
Overweight/obese	12.9	23.5	11.4	18.9	28.0	24.8

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These data are presented in Table 10.2. When Jack analysed the data, he found that from 1985 to 1995, the level of obesity tripled in all age groups for both boys and girls. In its report, the Australasian Society for the Study of Obesity uses other research to reach the conclusion that, 'regardless of gender the prevalence of overweight and obesity among young people in NSW has risen from 20 per cent in 1997 to 25 per cent in 2004'. This was validated by looking at the ABS data for 2011–12 (*4338.0 – Profiles of Health, Australia, 2011–13*), which showed that the trend continued even though the age brackets were not quite the same and this was for the whole of Australia. Jack thought he might be on to something as the data suggest the problem concerns more than just New South Wales and is growing.

As a result of this and other research, Jack has decided to design a fitness program to encourage young people to become more active. 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 (see http://cambridge.edu.au/redirect/?id=134), 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 presents research results in text format. It makes the following statement:

> Between April 2003 and April 2006, the sport participation rate for boys remained just under 69 per cent while the rate for girls rose from 54 per cent to 58 per cent.

Results of ABS research into children's participation in selected physical recreation activities are presented in table format (see Table 10.3).

These data tell Jack that bike riding 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.

Table 10.3 Children's participation in selected physical activities, 2006

		Number	Participation rate (%)
Males	Dancing	32.4	2.4
	Skateboarding or rollerblading	399.3	29.2
	Bike riding	1003.0	73.4
Females	Dancing	300.1	23.1
	Skateboarding or rollerblading	228.5	17.6
	Bike riding	803.2	61.9

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The survey will provide students with an image and a word to indicate an activity, such as a picture of a bicycle and the word 'bike', a picture of a surfer and the word 'surfing'. 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 demographies). That data could be extrapolated to represent the whole target for his design brief.

Surveys are a useful tool to collect a great amount of data quickly and easily. Table 10.4 shows a survey used by a student who was planning to design a beach bag.

It was created in a spreadsheet to enable this student to easily present results in a chart format.

From the pie chart (see Figure 10.5), it was very easy to determine that towel and swimsuit were most important. The results also showed that a compartment for a phone should be included and that a cool area for drinks would be useful.

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.

Investigating teenage needs when going to the beach

Please note that your responses will remain anonymous and confidential.

What items do you want to take with you to the beach? (Please tick)	Male	Female
Swimsuit		
Towel		
Phone		
Wetsuit		
Hat		
Sunscreen		
Spare clothes		
Food		
Drink		
Wallet		
Other (Please list)		

Thank you for taking the time to complete this survey.

Table 10.4 Student's beach bag design survey

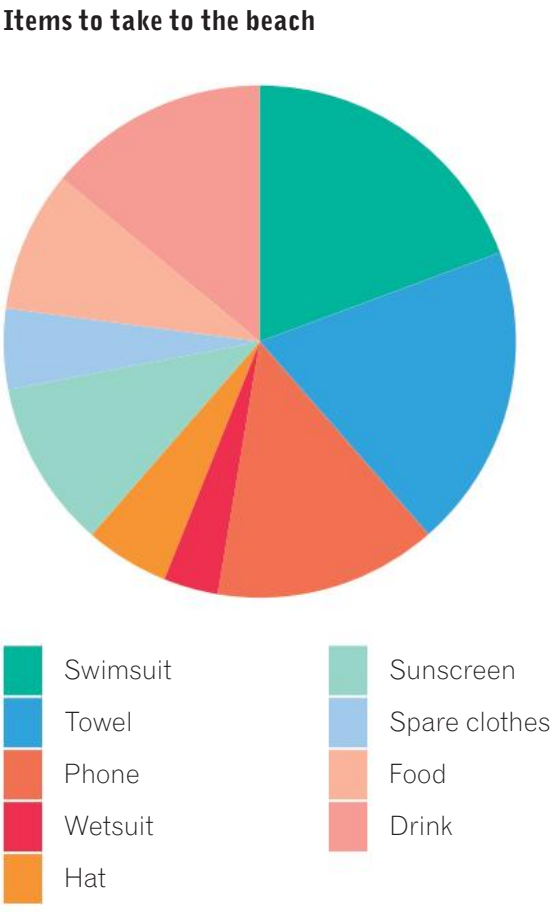


Figure 10.5 This pie chart shows data collected about what teenagers need at the beach.

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10.3 Ethics in research

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.

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 ©



Figure 10.6 What could Jane have done differently in her situation?

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.

ACTIVITY 10.5

Jane plans to design a range of clothing that is suitable for people who have arthritis and have difficulty in manipulating buttons and zips. In her research plan, she has stated that she will interview 10 people who suffer from arthritis. 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 the findings clearly communicated.
- Charts and graphs make it easier to interpret research findings.
- 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 What is meant by the term 'qualitative research'? Give an example from your own 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. Draw and label five different ways to graphically present data.
7 Define the term 'statistical analysis'.
8 Explain what is meant by the term 'ethics'. Provide an example to illustrate how to behave ethically.
9 Explain the terms 'copyright' and 'patent'.
10 Define the term 'plagiarism' and explain how it might impact on research. You should make reference to intellectual property in your response and explain how it can be protected.

Extension tasks

1 Write a set of guidelines that will promote ethical research, to be used by Design and Technology students.
2 Explore the Australian Bureau of Statistics website (see http://cambridge.edu.au/redirect/?id=134). Find a topic that interests you and investigate the statistical information available to you. Think about the different ways the data are presented. From the ABS, 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?

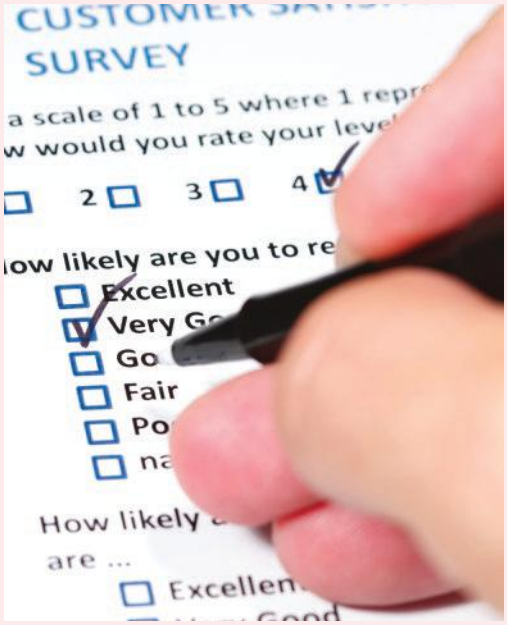
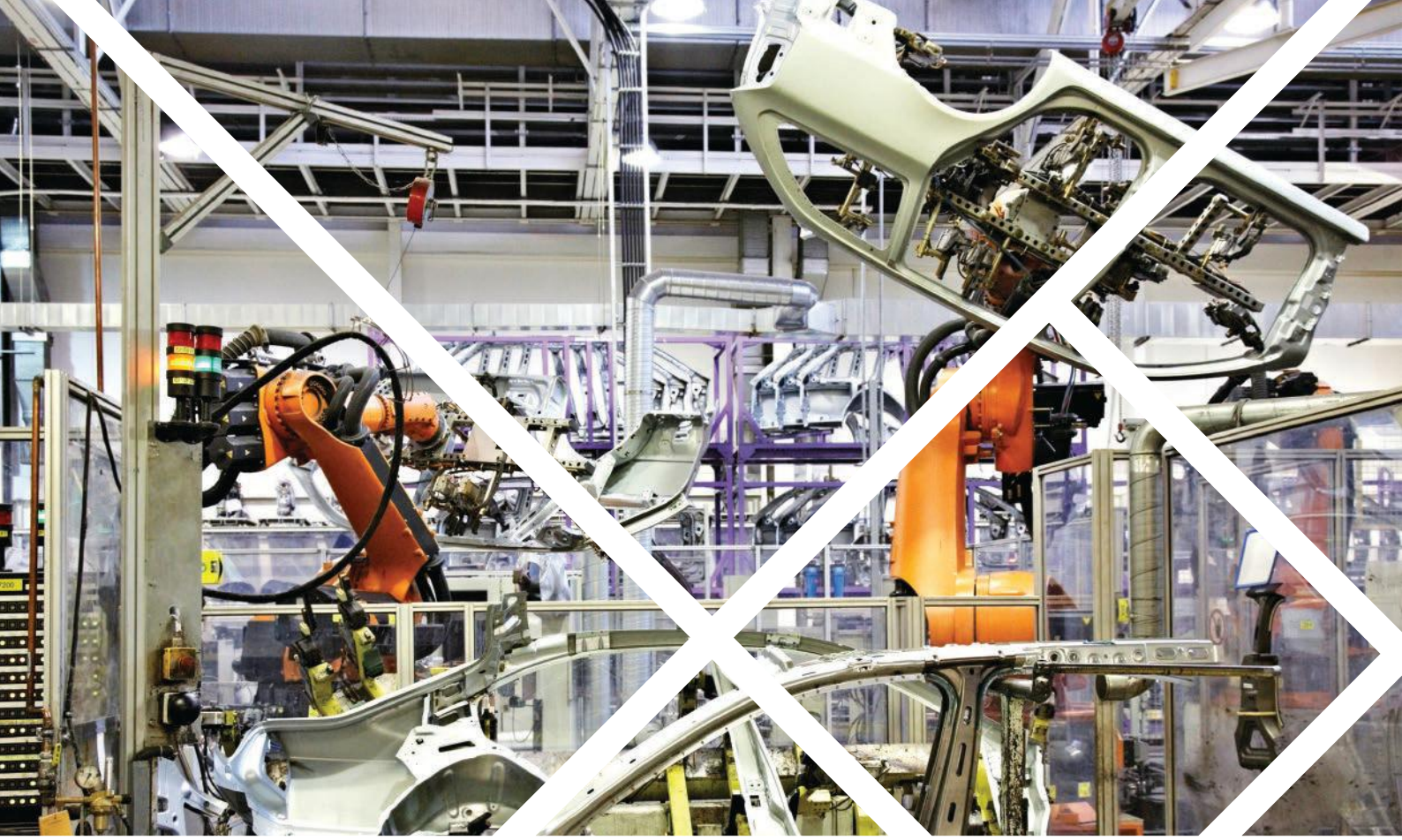


Figure 10.7

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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. 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 in 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, as often the designer is also an engineer, doctor, tradesperson, scientist and so on.

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

1. Subtractive processes: This is where the raw material has processes that remove materials from it in order to achieve its final shape.
2. Additive processes: This is where the final material has processes that add materials together 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.

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.

Look at the examples of wheels of differing complexities and manufacturing technologies shown in Figures 11.1–11.7 on page 102. 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 Figures 11.1–11.7, can you identify the types of processes that may 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 11.1 Solid stone wheel, shaped from solid material



Figure 11.2 Wooden wheel, pieces of timber shaped and assembled together



Figure 11.3 Metal wire wheel, wire welded onto a rolled steel wheel and chrome plated



Figure 11.4 Carbon fibre wheel, with machined alloy bolted on and glued together



Figure 11.5 Cast aluminium alloy wheel, with additional parts bent, welded and machined to produce a complex shape



Figure 11.6 A higher quality alloy wheel where the casting, machining and welding to produce complex shapes are of a higher specification



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.

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11.2 Manufacturing and production processes in industrial and commercial settings

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.

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

(continued)



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Process	Tools or equipment	Materials most commonly applied to	Examples of process or product
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
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
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

(continued)

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Process	Tools or equipment	Materials most commonly applied to	Examples of process or product
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



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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, drop forging or by pressing, compression or by shock; can be with heat, depending on material	Specialist equipment as per equipment manufacturer. Hammers – hand and mechanical. Anvils and dies may be used.	Metals, manufactured materials	Automotive suspension parts, spanners, sockets
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 50 m 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 may be available. Describe how these resources could be used to benefit a design project you have completed.

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.

1. 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.
2. Small-scale production, batch production and job lot production, with limited quantities and small variations in each product feasible: 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 cost. 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.
3. 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.

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

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

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

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



Figure 11.8 A potter in a studio. This handmade method is effective in a one-off design, but it would be difficult to mass-produce identical items using this method.

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CASE STUDY 11.1

How HSV builds a car

HSV is a premium Australian car manufacturer, specialising in performance vehicles using a strategic relationship with General Motors Holden to produce cars that automotive enthusiasts want to own and drive. HSV has been designing and producing performance cars since 1988 and has developed all its vehicles in-house to meet a specific market in Australia. This target market has seen the company grow from small beginnings to being exported around the world and is unique in the Australian market as being able to develop and produce world-class cars such as the new Gen-F range. The team at HSV has a passionate engineering background, and each model has been developed with quality, value for money and performance a priority.

The success of the brand has resulted in vehicles being exported and having a significant cultural following. Producing about 3000 vehicles per year makes HSV a very small automotive producer on a global scale. However, being clever at what it does to produce high-quality products that the market wants has resulted in the development of efficient production practices. As an example of quality complex small-scale manufacturing, HSV can vary its production to be flexible enough to meet changes in customer demands (changing the ratio of vehicles being produced within the range to match orders).

facia
the dashboard area of a motor vehicle





Figure 11.9 An HSV in production

But the agility in changing models from the VE platform to the Gen-F platform has relied on how HSV has cooperated in the development of Holden's core vehicle. When Holden began developing the Gen-F platform, HSV was part of the process and was able to bring to market its enhanced product at the same time. Working with the common supply chains, HSV engineers and designers developed the production processes together and HSV now has a product that fits in with the production schedules of Holden as the supplier of core vehicles. Just-in-time supply of all aspects of production keeps costs down, flexibility high and quality of products a priority.

The build of an HSV vehicle is a two-part, two-state process. The core vehicle is built by the Holden vehicle assembly plant (VAP) in Elizabeth, South Australia. The core vehicle is then shipped to the HSV manufacturing facility in Clayton, Victoria. The reason behind the two-part process is that many of the additions HSV carries out cannot be packaged into the initial Holden VAP build.

The core vehicle is supplied to HSV as a complete running car. This creates some double handling in certain areas that cannot be avoided. The vehicle needs to be compliant to be able to be released from the Holden VAP, which means it is supplied to HSV with items such as front and rear **facias**, side skirts and tail lamps. All these items are replaced during the HSV build and recycled back to the VAP for use on the next batch of HSV builds.

The core vehicle goes through 13 stations to transform it into an HSV:

1. strip/preparation
2. exhaust/coolers
3. electrical
4. rear suspension
5. front suspension
6. rear body
7. front body
8. side skirts
9. brakes/wheels/tyres
10. wheel alignment
11. badging/programming
12. final inspection
13. data dots.

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Strip/preparation

This process takes the core vehicle and prepares it for the production process. Raw plastic front/rear facias and side skirts are removed. Front wheel house liners are removed. Rear mufflers are removed.





Figure 11.10 The preparation phase

Exhaust/coolers

During this process, the standard Holden exhaust system is replaced with HSV spec components. Depending on the model, the exhaust manifolds are changed for HSV exhaust headers (extractors), and intermediate mufflers and rear bi-modal mufflers are fitted. Certain models have cooling system upgrades; supercharger intercoolers, engine, gearbox and differential coolers are fitted.











Figure 11.11 The replacement of the exhaust and coolers

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Electrical

All HSV-related electrical upgrades are fitted at this stage. Holden tail lamps are replaced with the HSV LED lamps. Accessory gauges and HSV enhanced driver information systems are fitted.





Figure 11.12 The HSV tail lamps

Rear suspension

Holden left and right rear suspension assemblies are removed and replaced with HSV assemblies. Depending on the model, HSV sport or HSV magnetic ride control suspension can be fitted.





Figure 11.13 The adjustment of the rear suspension

Front suspension

Holden left and right front suspension assemblies are removed and replaced with HSV assemblies. Depending on the model, HSV sport or HSV magnetic ride control suspension can be fitted.

Rear body

Rear facia and rear boot lid spoiler are fitted. Note the sub-assembly of small components into larger sections to be fitted at specific stations.





Figure 11.14 The rear bumper assembly

Front body

Front fascia and front fender vents are fitted.



Figure 11.15 The front body assembly

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Side skirts

Left and right side skirts are fitted.



Figure 11.16 Side skirts

Brakes/wheels/tyres

Standard Holden brake rotors and callipers are removed and replaced with HSV components. A full brake system bleed is carried out. HSV wheels and tyres are fitted.



Figure 11.17 HSV brake components

Wheel alignment

Front and rear wheel alignment is carried out to HSV specs.

Badging/programming

All exterior badging is fitted. HSV electrical systems are programmed.

Final inspection

A full vehicle visual inspection, including checks of safety critical components, is carried out. A road test is carried out.







Figure 11.18 Final inspection

Data dots

The vehicle underbody is sprayed with data dots. The dots carry the vehicle's VIN and are applied as a theft deterrent and aid for identifying stolen and recovered components.





Figure 11.19 The finished product

Source: Andrew Purcell, HSV

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ACTIVITY 11.3

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. 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?

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

Examples of manufacturing technology used by TSA Engineering

The laser cutter (Figure 11.20) 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.

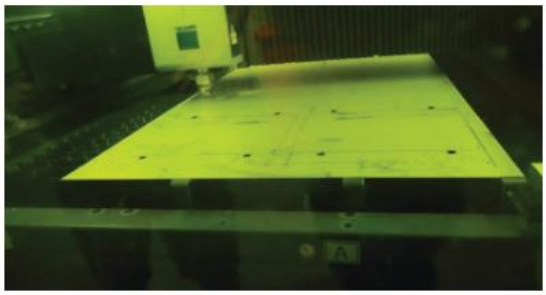


Figure 11.20 A laser cutter

The laser cutter operator is protected inside a booth (Figure 11.21). Work health and safety when using specialist processes is part of the design of the machinery as well.

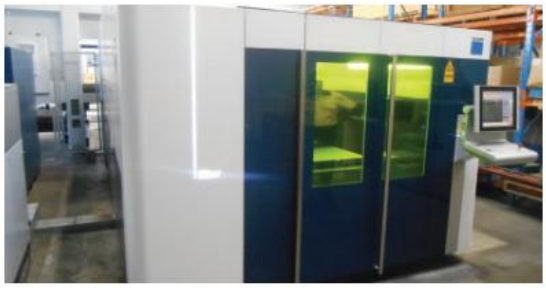


Figure 11.21 A booth to protect the laser cutter operator

Programming the laser cutter (Figure 11.22) requires great skill in being able to interpret the CAD drawings into machine code suitable for CAM.

Machines like the drill press shown in Figure 11.23 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 11.24).

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Figure 11.22 Coding the laser cutter

Specialist folding machines (Figure 11.25) 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 11.23 A drill press

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.





Figure 11.24 Custom production

Computer-aided manufacturing

Computer-aided manufacturing (CAM) 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 computer-aided design (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.



Figure 11.25 A folding machine being operated

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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.

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.

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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?
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 which technology 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?



Figure 11.26

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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 now design and produce. Computer-based technologies may be used at every stage of a design process, from research, experimenting, prototyping and project management through to the 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.

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. 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.

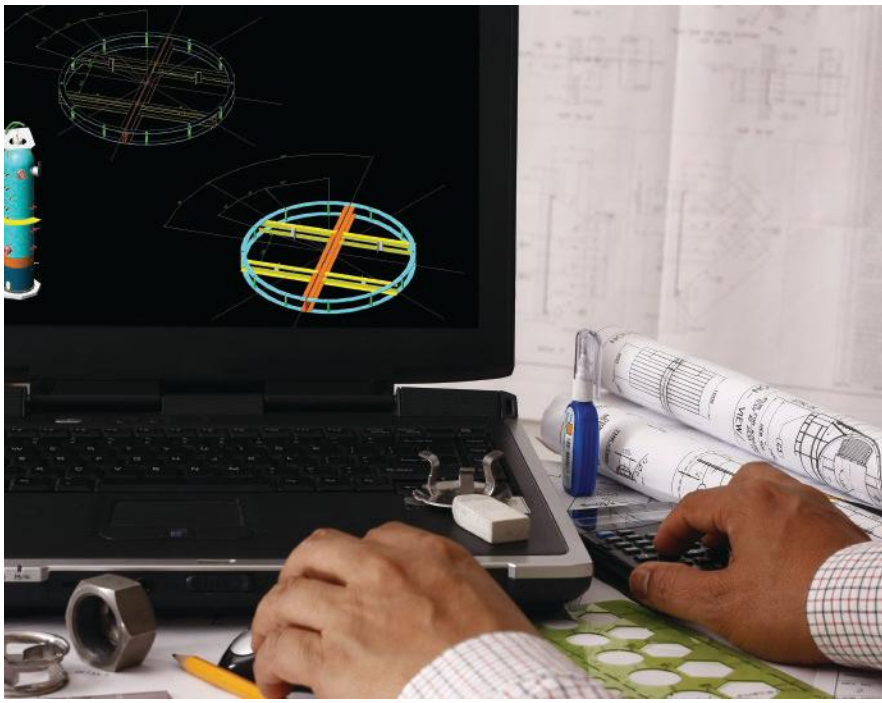


Figure 12.1 Designers use a range of technologies.

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 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,

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such as Microsoft Windows, Mac OS and Linux, which act as an interface and host a range of software. Software ranges in function from the simplest word processing and graphics programs to presentation and voice recognition software.

A computer on its own, no matter how powerful, is of limited value without external devices. Scanners, printers, digital cameras, data projectors, production machines and video recorders make the computer an outstanding tool for recording, sorting and presenting any kind of information related to the design process.

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.

ACTIVITY 12.1

Create a mind map to show where you may be able to use computer-based technologies in your design process.

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 detail 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 final end product in 3D form.

ACTIVITY 12.2

Describe the benefits to the designer, producers and client of using computer-based modelling.

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CAD software, such as Desktop Pro, 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 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 used to take many months and require 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- and time-effective process for the designer.

Computer-aided manufacturing facilities allow you 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.

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. Time is the fourth dimension. 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. For example, 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

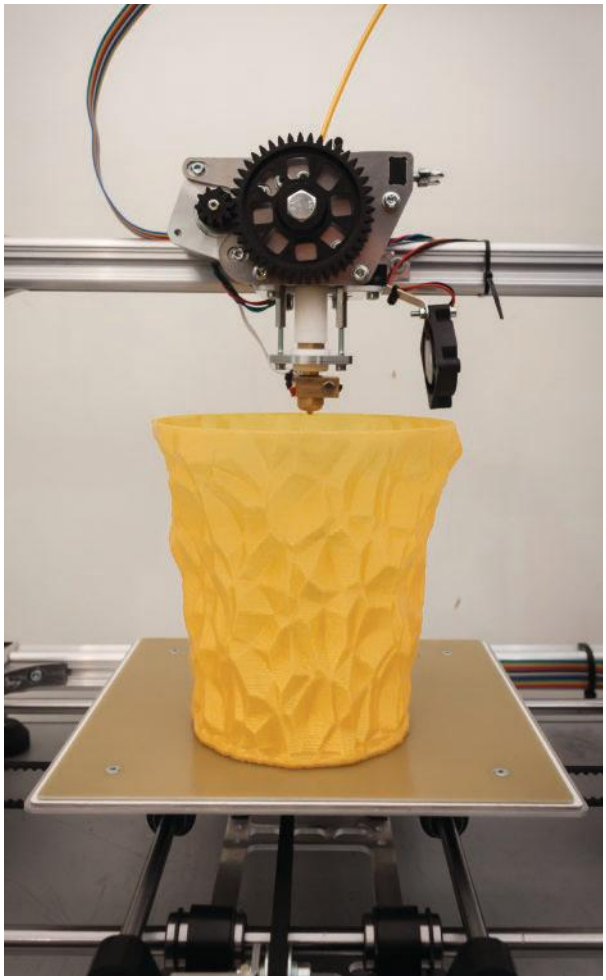


Figure 12.3 A 3D printer

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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 regulary updated website used to cover a single subject

podcast
a digital audio file available to download from the internet

wiki
a collaborative website or database that allows all users to update and edit the content

With the common use of the internet, information is being shared in real time through Really Simple Syndication (RSS) feeds, 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.

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.



Figure 12.4 A flight simulator

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 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.

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ACTIVITY 12.3

Research a design process used for one of the following:

- a skateboard
- an online role-playing game
- a school bag
- an apartment complex.

Account for the ways in which simulation plays or could play a role in that design process.

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.

CASE STUDY 12.1

Vince Aloi

Vince Aloi is a creative director at Vetro Design. Vince has designed for over 20 years. His works include branding, print, websites, multimedia, corporate and annual reports, advertising, book design brochures and catalogues, campaigns, concepts, logos, photography, posters and typography.

Vince's design process often involves many people. He collaborates with specialists in the field, such as photographers, copywriters and programmers.

Vince works closely with the client in the initial design brief phase. This aids both parties in understanding what is required in the project. He still uses traditional freehand drawing in thumbnail sketching for idea generation, but moves on to the use of a variety of digital technologies. Vince works intensely with computer technologies: researching online photo stock libraries, using the internet to find information, utilising online blogs and analysing creative websites. The design ideas and prototype stage, or mock-ups, utilise many design software programs. A digital approach is particularly useful when designing the layout of information and images, as changes to position and fonts can easily be made.



Figure 12.5 Victoria Police Health and Safety Calendar by Vetro Design

Most design work at Vetro Designs is digitally based. Whether creating an image to rebrand a product, or completing a photo shoot for an advertisement, digital means will be used.

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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. Designers can make great use of these technologies, sending and receiving information that relates to their work. Technologies such as voice over internet protocol (VOIP) and videoconferencing are replacing many of the traditional forms of communication. These technologies have overcome many of the challenges previously presented to a project, 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**.

prosthesis
an artificial device used to replace a missing body part

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.

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.

ACTIVITY 12.4

1. Create a mind map, exploring 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.

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.

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 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.

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Figure 12.6 Computer technologies can help with a design folio.

- 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.

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 internet sites to guide you in producing great presentations.

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 myriad challenges.



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Chapter summary

- The technologies of infrastructure, smart technologies and digital communities impact on the development of the economic and social global networks; and consequently on the life and work of designers.
- Just like in industry, students can complete their research, presentation ideas and production of plans with greater efficiency and to a higher standard than ever before by appropriately using computer technologies.
- Computer-based technology applications may be useful for modelling, researching, simulating, visualising, communicating or presenting ideas and processes.
- The use of computer-aided design and computer modelling has enabled designers to easily identify more appropriate designs and can allow designers to see their work, as it would be in the colours and textures of the finished product, at various stages of the design process.
- Designers discriminate in the choice and use of computer-based technologies.

Chapter summary tasks

1 Describe how you can incorporate computer-based technologies in your design and production process.
2 Discuss how CAD and CAM have influenced the end result of a product.
3 Explain how simulation and modelling can influence an end product.
4 Describe five basic elements of good computer-generated presentations.
5 Digital still images can be stored as TIFF, GIF, BMP or JPEG files. Investigate the differences between the common file types and their advantages and disadvantages.
6 The difference between good and poor communication can significantly affect your final result in Design and Technology. What are the main points to remember about communication?
7 3D modelling is a powerful tool for developing good designs. Discuss the ethical concerns of using the 3D printer.
8 The internet is a huge source of information and images. How can you avoid infringing the intellectual property rights of the owners of the work that you use?
9 Research on the internet allows instant access to up-to-date information from a wide range of sources. How can you ensure that the information you are using is accurate?
10 3D printing is impacting on the creation of many products. Think about the future uses of 3D printers and describe how you see them being used in 10 years' time.

Extension tasks

1 The development time between initial idea and final production has been dramatically shortened because of the adoption of computer-linked collaborative design, 3D computer modelling and rapid prototyping. Identify a recent product and research how the use of these new technologies affected its design process.
2 Search engines are very powerful research tools. Choose a large search engine such as Google or Bing and find out how it collects data from the internet and how it allows you to quickly search its database. Does the search engine have advanced search features that could be useful to you? How do you use these?

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Part Two
HSC

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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

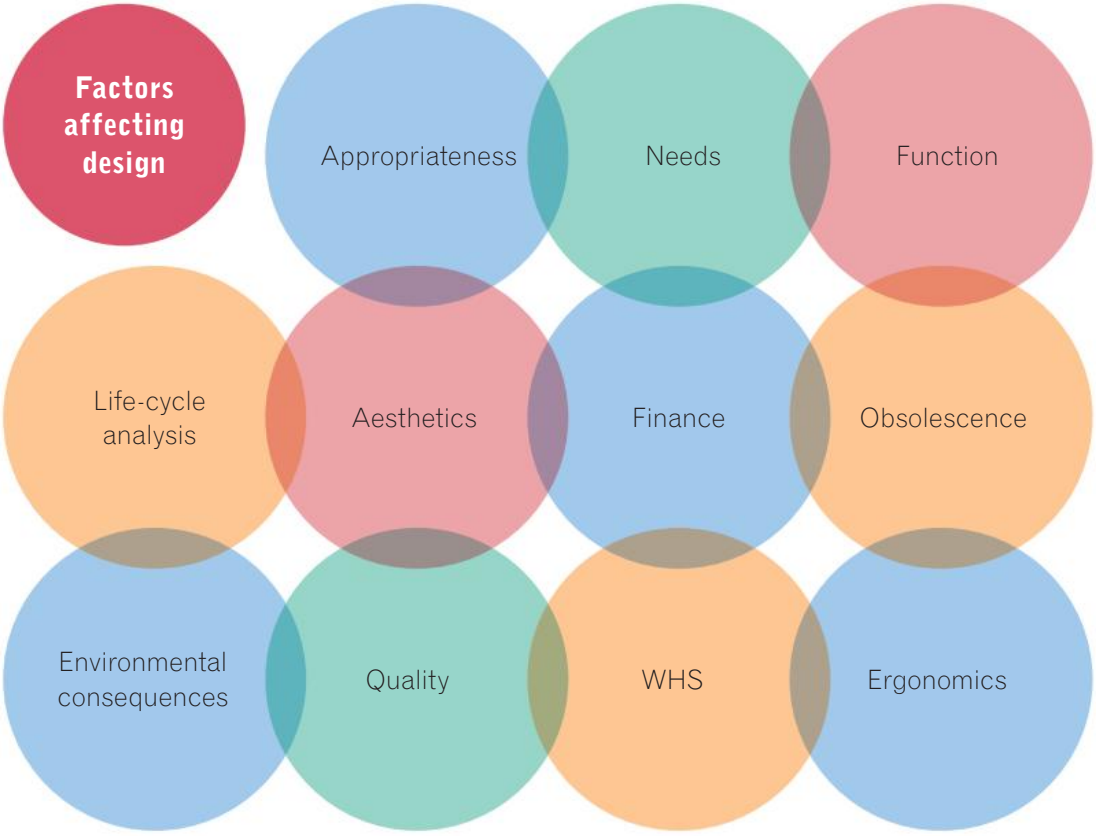


Figure 13.1 Factors affecting design

There are a range of factors that may impact, either positively or negatively, on the development of your major design project (MDP). The list of factors is not exhaustive and should be applied differently to each design. Some will have greater influence on your work than others. Make sure that you consider each factor, then be selective and document only those of significance to the development of your project.

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 durable, non-toxic materials, have minimal weight, use bright colours, and use large, clearly labelled buttons or control mechanisms incorporating symbols rather than words.

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.

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

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Figure 13.2 The key to good design

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, 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.

secondary function
additional features that make a product different and preferred to competition products

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.

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.

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. If two products perform the same function, it will often be their aesthetic qualities that determine their success. People like to use things that look good and work well.

Finance

Finance refers to the amount of money required to complete all phases of the development of a product. This may include research and development, 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. 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. Finally, the designer needs to consider the payback period or how long it will take before the product starts to make a profit. The management of finance is crucial to the success of any project. 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.

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 that are designed to be used by people and aims to ensure that workplaces, products and systems are designed to fit the people who use them. Ergonomics uses data obtained from several disciplines, including anthropometry (body sizes and shapes), biomechanics (muscles, levers and forces) and environmental physics

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(noise, light, heat, cold and radiation). It looks 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 pain or physical injury to the user.

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.

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. WorkCover is the government regulatory body responsible for workplace safety. For students, the classroom or workshop is your workplace, and rules relating to safe work practices are implemented to ensure your safety. 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 manufacturing of their products and ensure materials and processes used do not harm workers. They must consider the safety of the consumer when using their product. Safety testing should always be carried out on prototypes and modifications made if there is any chance of harm to the user.



Figure 13.4 Ergonomic design can reduce physical and mental stress to improve performance.

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 durability. We expect a high-quality product to perform well for a long period of time. 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. 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 custom production, which again make a product more expensive to the consumer.

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Figure 13.5 The Earth's future is our responsibility.

Short-term and long-term environmental consequences

As designers, we need to consider the environmental impact of our work. Short-term environmental impacts can be minimised by making informed choices about the selection of resources and the production of wastage and pollution. Designers have a responsibility to actively seek sustainable alternatives to non-renewable resources to preserve our natural resources for future generations. The selection of processes that are less harmful to the environment should also be considered. 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.

Long-term environmental consequences, such as **global warming** resulting from the **greenhouse effect**, rising sea levels, loss of biodiversity and the depletion of the ozone layer, may have catastrophic global impacts if we, as both designers and consumers, do not actively change our behaviour. Sustainability means using only what we really need and no more, to ensure that future generations have access to natural resources.

global warming increases in the average land and sea temperatures on Earth

greenhouse effect the gradual warming of the Earth's surface caused by an increase in gases in the atmosphere (caused by human activity)

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 computer industry and fashion, rely heavily on obsolescence to maintain high sales levels, encouraging consumers to buy the latest version or style.

Built-in obsolescence refers to when a product has been designed to fail within a given period of time. Built-in obsolescence is incorporated into the product at the time of design. It 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. Built-in obsolescence ensures new technologies are adopted and, of course, leads to repeat sales for businesses.

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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).

Life-cycle analysis is sometimes 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.

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. How will each factor impact on your MDP during the following stages:
   - **a** design
   - **b** production
   - **c** advertising/marketing
   - **d** consumer acceptance of the finished product?
3. Prioritise your list of relevant factors 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 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?

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



Figure 13.6 Cardboard packaged for recycling

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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.

ACTIVITY 13.2

As individual designers, we each have our own opinion about what makes for good design and ultimately a great product. Working in groups, select one of the following statements and prepare a formal debate examining both the positive and negative cases.

1. Function and aesthetics are equally important to the success of a product.
2. Built-in 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?

Figure 13.7 Aesthetically pleasing water-saving showerhead



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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, however, may refer to products that have not only failed to make money for the designer but may not have performed as desired. They may even have caused harm to users. Although failure is an unavoidable part of the design process we must work through and resolve as a product is refined and developed, allowing failure to be evident in the finished product must be avoided at all costs.

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 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.
- 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.

CASE STUDY 13.1

The Segway

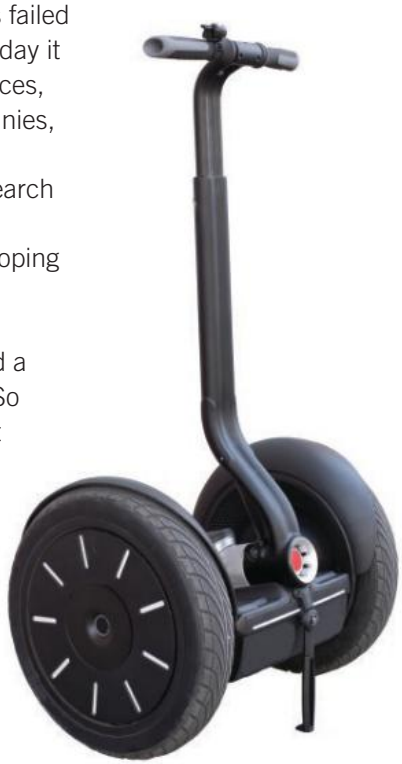
In 2002, inventor Dean Kamen launched the Segway, an innovative two-wheeled, battery-powered electric personal transportation vehicle. He promised a vehicle that would revolutionise the way people moved around in urban areas, saying the Segway 'will be to the car what the car was to the horse and buggy' ('Reinventing the wheel', *Time*, 2 December 2001).

When the product was launched, the head of Segway, venture capitalist John Doerr, predicted that Segway sales would hit $1 billion faster than any company in history. More than 10 years after its release, the Segway has failed to gain significant market acceptance. Today it mainly sells in small batches to police forces, urban tour guides and warehouse companies, not the general public.

Kamen dedicated 10 years to the research and development of the Segway and the company spent about $100 million developing the product. Kamen had successfully developed numerous products before, including a portable dialysis machine and a motorised wheelchair that climbs stairs. So what went wrong with the Segway? Was it just ahead of its time, or did other factors contribute to its failure?

One problem may have been insufficient market research during the initial development. Kamen produced a transportation device that was classified as a road vehicle in some countries, requiring licensing, while it was illegal to use on roads in other countries. It was designed to move people around in busy cities, but was seen as

Figure 13.8 The Segway



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Figure 13.9 Tourists using the Segway

a danger to pedestrians if used on the footpath and a danger to the operator if used on the road.

The price of the Segway may have been responsible for its limited market success. With a price range of $4000 to $7000, it may have been too high to attract a large consumer base. It was only a single-user transportation device, and this, combined with the high price, may have deterred consumers.

Conducting a thorough needs analysis may have identified some problems before releasing the vehicle. It was a personal transportation device and yet it was big and bulky and weighed more than 30 kilograms. Where would commuters safely leave it at the end of their journey? It certainly did not solve city parking problems. The limited battery life, which meant the vehicle could only travel about 11 kilometres before requiring recharging, created further obstacles. How and where would commuters recharge their vehicles when no infrastructure existed for this purpose?

And finally, the Segway required training before an operator could ride it safely. The company initially required buyers to go through a minimum of four hours of hands-on instruction, but its marketing strategy of selling the vehicle online made this a difficult problem to solve.

The Segway may have been a great product, but it was not a solution to an identified problem. A lack of sound research to clarify which segment of the market should be targeted and to identify exactly what they needed and could afford, combined with failure to understand legislation relating to transportation devices, contributed to the commercial failure of this product.

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 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 Segway 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?

Design successes are 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).

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CASE STUDY 13.2

The Active Reactor

The Active Reactor is a revolutionary product designed to control the operation of high-intensity discharge (HID) lamps. It has successfully been incorporated into both high-pressure sodium and metal halide lamps commonly used in street lighting, floodlighting and industrial lighting. This Australian innovation has solved a range of problems through clever design, delivering substantial energy savings, which means reduced electricity costs, reduction in greenhouse gas emissions and extension of the lamp life for streetlights. While the target market is large industry, electricity distributors and councils, this innovation will have many positive impacts at both the community and global levels.

The Active Reactor is driven by a pre-programmed electronic control unit. Continual interrogation and feedback allow the device to vary its power, delivering the minimum amount needed, while ensuring the output of a constant level of light. This is different from the conventional ballast, which supplies a constant power supply with the expectation that the light output will deteriorate as the lamp ages and nears the end of its useful life. Therefore, when a lamp is new and efficient the power level delivered will produce a higher light output than required to ensure the light output is still sufficient when the lamp ages and loses efficiency. Using the Active Reactor, the power supplied to a new lamp can be reduced to the minimum required to ensure the light output complies with the street lighting standards (Australian Standard AS 1158) thus reducing energy requirements and operating costs.

Lamps controlled by the Active Reactor run all their life below their rated power. This means the lamp runs at a lower thermal loading, reducing chemical reactions within the lamp that result in ageing and extending the useful life of the lamp. Field and laboratory trials have indicated a 50 per cent increase for metal halide lamps and a 100 per cent increase for high-pressure sodium lamps. The extension of the useful life of the lamp results in substantial savings in both replacement cost and maintenance for electricity distributors and other users. This ultimately means a more consistent and reliable lighting supply for the community with fewer and less frequent failures.

Energy saving is another reason for the success of this innovative product. The cost of electricity has risen dramatically in recent times and the release of a product with the ability to reduce energy consumption was perfectly timed to ensure its market success. The reduction in electricity consumption when lamps are controlled by the Active Reactor is substantial, with typical energy savings of 18 per cent for metal halide lamps and 25 per cent for high-pressure sodium lamps.

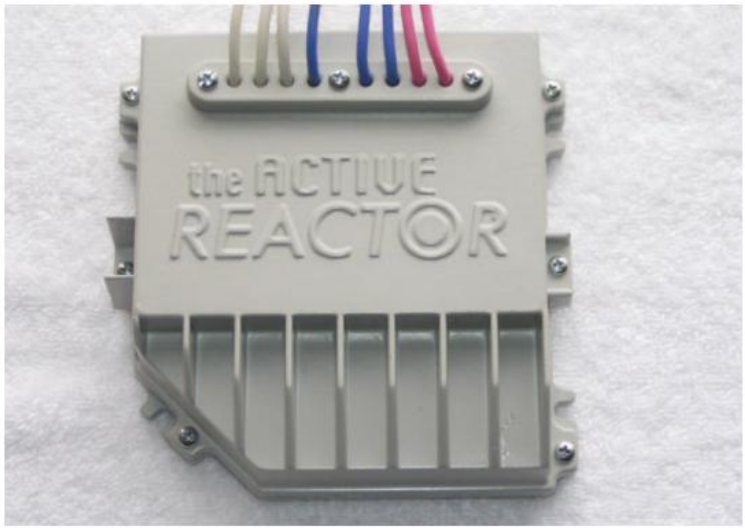




Figure 13.10 The Active Reactor will revolutionise the street light.

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Figure 13.11 Components of the GravityLight



Figure 13.12
The GravityLight

CASE STUDY 13.3

GravityLight

London designers Martin Riddiford and Jim Reeves spent four years developing the GravityLight as an affordable way for people in developing countries to light homes, recharge batteries or power a radio. Their goal was to provide clean, efficient light for the 1.5 billion human beings who do not have reliable access to electricity and rely on kerosene-fuelled lamps. GravityLight uses the Earth's gravity to generate enough power to light an LED bulb for half an hour, with no electrical grid, batteries or external generator required.

The GravityLight was designed in response to a challenge from the charity Solar Aid. The brief was to develop a light with a photovoltaic panel and battery for under $5, to replace harmful and dangerous kerosene lamps used extensively in remote villages throughout Africa and the rest of the developing world.

It quickly became evident that the cost of materials would make it impossible to meet the target price point. Batteries were identified as the major hurdle due to their high cost, short lifespan and inefficient use of energy. Manually powered designs such as wind-up radios or pedal-powered lights had been developed in the past with limited success and acceptance.

Harnessing kinetic energy became the goal. The idea was developed and tested using a rig created from bicycle wheels, chains and a hand-crank torch. Powered by gravity, the GravityLight operates by using the energy produced from the controlled descent of a weight to power a light bulb. The weight, a fabric bag supplied with the GravityLight, can be filled with any available material – sand, soil or pebbles. It is physically lifted to the suspended lamp and as the weight slowly descends under that force of gravity, kinetic energy is converted into electrical energy via a series of gears, providing continuous light for approximately 30 minutes. The supply is continued by raising the bag.

A community-based funding scheme allowed 1000 units to be produced and supplied free of charge to villagers in Africa. Feedback from this trial allowed refinement of the design. Production volumes improved economy of scale and drove production costs down, making the GravityLight available to villagers for less than $5. The cost of a GravityLight is recouped by villagers within three months of purchase, with no need to buy expensive kerosene and no ongoing running costs. Exposure to harmful kerosene fumes is eliminated and the incidence of severe burns from upturned kerosene lamps has been dramatically reduced.

ACTIVITY 13.5

Answer the following questions based on Case Studies 13.2 and 13.3. You may work as an individual or in a group.

1. Can you identify any common factors in the development of these design successes?
2. What factors led to their success?
3. What can you learn from such successes?
4. How can you apply such success to your MDP?

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Chapter summary

- Many factors affect design.
- What might initially appear successful may actually be full of problems.
- Thorough testing and prototyping is essential.
- Market research to understand the needs and wants of the target market is essential.
- The factors affecting design are interrelated.
- Long-term success requires 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?



Figure 13.13

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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. 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.

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 only familiar tools, materials and techniques associated with their particular field of expertise. 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 the **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 and creating a diverse range of products, including concept cars, uniforms for the Australian Olympic team, mobile phones and the Qantas first-class Skybed.

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. 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.

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 learn about successful methods and ways of working as well as identifying problematic areas and things to be avoided. Professional journals and design magazines frequently offer case studies and in-depth interviews with designers, exploring the process that makes their work unique. The internet is a valuable tool for research into the work of designers from all backgrounds, allowing quick access and up-to-date information. 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 actually carrying out the practical work of creating the design. Valuable experiences such as these will enhance your own design work, allowing you to learn from the successes of those who design for a living and

iconic
represented as worthy of celebration and great respect



Figure 14.1
A design team at work

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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. Many will be part of a collaborative team where professionals from different design backgrounds contribute their unique skills and expertise when developing a product. When producing your MDP, you do not have this luxury – you must carry out multiple roles – designer, manufacturer, marketing adviser, 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.

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. While each design process may vary the order of steps or place greater emphasis on particular stages, some aspects will be common to all.

The design process is not a linear start-to-stop process made up of steps arranged to be followed in a specific order. Design should be a **cyclical process** that continues until both the designer and client are satisfied with the outcome. An iterative design process, where feedback is used to improve and modify the outcome, is an important part of successful design.

cyclical process
a continuous process, where particular states occur again and again

There is no definitive entry and exit point. When redesigning an existing product to increase market share, it may be appropriate to start with research and testing of new or emerging materials 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.

Design is not a one-way process, as sometimes we need to go back before we can continue to go forward. For example, research and testing 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.

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, evaluation is carried out continuously throughout the entire project and used as a

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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.

Finally, the design process does not end when you get to the bottom of the list of steps. Remember that it is a cyclical 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 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 whether modifications need to be made to increase market share or whether processes can be streamlined to reduce production costs.

The basic stages of the 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.
- Evaluation: Ongoing throughout design and construction; checking the outcome against the identified need or opportunity to determine the level of success.

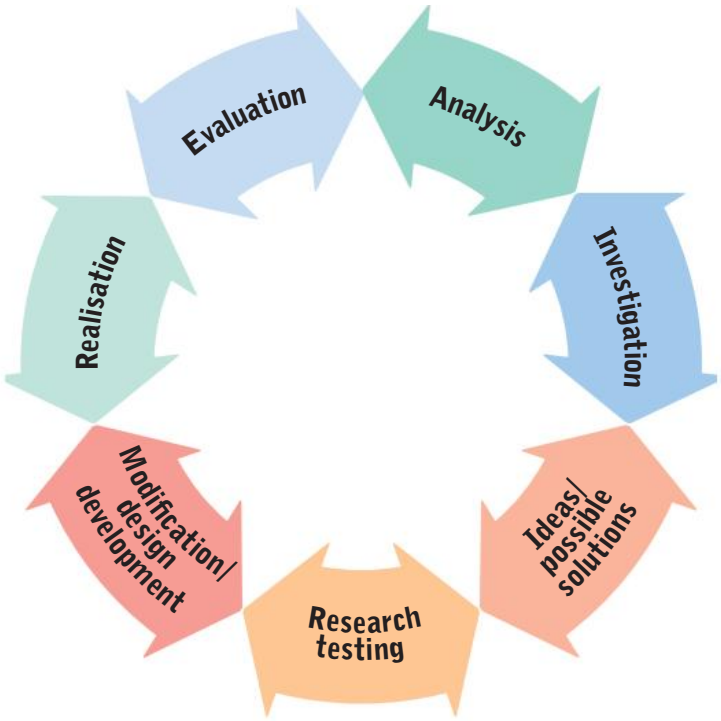


Figure 14.2 Basic stages of a design process

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. 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.

adorn
make beautiful

CASE STUDY 14.1

Designer profile: Cinnamon Lee

Cinnamon Lee is an Australian artist and craftsperson. Although formally trained as a goldsmith and silversmith, Cinnamon's work encompasses custom-made precious metal jewellery, unique precious objects and contemporary lighting. The skills developed through her initial training at the Canberra School of Art (now the ANU School of Art) form the basis of her work, which is driven by the medium of metal and its unique working properties.

While her work is firmly grounded in the application of traditional hand fabrication skills and craft principles, her interest in new and emerging technologies has encouraged her to investigate possibilities and push the boundaries of design, resulting in unique and beautiful objects that could not be produced using traditional techniques alone.

Cinnamon's work involves the innovative use of digital manufacturing processes, specialising in the combination of 3D computer modelling and rapid manufacturing processes and traditional gold and silver smithing techniques to produce work that explores the intersection between technology, the machine and the handmade. The subtle interactions that occur between people and objects continue to provide inspiration for her work, whether it is functional or emotional, worn on the body or **adorning** a room.

Her exposure to 3D printing technology and its possibilities began in 2000 while she was a student at ANU. The university acquired an early-model fusion deposition modelling (FDM) rapid prototyping machine that extruded ABS plastic. Initially attracted to the translucent quality of the white ABS plastic that the machine used, Cinnamon saw the potential for using the plastic models as end products in her lighting designs rather than just models or prototypes. Further work revealed that 3D printing or additive manufacturing allowed her to produce more elegant and efficient design solutions, eliminating many of the limitations created by conventional subtractive manufacturing techniques.

Cinnamon recognises the value of traditional techniques but is not afraid to incorporate technology and exploit its potential in her work. The combination of computer-aided design (CAD) and computer-aided manufacture (CAM) with traditional hand fabrication techniques allows her to generate complex forms with a level of accuracy and intricacy that would be difficult to produce using conventional methods



Figure 14.3 Cinnamon Lee's *Up Lamp 2*, 2005, stainless steel, 925 silver, rapid prototyped ABS plastic, 12V halogen light source



Figure 14.4 Examples of Cinnamon Lee's work

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alone. High-definition three-dimensional printing techniques, combined with the lost wax casting process, allow for these forms to be realised as tangible, wearable objects.

Skill in manipulating CAD software features in Cinnamon's work, with rotationally repeated shapes joined by a minimal support framework. This intricate repetition of pattern is then transformed through the use of 3D modelling to produce an intricate structure that challenges traditional construction techniques.

Cinnamon's blend of old and new, traditional and technological, makes her an inspiring designer.

> Through my jewellery I attempt to expose the potential of technology by highlighting ways in which a marriage can be found between traditional and contemporary techniques. I feel the digital tools in my 'virtual workshop' have now become as influential in my design process as the hand tools on my bench.
>
> *Source: Cinnamon Lee, http://media.uow.edu.au/news/UOW162375.html*

Cinnamon's practice spans over 15 years, during which time she has exhibited widely. Both her jewellery and lighting have been acquired for a number of public collections, including the National Gallery of Australia's Decorative Arts Collection. Cinnamon's studio is currently located in Sydney and her work is available exclusively through a small number of retailers in Australia.

ACTIVITY 14.2

1. 3D printing is an example of additive manufacturing. Investigate the advantages of additive manufacturing.
2. Traditional jewellery-making skills use subtractive manufacturing techniques to produce a finished product. Find other examples of subtractive manufacturing and compare the techniques used to additive manufacturing techniques.

CASE STUDY 14.2

Designer profile: Andrew Simpson

Andrew Simpson is an industrial designer who 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. He is the founder and head designer of Vert Design, a design house based in Sydney.

Simpson'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. He is perhaps best known as co-founder of the successful Balmain Boat Company, which creates flat-packed, do-it-yourself sustainably designed rowboats and sailboats.

Simpson 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 glass-blower while studying and attending lectures across disciplines to experience diversity of ideas and practice.

While his current work utilises cutting-edge technologies, Simpson 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.

Simpson is one of a handful of designers involved with Sydney-based Supercyclers, 'an international collective of designers who are



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Figure 14.5 Samples of Andrew Simpson's work. A classic rowboat from The Balmain Boat Company (left). Incalmo vases, made from post industrial solar glass sheeting (right).

focussed on building a sustainable future'. In 2012, Simpson 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 Simpson.

> 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, http://www.indesignlive.com/articles/people/In-Profile-Andrew-Simpson

ACTIVITY 14.3

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 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.
- Explore widely to gain inspiration, and always be inquisitive and open-minded.

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 Cinnamon Lee and Andrew Simpson.
9. Describe how Cinnamon Lee and Andrew Simpson have utilised technology to enhance their design and production.
10. Both Cinnamon Lee and Andrew Simpson are successful designers. List six points to explain why they have achieved success.

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. Conduct an interview with the designer and 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 flow chart based on your customised design process, incorporating as many steps as you can determine at this stage that you will need to work through when developing your MDP. Display the process chart in a prominent place so you can refer to it when working on your MDP. Make it a work in progress and add new steps 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 target market's needs. It is also important to be aware of historical and cultural influences that have shaped design and production.

Social, cultural, global, political, economic and environmental influences directly and indirectly affect trends and in turn impact on design and production.

Social issues

'Social issues' 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 Indigenous Australians.

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.

Social conscience

Social conscience refers to values; to individuals' 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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Globalisation

globalisation
the ongoing process of integrating economies, societies and cultures through global networks

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 cooperatively.



Figure 15.1 Globalisation can lead to new and interesting inspiration for designs.



Figure 15.2 Satellites provide instant communication between nations.

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.

Political issues

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.

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

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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. Visit the ComLaw website (see http://cambridge.edu.au/redirect/?id=135) for more information.

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 (see http://cambridge.edu.au/redirect/?id=136) 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.

Economics

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. 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.

Some consumers inform themselves about the labour conditions used in the creation of the product, and 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.

Figure 15.3 Australian Made logo



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Figure 15.4 Using recyclable materials reduces waste disposal.

ACTIVITY 15.2

Debate the following topic in class: 'All Australian designs must be designed and produced in Australia'.

biofuel fuel derived from biomass (recently living organisms or their metabolic by-products, such as manure)

Environmental issues

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.

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.

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. 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. The cost of oil fluctuates unpredictably – it is a finite resource – and its production and use creates a lot of pollution. This has stimulated a real need to develop alternative energy sources such as solar energy and **biofuel**.

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.

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.
2. Offshore production should not occur for Australian products.
3. Globalisation has improved the world of design.

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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 settlement of Australia occurred from 1788. Prior to that, the traditional owners of the land, the Aboriginal peoples, had their own social order. They were self-sufficient and utilised the land for their needs, constantly moving to ensure that the land was protected and to minimise their impact on it. They took care of their needs and did not exploit their land. They produced all their tools and clothing from the local environment.

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

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.

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



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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 original inhabitants, 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, 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.



Figure 15.5 The influence of culture on design

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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.

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 (ICT) 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.

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. 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.

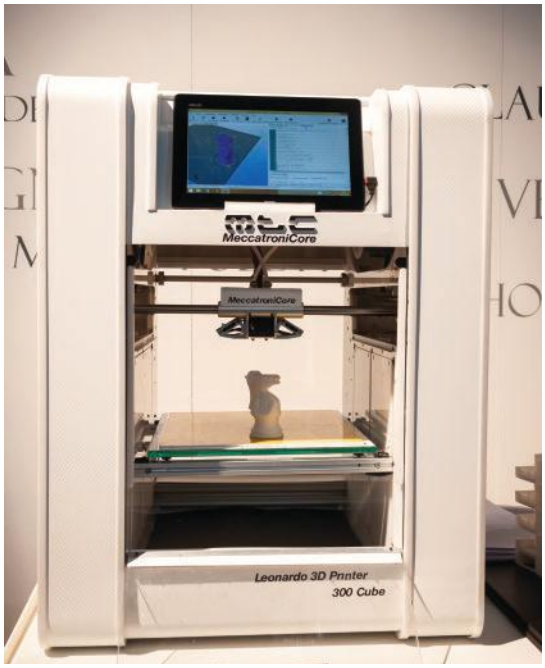


Figure 15.6 A 3D printer creating a knight (horse) chess piece

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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. Economics plays an integral role in the success of a product. Discuss, using specific examples to justify your argument.
4. Outline how technological change has impacted on our lifestyle and the nature of work in Australia in the twenty-first century.
5. 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.
6. For a designer you have studied, discuss how technology has changed the nature of their work. Provide specific examples.
7. Discuss how social changes have allowed for developments in home appliances.
8. Identify and describe how environmental factors are being addressed in new innovations.
9. 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.

Extension tasks

1. Analyse how multiculturalism has influenced the design of some products. Provide specific examples.
2. As a news reporter, you are conducting an interview about wind power. You want to highlight both the environmental and social impacts of this technology. Write a list of questions you could ask in order to gather appropriate responses. Provide suggested answers from a local farmer who wants to build a wind farm and from a townsperson who is against the wind farm.

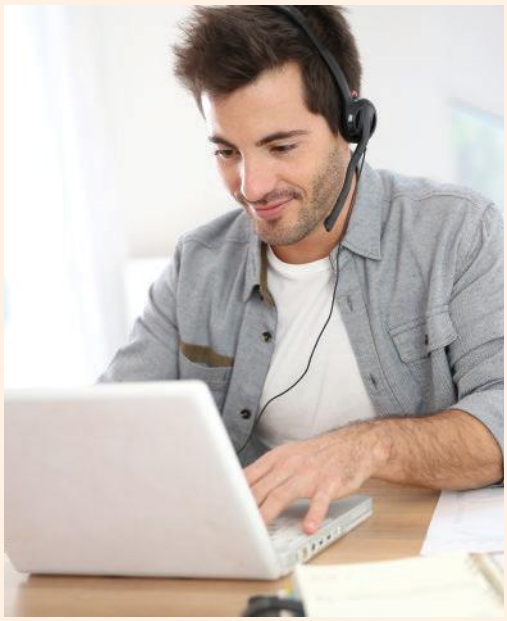


Figure 15.7

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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:

- the atomic bomb
- the electric chair
- genetically modified foods
- stem-cell research
- genetic engineering.

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. **Drone** technology has created a range of mixed emotions. Many will feel negative about the use of this technology in war or in spying, but then we can 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 traffic congestion is impeding movement. It can also be 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.



Figure 16.1 Drone technology is very controversial.

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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
- 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?

Intellectual property rights

Organisations and legislation that protect designers include IP Australia, Standards Australia, 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 ©.

trademark
the name or other symbol used by a manufacturer to distinguish its products from those of competitors

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 ®.

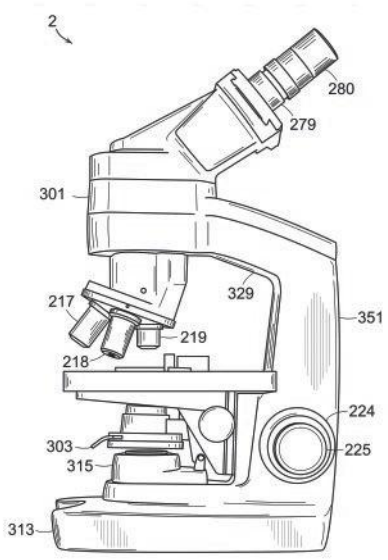


Figure 16.2 A patent diagram for a microscope

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16.2 Ethical and 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.

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 (CFCs) 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.

ACTIVITY 16.1

Visit the Department of the Environment website (see http://cambridge.edu.au/redirect/?id=137) and explore the topic of air quality. Debate the issue: 'Air pollution is the most important environmental issue of our time.'

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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Figure 16.3 Air pollution, landfill and drought all contribute to environmental damage.

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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 through to the disposal of the products after their useful life.

ACTIVITY 16.2

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.

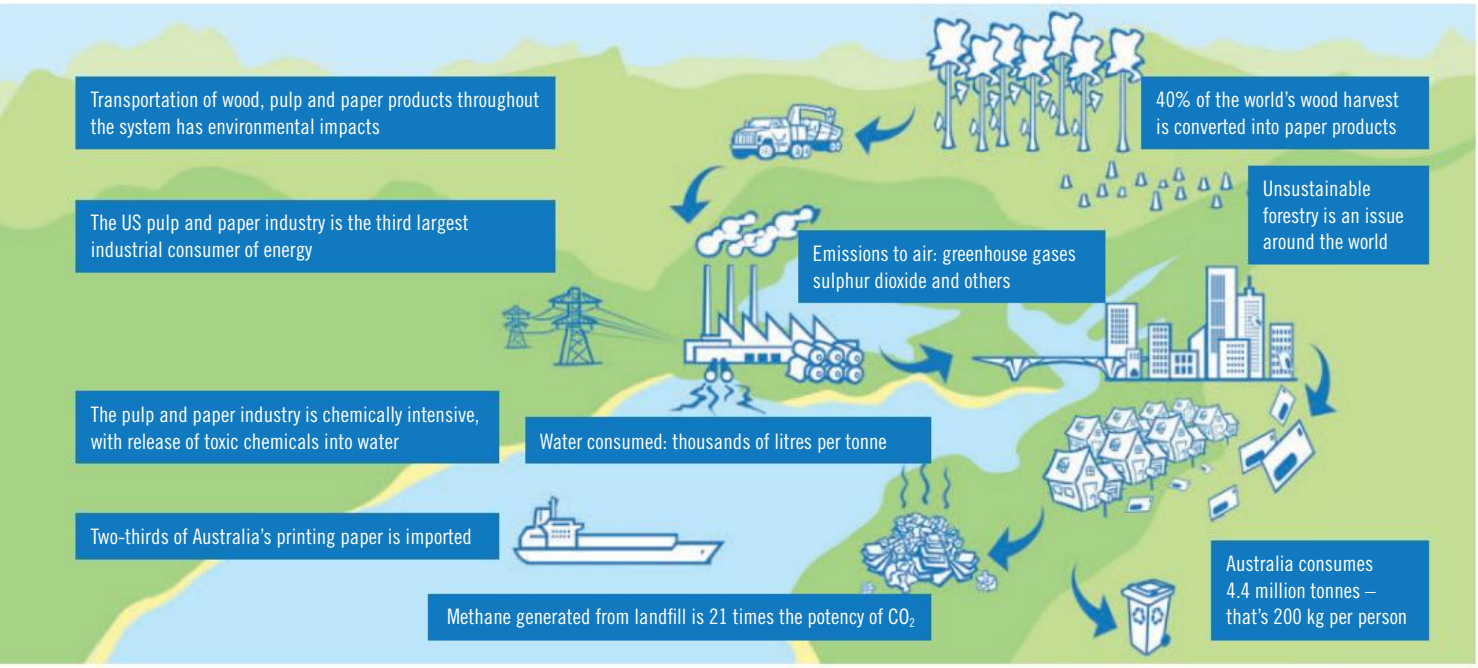


Figure 16.4 The environmental impact of paper production

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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.

Solar power

Solar power systems convert energy from sunlight into direct current (DC) electricity. An inverter then converts this direct current to alternating current (AC), 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

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 cars and hybrid cars are also being developed.



Figure 16.5 Solar panels on a roof

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 5 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.

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 hydro power 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.



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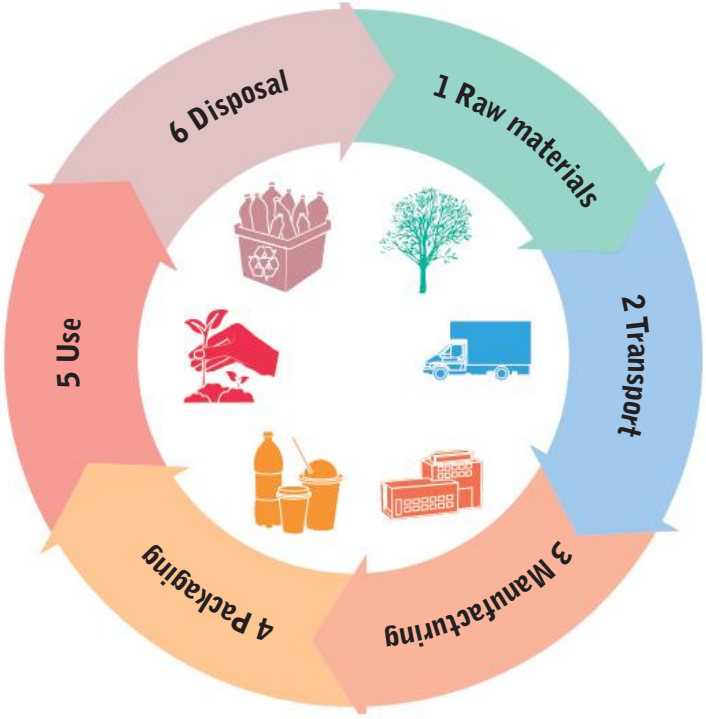
Figure 16.6 Water pipeline to the hydroelectric power station at Tarraleah in Tasmania

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, clean and there are no greenhouse gas emissions.

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 federal government has developed a carbon trading scheme to encourage the reduction of carbon emissions. The government also provides support for the development of technologies like clean coal energy production.

Figure 16.7 The production process



What is GreenPower?

The GreenPower Program (the Program) is a government managed scheme that enables Australian households and businesses to displace their electricity usage with certified renewable energy. The Program was launched in 1997 after 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; and
- 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, http://www.greenpower.gov.au/About-Us/What-Is-GreenPower

ACTIVITY 16.3

Complete an LCA 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 GreenPower.
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 sustainable technologies. Refer to specific case studies in your response.
7 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.
8 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).
9 Critically analyse the impact that your MDP will have on society and the environment.
10 Critically analyse ethical issues in relation to offshore production. Give specific examples.

Extension tasks

1 Critically analyse ethical and environmental issues relating to expanding urban development.
2 Define the term ‘sustainability’. Discuss the importance of using renewable resources. Use examples to support your answer.

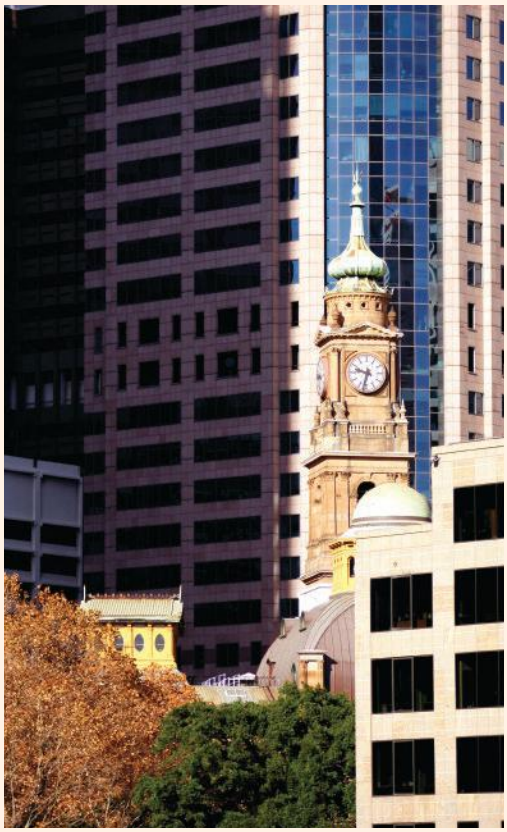


Figure 16.8

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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.

Two 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.

CASE STUDY 17.1

The Dyson Airblade™ Tap

An innovation from Dyson, the Dyson Airblade™ Tap, allows hands to be dried at the sink in 12 seconds. There is no need to go to a separate drying area. As with his previous designs, James Dyson has identified an everyday problem and created a unique design solution. In this case, he has further developed his Airblade™ hand dryer. Moving to a separate hand-drying area means that water is often dripped on the floor, creating a potential hazard. The Airblade™ Tap contains a hand dryer that works by scraping water from hands using a high-powered digital motor designed by Dyson. It is one of the world's smallest fully integrated 1600-watt motors. It is the only hand dryer motor powerful enough to draw up to 30 litres of air a second through a HEPA filter, and then dry hands in 12 seconds.



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Figure 17.1 A Dyson Airblade™ Tap

Air is forced through two continuous apertures the width of an eyelash – creating sheets of air travelling at 400 miles per hour. It uses digital pulse technology – spinning 88 000 times a minute with the potential to suck in 37 litres of washroom air every second. A HEPA filter purifies the air before blowing it onto hands, so it is also hygienic. And it uses up to 80 per cent less energy than conventional warm-air hand dryers. It also eliminates the need for paper towels, which generate landfill, are expensive to restock and dispose of, and can be wasteful and create mess. It offers businesses and public venues the opportunity to lower their running costs, provide a fast, hygienic method of hand drying and reduce their carbon footprint at the same time. With improvements in the air multiplier technology, the designers were able to make the fan 75 per cent quieter.

James Dyson has designed and produced a range of other innovative products, such as the bladeless fan and the bagless vacuum cleaner, that reflect his eye for good design and new technology that works – performing better than the competition. Dyson is known to support working from a point of failure. He says: 'failure is a wonderful starting point because when something fails you have then got to think and experiment to overcome that failure'.

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.

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 many products, from mobile phones and wristwatches to 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.

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Figure 17.2 Using a GPS device

ACTIVITY 17.1

1. Discuss the impact that GPS technology has had on the motor vehicle industry.
2. Research the GPS technology used in one of these industries: farming, construction, mining, surveying, package delivery or logistical chain management.

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.

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, 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.

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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.



Figure 17.3 The CSIRO research hub in Melbourne

ACTIVITY 17.2

Visit the CSIRO website (see http://cambridge.edu.au/redirect/?id=138). 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.

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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.

The standards (published documents) are used to define the criteria to ensure products, services and systems operate reliably and safely in the manner that is intended. 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.

> 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.
>
> 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, http://www.standards.org.au/StandardsDevelopment/What_is_a_Standard/Pages/default.aspx*

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 Australia to protect their designs. A range of different types of protection exist 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: GymLink, http://www.gymlink.com.au/gymlink.php?content=fitness-business-ip-protection

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



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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 (see http://cambridge.edu.au/redirect/?id=139) for more information.



Figure 17.4 Durable polymer bank notes are an Australian innovation.

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.

Through the Small Business Council and its website (see http://cambridge.edu.au/redirect/?id=140), 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 (see http://cambridge.edu.au/redirect/?id=141).

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 (see http://cambridge.edu.au/redirect/?id=142) 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

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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 (see http://cambridge.edu.au/redirect/?id=143) 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 (see http://cambridge.edu.au/redirect/?id=144) for more information.

ACTIVITY 17.3

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.

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.



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Figure 17.5 Gary Gale's invention – knitted plastic shade fabric

Some successful entrepreneurs who possess many of the characteristics listed on page 171 are:

- Craig Winkler – founder of the software company MYOB
- Nabi Saleh and Peter Irvine – developers of the Gloria Jean's franchise in Australia
- Brian Dolling – inventor of a plastic wine stopper
- Bruno Schiavi – creator of the Pocket Sock
- Gary Gale – inventor of a knitted plastic shade fabric.

ACTIVITY 17.4

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 make 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 17.5

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.
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.



Figure 17.6

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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, but can be defined (in the context of designing) 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 is the 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 you can learn from such a task 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 to be 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 (see http://cambridge.edu.au/redirect/?id=145)
- Dinosaur Designs (see http://cambridge.edu.au/redirect/?id=122)
- Alessi (see http://cambridge.edu.au/redirect/?id=146)
- Collette Dinnigan (see http://cambridge.edu.au/redirect/?id=147)
- Powerhouse Museum (see http://cambridge.edu.au/redirect/?id=148)
- Car Body Design (see http://cambridge.edu.au/redirect/?id=149).



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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 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. 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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CASE STUDY 18.1

HSV: The design of a new Australian model

Styling and engineering

The design intent for all HSV vehicles is for the customer to have a car that is instantly recognisable as an HSV product. Although the vehicle is based on a Holden product design, changes are made to give it a significantly different style to a Holden. Changes to the styling of front and rear facias, side skirts, tail lamps, front fenders and wheels have been used in different combinations in the past. Interior styling is also altered by the use of different fabrics, colours and designs. Seating is designed to give a more sporty feel by the addition of HSV-designed substructures and foam supports.

As HSV is a performance-based company, styling needs to be bold and aggressive. This is achieved by the use of larger diameter and width wheel sets, lower suspension stance and lower, more aggressive body additions.

HSV has its own modelling studio where viable concepts are clay-modelled in 1:1 scale for reviewing. Once the HSV product group has signed off a design in clay, the model will be digitised and transferred to CAD data for use by the engineer.

The HSV engineers work closely with the stylists in order to meet the performance parameters of the car. HSV are not just dressed up Commodores, but are genuine engineered vehicles with enhanced performance. This philosophy means up to 30 engineers are involved in the development of the car.

They are responsible for ensuring the whole package works together. Every component is developed, tested and evaluated along with the visual package. Performance of all components is critical and quality of the complete car requires all aspects of the supply chain to be on board to deliver. This is why it takes three years from concept sign-off to production time to develop.

Changes to the major components such as engines meant that brakes and suspension required some clever engineering. Additional engine performance in the GTS model required significant development of greater cooling requirements at the front of the car. Seen in the pictures on page 178 is the front facia of the Clubsport model and the GTS. The changes under the facia are even greater, with a complex series of cooling ducts needing to be developed, thus changing the face of the car.

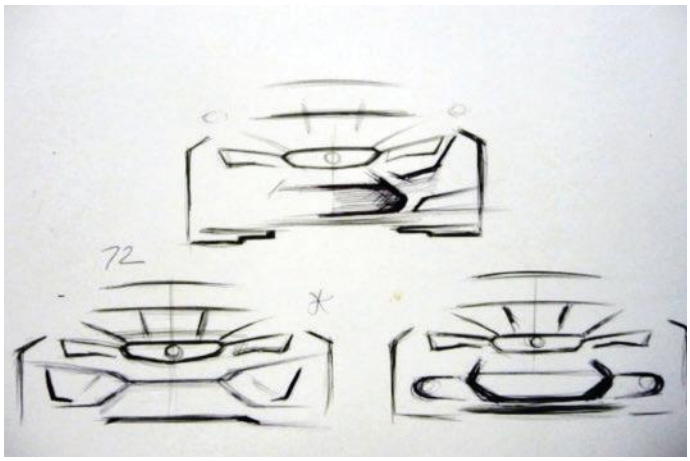
Without the engineers and stylists working together to develop the Gen-F model, HSV would not have been able to bring it to market with assurance to customers that it would be a functional performance vehicle. Once both stylists and engineers are satisfied that they have a design ready to go, they will work with component suppliers to develop the parts to the specifications needed. Brakes, suspension, engines, seating, tail lights and body work are all developed with the suppliers so that the product performs as an HSV should.



Figure 18.2 This GTS is complete – all assembly, testing, quality assurance checks with data dots and ready to go.

Source: Pictures and words with kind permission of HSV. Many thanks to Andrew Purcell of HSV Customer Relations.

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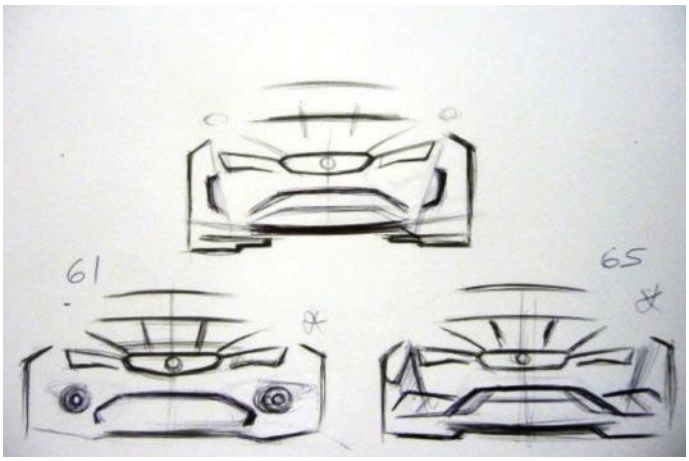










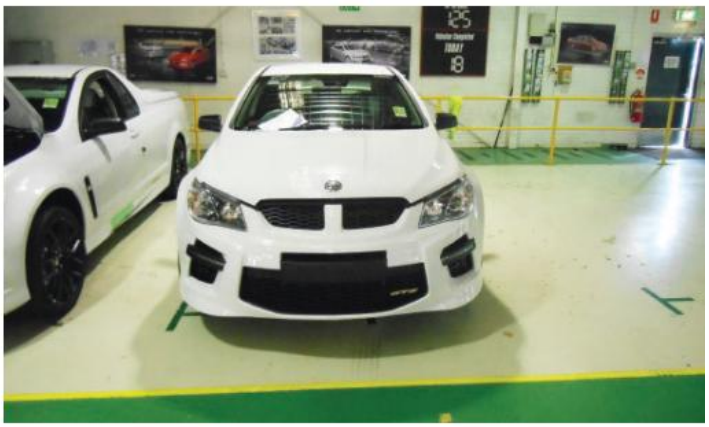


Figure 18.3 All to get to the finished product waiting to leave the factory floor

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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 may 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 above and how they have or have not impacted on the work of your chosen designer.

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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 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:

holistic
an approach that emphasises the importance of the whole

- 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?

CASE STUDY 18.2

Barrier Reef corals deliver world first for sunscreen

CSIRO, in partnership with skincare company Larissa Bright Australia, has created the world's first UVA/UVB sunscreen filters which mimic the natural sun protection used by corals on the Great Barrier Reef.

The breakthrough paves the way for a new generation of sunscreens which harness the same protective barriers developed by Australia's Great Barrier Reef corals over millions of years to survive in the harsh Australian sun.

The new UV filters are resistant to both UVA and UVB rays and are clear and colourless, which means they can be used in any cream emulsion.

CSIRO scientists have spent the last two years adapting the coral's sunscreen code so that it can be safely used as an ingredient in human sunscreen. The coral's sunscreen was improved to create a suite of 48 new sunscreen filters.

The research builds on work by scientists at the Australian Institute of Marine Science (AIMS), who were the first to discover the natural sun-screening ability of coral on the Great Barrier Reef.

Larissa Bright Australia, in partnership with AIMS, studied the results of over 20 years of AIMS research into how shallow-water corals protect themselves from UV light before approaching CSIRO.

'We wanted to find a way to convert this natural method of coping with exposure to the intensive UV rays from Queensland's sunshine, into a safe and effective sunscreen for human use,' Larissa Bright, company director of Larissa Bright Australia, said.

'We feel these filters will set a new standard in broad spectrum sunscreen. They mimic the natural sunscreen coral

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Figure 18.4 Larissa Bright and Dr Mark York

has developed and used over millions of years,' she adds.

CSIRO research scientist Dr Mark York, who led the research project in conjunction with senior research scientist Dr Jack Ryan, said: 'The molecular make-up of the coral's natural sunscreen filter was quite complex, but the real challenge was modifying it so that it was resistant to both UVA and UVB radiation in one molecule, which is what makes these filters so unique.

'The filters are clear in colour, virtually odourless and very stable, which makes them easy to be incorporated into any emulsion,' he adds.

AIMS research director Dr Jamie Oliver is very pleased to see their research used as the foundation for this exciting development. 'This is another example of AIMS researchers providing the science to underpin the use of Australia's tropical marine resources in an innovative and beneficial manner,' he said.

The broad spectrum coral sunscreen filters are expected to be available to consumers across the globe within five years. The research conducted by CSIRO was part of Enterprise Connect's Researcher in Business Program, which places scientists into industry to assist Australian research and development projects.

Source: CSIRO, http://www.csiro.au/portals/media/barrier-reef-corals-deliver-world-first-for-sunscreen

ACTIVITY 18.2

Critically analyse the innovation described in Case Study 18.2. 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.

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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 sunscreen filters outlined in Case Study 18.2 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. Outline reasons why some products of good quality are rejected by customers.
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 Larissa Bright differ in their design processes?

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?

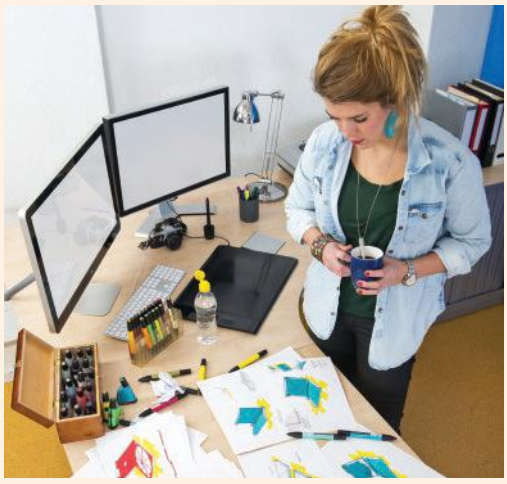


Figure 18.5

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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.*



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19.1 Researching and developing ideas

Try to approach your major design project (MDP) with an open mind. Look for everyday problems that consumers encounter, flaws in existing products and opportunities that are waiting to be explored. 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.

ACTIVITY 19.1

1. Cognitive organisers are useful when generating ideas. Create a spider diagram or mind map about 'My interests, hobbies, 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.
2. Create a table. For each problem identified, make a list of possible solutions. Think big at this stage and explore every option. For example, one of your interests may be tennis. A problem may be the expense of having your racquet restrung when you break the strings. Possible solutions could include finding a stronger material for the strings, a less expensive process for restringing racquets or a complete redesign involving an alternative to strings!

Identification and exploration of a need

Ideally, you should begin by identifying a need or recognising an opportunity. This is not always easy to do, so begin by asking questions about products and services that you have used. A need may be the solution to a problem you have encountered.

- 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?

Every day we encounter products, systems and environments that could work better. You may identify an opportunity to improve an existing product. This could be the result of:

- exploring alternative energy sources, such as solar power, to create a product that is more energy-efficient
- selecting renewable resources for production to reduce environmental impact
- using different manufacturing processes to produce the product more economically
- creating a multifunctional device that combines the function of two or more products.

The opportunity 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 may be designer-driven, fuelled by the designer creating products that will hopefully be desirable to consumers.

It is important to realise that, while your MDP should demonstrate quality and innovation, it does not necessarily have to be something brand new. Many innovative products are the result of design modifications

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enabled by advances in technology, materials, tools, creativity or knowledge.

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. The answers ensure that the product being developed is in direct response to what the target market desires. Conducting a needs analysis can help you to find a **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.

Some questions to guide your needs analysis may include:

- What type of need have I identified? Is it a personal need, a community need, an environmental need or other?
- Who will want to use my product? What is my target market?
- What do they want or need the product to do?
- How do existing products fail to meet this need? Have I identified a niche?
- What demographic features identify this group?
- Can I alter aspects of my design to make something that will appeal to a wider target market?
- Can I produce a product that is both desirable to the target market and economically viable?

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.

Your needs analysis will assist you in developing your individual design proposal. This should take the form of a design brief, which broadly outlines what you 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. 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.

niche
a gap in the market; a small, specialised group of consumers for whom no adequate product exists

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.



Figure 19.1
Communicating the news via different media

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CASE STUDY 19.1

Printed solar panels

Free power from the sun was the promise of solar technology. However, decades after developing the ability to capture the sun's energy and convert it to useable electrical energy, we are still a long way from developing a commercially viable alternative that is cheap enough to replace conventionally produced electricity.

Problems with solar panels currently available include the high cost of manufacturing and the low efficiency. But a new and improved design utilising 3D printing may eliminate many of these problems.

Australian researchers from the Victorian Organic Solar Cell Consortium (VICOSC) – a collaboration between CSIRO, the University of Melbourne, Monash University and industry partners – have managed to print large, paper-thin, lightweight, flexible solar panels. The A3-sized panels are created by laying a liquid photovoltaic ink onto thin, flexible plastic utilising a new printer worth $200 000 at the CSIRO laboratories. This is not a new technology, but the ability to create such large cells and apply them to a thin flexible film is a breakthrough. Three years ago, the largest cell produced using this method was just the size of a fingernail. Today cells that are 30 centimetres wide can be produced. Exhaustive research, testing and iterative design developments have finally paid off.

While purchasing this printer technology is well out of the reach of everyday consumers, the consortium believes that with 3D printing technology progressing so rapidly and prices falling in response to demand, in the foreseeable future we could all have the ability to print our own solar panels at home.

The short-term application of this technology is for consumer devices and integrated electronics, such as embedding the panel into the case of a laptop computer or mobile phone to extend the battery life. Longer-term applications include integration into exterior surfaces of office blocks and skyscrapers, adhering to windows and roofs to capture the sun's energy.

While a process for producing large quantities of inexpensive solar panels is certainly a breakthrough in the quest for a viable alternative energy source, the problem of how to store solar-produced electricity to use when the sun is not available is an ongoing problem. Battery technology has greatly improved and may be an option for remote locations; however, it is an expensive solution. In populated areas, the option of individual households selling solar-produced electricity back to the electricity distributors is available. Utilising a two-way metering system, households pump excess solar-produced electricity back into the grid during sunlight hours and draw from the electricity grid when energy is needed at night.



Figure 19.2 Dr Scott Watkins of the CSIRO with a printable solar panel

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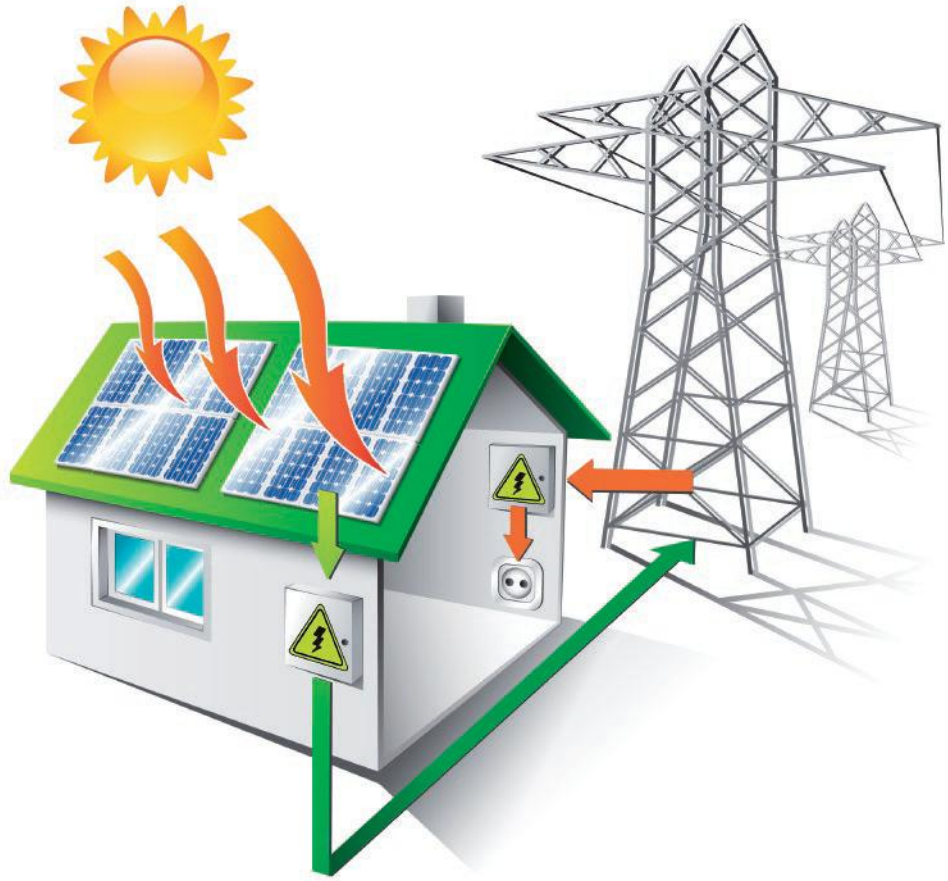


Figure 19.3 A home using the electricity grid to store solar energy

Areas of investigation

Just as a designer would carry out a thorough investigation of everything from options of materials and suppliers to competition in the market prior to committing to the expense of setting up manufacturing, you will need to investigate all possibilities that may impact both positively and negatively on the success of your MDP.

Begin by making a list of all the things you need to find out about in order to design and construct your MDP. This list may grow as you investigate and discover things like new techniques and alternative materials that you may not have considered. Make sure you list relevant areas to investigate that will assist in the development of your project. You can record your areas of investigation using mind maps or tables, but you need to explain how and why the investigation is important to your individual MDP. Do not forget to evaluate this section, explaining how your investigations have impacted on the development of your

Table 19.1 Areas of investigation

What
What is to be investigated Make a comprehensive list of everything you need to find out about. Keep it relevant to the design and development of your MDP. If you include something for investigation, make sure you investigate it.
How
How you will investigate it Will you use books, magazines, professional journals, the internet, talk to experts, look in shops and catalogues and so on? Will you use a primary or secondary research source? Use multiple forms of communication to record your findings.
Why
Why this factor is important How will finding out about it impact on the success of your MDP? What would be the result of not investigating this factor? How will this research help in the development of your MDP?

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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.

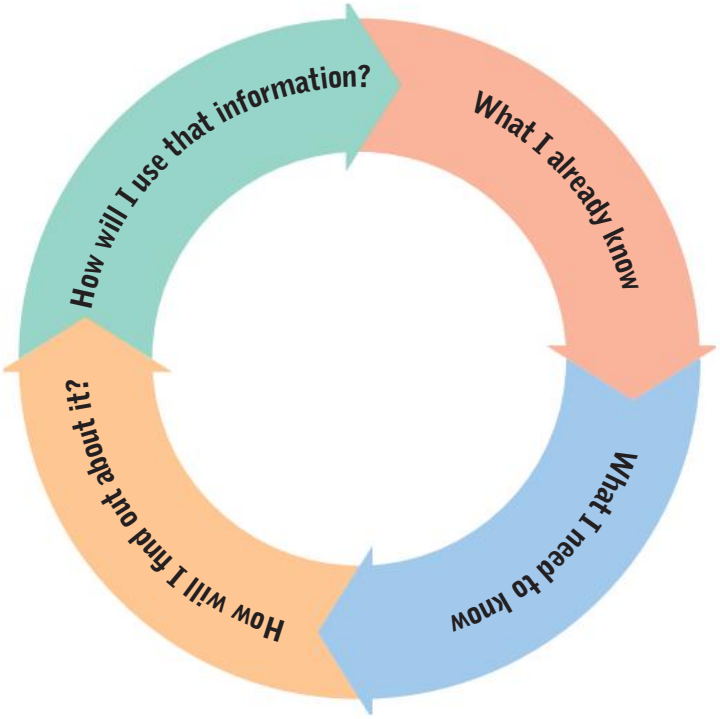


Figure 19.4 Investigation cycle



Figure 19.5 How will you investigate?

19.2 Parameters of design

All designers work within boundaries or parameters. These are constraints or restrictions to which the designer must adhere. 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, Board of Studies, Teaching and Educational Standards NSW 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
- size.

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 set out to achieve and provides a standard against which success can be measured. It is a vital tool that you will use throughout the development of your MDP to evaluate your work, determine your success and ensure that you are staying on track. In other words, you will 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.

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The criteria must clearly relate to the need or opportunity you identified and/or should answer the problem identified in the design brief.

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. You may also consider adding criteria to address areas such as cost/budget, safety, sustainability, ergonomics, time management and intellectual property.

To gain top marks in this section, 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.

Criteria	Critical analysis	Impact if not achieved	Standard to achieve
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?	What is the minimum requirement to consider this criterion has been achieved?

Table 19.2 Criteria to evaluate success

19.3 Research and experimentation

Research and experimentation will occur throughout the design and development of the MDP. Sometimes it will 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.

Make sure that you are selective. 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 the experience and knowledge of others to help in the production of a product. Research can be obtained from a variety of sources:

- 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. The value of the internet lies in the fact that the information is current and up to date.



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- Journals and professional magazines: Use these whenever possible, as the data are considered reliable. Journals are excellent for inspiration about current trends and fashions and to gain exposure to the work of Australian designers.
- 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.
- Interview and observation: These allow us to share the knowledge and expertise of professionals and practising designers. Expert opinion and guidance from those with greater skills and knowledge are always valuable, but be aware of personal opinion and bias when taking advice.

Figure 19.6 Primary research





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 evidence, both physical and photographic, of all testing. When compiling your folio, be selective and only include material that is relevant and that best highlights your design development.

Research will create an accumulation of information for you to draw upon when working through your project. Again, keep everything, but do not include everything in your folio. Be selective and summarise the findings of your research, including only those sources that had an impact on your design decisions. Use a bibliography to appropriately document the sources of information.

Primary research

This requires interacting with potential consumers, existing products, manufacturers and suppliers to collect first-hand evidence. Your primary research 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
- conducting surveys, interviews and questionnaires with potential consumers, manufacturers and retailers
- evaluating the findings of primary research and explaining the impact of this information on the development of the MDP.

Use a variety of techniques to record and display your results.

Figure 19.7 A survey can provide valuable quantitative data.

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Secondary research

Secondary research means drawing on the findings of others using established information and knowledge.

- Search on the internet – it is a wonderful tool for secondary research.
- Use statistical data such as census information to justify decisions about your target market.
- Use your local library – read research articles and technical journals for current information.

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 research methods and secondary research methods you will use to get the information you need. 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.



Figure 19.8 Secondary research

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.

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Testing and experimentation

Do not conduct meaningless or irrelevant experiments. Carefully consider what your project hopes to achieve, how and where it will be used and who will use it to establish a list of tests that will positively impact on the development of your project.

Examples of relevant materials testing for an outdoor chair could include:

- strength tests
- heat tests
- UV resistance tests
- waterproofing tests
- durability tests.

Each experiment should be written 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
- 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.

Models and prototypes

Testing does not only mean scientific experiments. It should also include models and prototypes that have been used at different stages of the design process to test and refine ideas. These 3D communications are important evidence of your design development and should reflect design modification in response to the findings of other research and testing. A series of models can show the journey of your design project from a rough idea to a functional prototype. Label and display all models and prototypes as evidence of process for the markers.

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



Figure 19.9 Testing and experimentation

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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. Testing of construction and joining techniques, surface finishes and decorative techniques, and research into possibilities for reproduction using 3D printing and lost wax casting may be far more appropriate in this situation.

To demonstrate that the results of research and testing have been incorporated:

- 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 annotate and evaluate your sketches.
- Analyse and evaluate the results of tests and apply them to your MDP. If your experimental work shows that a particular material is the most suitable for the construction of your project, you should be using that material in your final product. You must justify your selection if you choose to use something different.
- 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, but may be pointless if you are creating something to suit your own personal taste.
- If you do conduct surveys, graph the results and analyse the findings. 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 an entertainment unit, but a production drawing with front and back views, list of notions, sample fabrics and colour choices may be more appropriate to a garment.



Figure 19.10 Creating a final design drawing

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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.
- 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 standards that the design solution must meet in order for it to be deemed a success. Establish and analyse your criteria – do not just list or describe them.
- A good MDP folio will succinctly communicate the journey that the designer worked through when developing the design solution.
- 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.
- 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 design development.

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 current and future needs may be addressed by the development of the printed solar panel?
6 What is the 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?



Figure 19.11

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Extension tasks

1 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?

2 Conduct a reverse-engineering exercise of a familiar product – something you use regularly or a product you have studied in class. Imagine that you are the designer of that product and consider how and why decisions and choices were made that led to the development of the finished product.
   - **a** What need or opportunity was initially identified?
   - **b** Create a mind map of possible design solutions that may have been considered.
   - **c** List areas of investigation (how, what and why) that may have directed the designer.
   - **d** Write a design brief that could have been developed for this project.
   - **e** Develop and analyse functional and aesthetic criteria for the project.
   - **f** Make a list of possible tests and experiments the designer would have conducted in order to successfully complete the project.

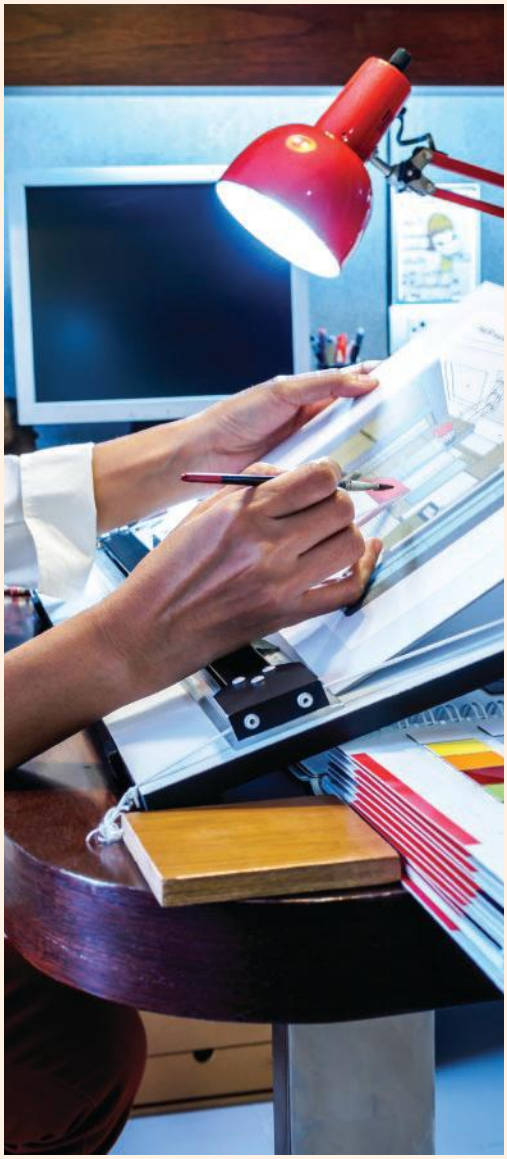


Figure 19.12

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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



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.

With the introduction of the *Work Health and Safety Act 2011*, designers are now even more responsible for the products, systems and environments they create (see http://cambridge.edu.au/redirect/?id=150).

They must consider safety as a prime need in any process they undertake and as a result of any action they perform. This means consideration of safety throughout the whole major design project (MDP) must be a priority and documented accordingly. Everything from the selection of materials to be used, manufacturing methods to be undertaken, intended purposes and use of the MDP through to the end of life or new life of the project (understanding the target audience is a factor here), 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.

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 (see http://cambridge.edu.au/redirect/?id=142) 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.

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 with Australian laws. You, as the designer of



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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 creates 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.

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 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 are remaining safe while being creative in the workshop.

Figure 20.2 Always review the safety material before operating machinery.

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.

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 the 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?

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 (see http://cambridge.edu.au/redirect/?id=151).

Welding safe operations procedures



Welders are at risk of burns, explosions, radiation, electrical shock and exposure to fumes. Please ensure you understand all safety procedures before using the equipment and report any problems to your supervisor.

Before using this equipment

1. Check that all Personal Protective Equipment (PPE) is readily available and in good condition. Once you are wearing all PPE ensure you have not missed any items.
2. Ensure fire extinguishers and first aid equipment appropriate to the procedure are readily available.
3. Ensure protective screens are in the correct place in order to protect other workers. General access to the welding area should be restricted to the welder only.
4. Check that all ventilation/extraction is operating and appropriate for the welding process.
5. Remove any flammable or combustible material located near the welding area.
6. Check all hoses, leads and equipment for damage and ensure threads and fittings to oxygen supplies are clean and oil-free. If there is any damage do not use the equipment.

While welding

1. Do not remove any PPE.
2. Remain at least 6 m from flammable material.
3. Protect any hoses, leads and equipment from hot metal to avoid damage.

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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:

- research on safe operating procedures
- safety tests
- reference to **material safety data sheet (MSDS)** information (see below)
- 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)**.

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.



Figure 20.3 A selection of personal protective equipment

material safety data sheet (MSDS) describes the identity, relevant hazard information, precautions for use and safe handling of a hazardous substance

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. Some websites containing useful information are:
   - Safe Work Australia (see http://cambridge.edu.au/redirect/?id=152)
   - National Safety Council of Australia (see http://cambridge.edu.au/redirect/?id=153)
   - MSDS FAQ (see http://cambridge.edu.au/redirect/?id=154)
   - SafeWork NSW (see http://cambridge.edu.au/redirect/?id=155)
   - Chemicals Australia (see http://cambridge.edu.au/redirect/?id=156).

personal protective equipment (PPE) a device or appliance designed to be worn individually to protect the user against potential hazards

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20.2 Ethical issues

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?

CASE STUDY 20.1

Designer profile: Ricky Barry

Ricky Barry is a small-scale Australian fashion designer who is concerned with sustainability and ethically creating clothing for people who want something unique. His summer collection, inspired by the concept Mother Earth, illustrates design that is efficiently sustainable and ultra-modern.

Ricky is an ethical designer who takes a stand on offshore processing, and his website states:

> We do not export to or import from other countries and keep all of our products and services in Australia for all Australians.
>
> *Source: http://www.rickybarry.net/155417804*

Ricky's work can be found at Bellsridge Cottage, a venue that also takes an ethical stand on ensuring individually crafted products and no mass-produced or imported items are stocked. Its website states:

> Bellsridge also looks forward to a sustainable future by providing recycled and repurposed items that have been lovingly repaired, restructured, altered and given a new life.
>
> *Source: http://www.bellsridgecottage.com*

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

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Figure 20.4 Ricky Barry designs

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 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 of automotive manufacturing to stop production in this country in 2016–17 may impact on 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.

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.

As a responsible designer, you can also consider the different tools and materials you purchase. Buying Australian-made products is one way 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.

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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?

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.



Figure 20.5 A house designed by Richard Cole

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 – from lighting, acoustics, thermal control and plumbing through to 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.

Richard Cole is one architect who has taken on this challenge in his work. Richard believes that buildings not only shelter, but can provide a fundamental connection with the world, that they embody the way we choose to dwell and they 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. Another 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.

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Figure 20.6 Students should think about the impact of their design on the environment.

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. Her justification detailed the research gleaned from a strength test of glues as well as a chat with an industry professional on what glues she could use. 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



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realisation of her 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. People are resources, and so is money.

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 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.



Figure 20.7 Detailed justification of resources strengthens your folio.

ACTIVITY 20.5

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 their 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 and then 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 (see http://cambridge.edu.au/redirect/?id=157).
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 What does the acronym MSDS stand for? What are they used for?
7 List some examples of PPEs.
8 Explain the difference between a hazard and a risk. Can you 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.

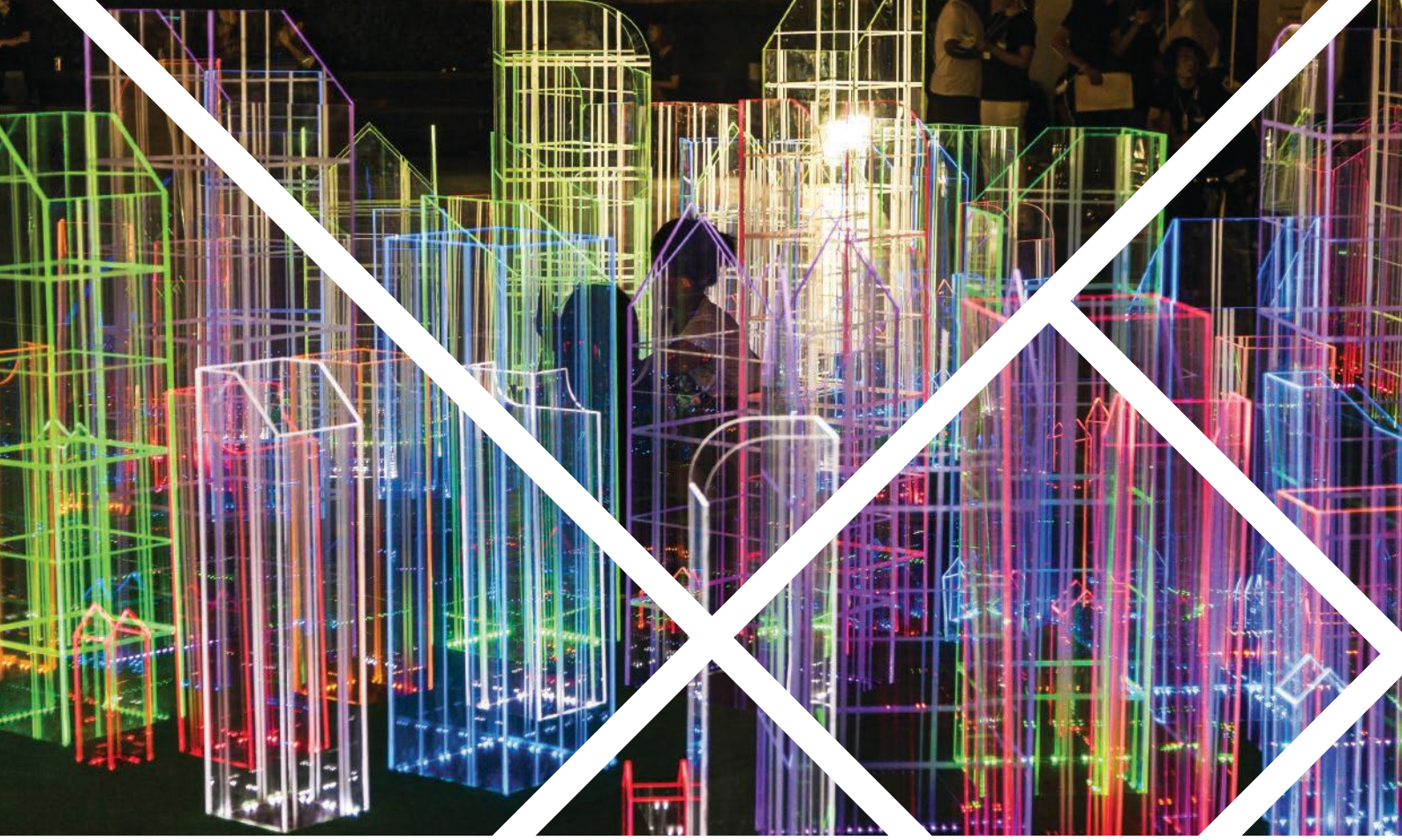
Extension tasks

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 20.8

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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.*



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21.1 Project evaluation

Functional and aesthetic criteria

Picture in your mind a set of scales; one side is labelled 'Function' and the other side is labelled 'Aesthetics'. Finding the right balance between function and aesthetics always poses a challenge for designers.

When it comes to identifying functional and aesthetic criteria of your major design project (MDP), you are asked to recognise and to distinguish these two fundamental design aspects. Present them separately, 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 it stays on track. The finished product should reflect your criteria – the things you selected as important. 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. Too many criteria can narrow your design to the point where you find it hard to evolve and grow your design as you learn along the way.

We need to examine how you will use the criteria you have set to evaluate:

- the level of success of processes undertaken throughout the design and construction of your MDP
- the overall success of the MDP in relation to the need or opportunity identified in the project proposal
- the impact of the MDP on the individual, on society and on the environment.



Figure 21.1 Skyscrapers in Abu Dhabi – balancing function and aesthetics

ACTIVITY 21.1

Consider the design requirements of the following three products:

- a swimsuit to be worn by members of the Australian Olympic swim team
- a pair of women's high-fashion stiletto-heeled shoes
- a competition-level tennis racquet.

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.

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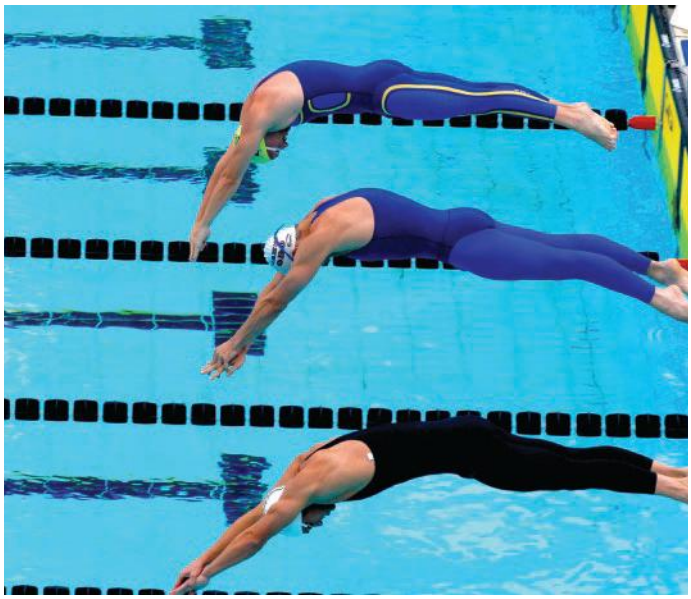


Figure 21.2 Olympic swimming team in high-performance swimsuits



Figure 21.3 Women's fashion shoes



Figure 21.4 A high-performance tennis racquet

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 take place after you have completed your MDP. Ongoing evaluation is essential to ensure you stay on track and produce the best possible outcome to meet the need or opportunity you identified. Documenting your ongoing evaluation allows for reflection on what has happened and the opportunity to plan for what is yet to come.

As the designer and producer of your MDP, you will continually be called upon to make decisions. From your initial thoughts and concepts, to the finishing touches on your project, you will make selections that will impact on the outcome 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 design development and justify why things changed

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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 that 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.

Table 21.1 Criteria for success for a range of culturally inspired jewellery pieces

Functional criteria	Critical analysis
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.
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.
Aesthetic criteria	**Critical analysis**
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.
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.

Table 21.2 Evaluation checklist for an MDP

- [ ] Go back and read your identified need or opportunity. What are you trying to achieve?
- [ ] List and evaluate what you want the project to do (functional criteria).
- [ ] List and evaluate what you want your project to look like (aesthetic criteria).
- [ ] Develop criteria that are appropriate and achievable.
- [ ] Check the criteria against the identified need or opportunity. Will the need be met if the criteria are achieved?
- [ ] Refer to your criteria regularly throughout the development of the project.
- [ ] Evaluate against the identified need or opportunity throughout the development of the project.
- [ ] Record your analysis of the criteria and the process you worked through to achieve success as ongoing evaluations.
- [ ] Evaluate the finished project against criteria for success and the identified need or opportunity.



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unambiguous has a clear meaning that can only be interpreted in one way

Clear, **unambiguous** criteria written in positive, achievable terms make it easy to see whether you have wandered off the 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. 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.

ACTIVITY 21.2

1. Select a familiar product that you use every day, such as your mobile phone, a bag or wallet, or your favourite jacket. Describe the functional and aesthetic criteria the designer of this product may have set when it was under development.
2. What other criteria, such as sustainability, would you consider if you were designing products targeting the same market?

Your design folio is the documentation of all steps worked through to complete your MDP. 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. If you painted your project deep blue in line with a marine theme, there should be an evaluation explaining why you chose that colour.

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, the reader can locate your evaluation headings and easily understand the processes you have used. When completing the final section of the folio, you will have ample evidence of application of ongoing evaluation that can quickly be referenced by the marker.

ACTIVITY 21.3

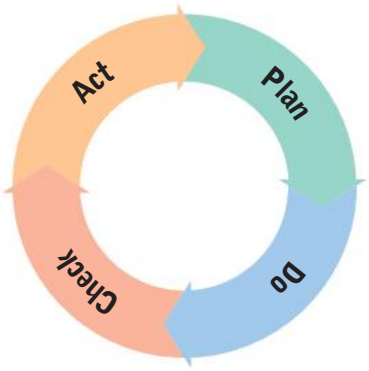
1. Develop a symbol that you will use to draw the marker's attention to your ongoing evaluation.
2. Create a theme and/or colour scheme to use for your ongoing evaluation.
3. Consider using a different font or coloured writing for ongoing evaluation.

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.

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.

Check Is it working? Determine the level of success of this step/process. Compare back to criteria for evaluating success.



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.

Figure 21.5 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.

21.3 The importance of practical research

Whenever you see the word 'testing', it really means practical 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, a good design folio is one that tells the story of how you arrived at the final solution.

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. Individual tests should flow from these needs. However, as you plan and 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 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. It may allow 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 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 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 the development of the design and usually fall



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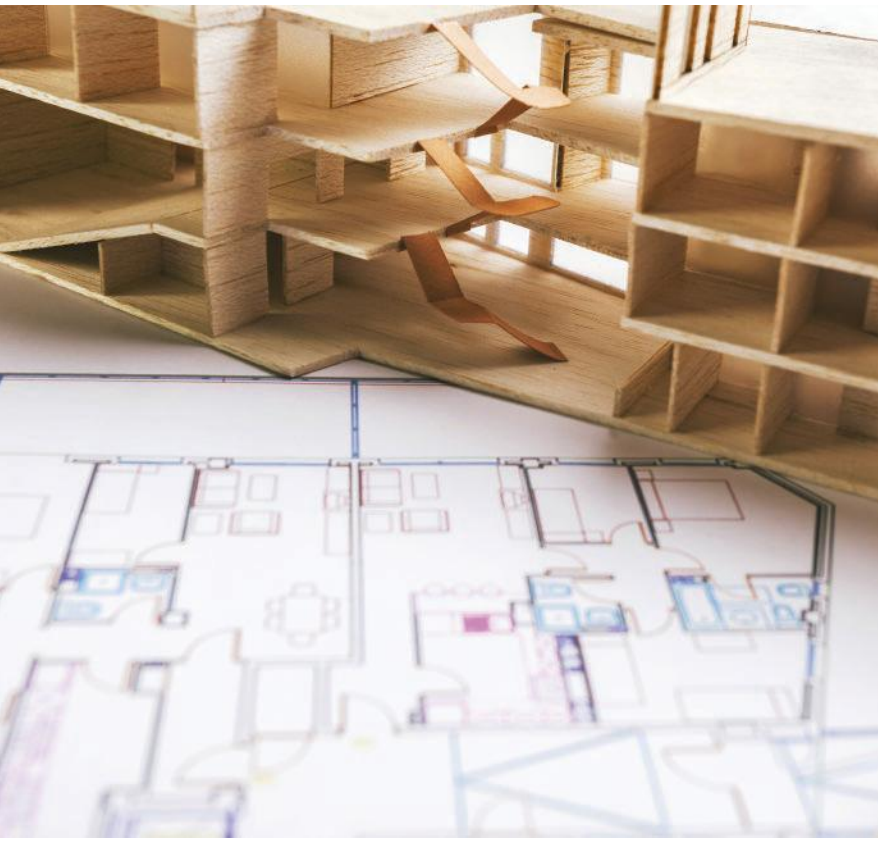




Figure 21.6 Models can be used to test design solutions and communicate ideas to the client.

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. Materials 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. Often used to show a client or focus group to allow evaluation of 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 design 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.

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.

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21.4 The impact of the MDP

All forms of designing and producing have widespread impacts that need to be considered. Impacts 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 consumer or end-user:

- 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?

Impact on society

Society may be viewed as a body of individuals living 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, the MDP has 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. Explore this fully, then try to extrapolate and consider the impacts if the project were developed for commercial production.



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CASE STUDY 21.1

Seeing Machines

Designed to reduce accidents caused by driver fatigue, the Driver State System (DSS), which has been successfully developed and implemented by Seeing Machines, uses eye tracking and facial recognition technology to monitor alertness and recognise symptoms of fatigue. The system is unlike many other fatigue monitoring systems on the market, as it is untethered, which means drivers do not have to wear devices such as a measuring cap or glasses that are plugged in to collect data for an in-cabin computer system.

Seeing Machines' research and development started in 2000 at the Australian National University. More than eight years of testing, prototyping, undertaking field studies and industry validation have gone into the development of this system.

The DSS In-Vehicle System (DSS-IVS) tracks a driver's head and eye movements using a console-mounted camera to produce a real-time assessment of drowsiness and distraction. The system uses complex eye-tracking **algorithms** and image-processing technology, is completely automated once activated and is suitable for all users, including those wearing eyeglasses, safety glasses or sunglasses. Microsleeps are detected instantly by the system and trigger both audio alerts within the cabin and vibration of the driver's seat. The driver does not need to wear special equipment, sit through any sort of calibration process or change their behaviour in any way. The system is installed into the cabin of the vehicle, not attached to the driver, allowing the driver to work as usual while the DSS monitors levels of fatigue and distraction.

Driver fatigue accidents may result in injury or death to the driver or others on the worksite and damage to expensive vehicles and machinery. While preventing drivers falling asleep at the wheel was the initial intention, the DSS has proven to do more than just reduce accidents. In addition, the DSS has been proven to increase awareness of worker fatigue and distraction, issues that negatively impact on employee productivity, and increase equipment maintenance and general running costs.

Visit the Seeing Machines website (see http://cambridge.edu.au/redirect/?id=158) for more information.

algorithm
a set of steps used to solve a calculation or problem

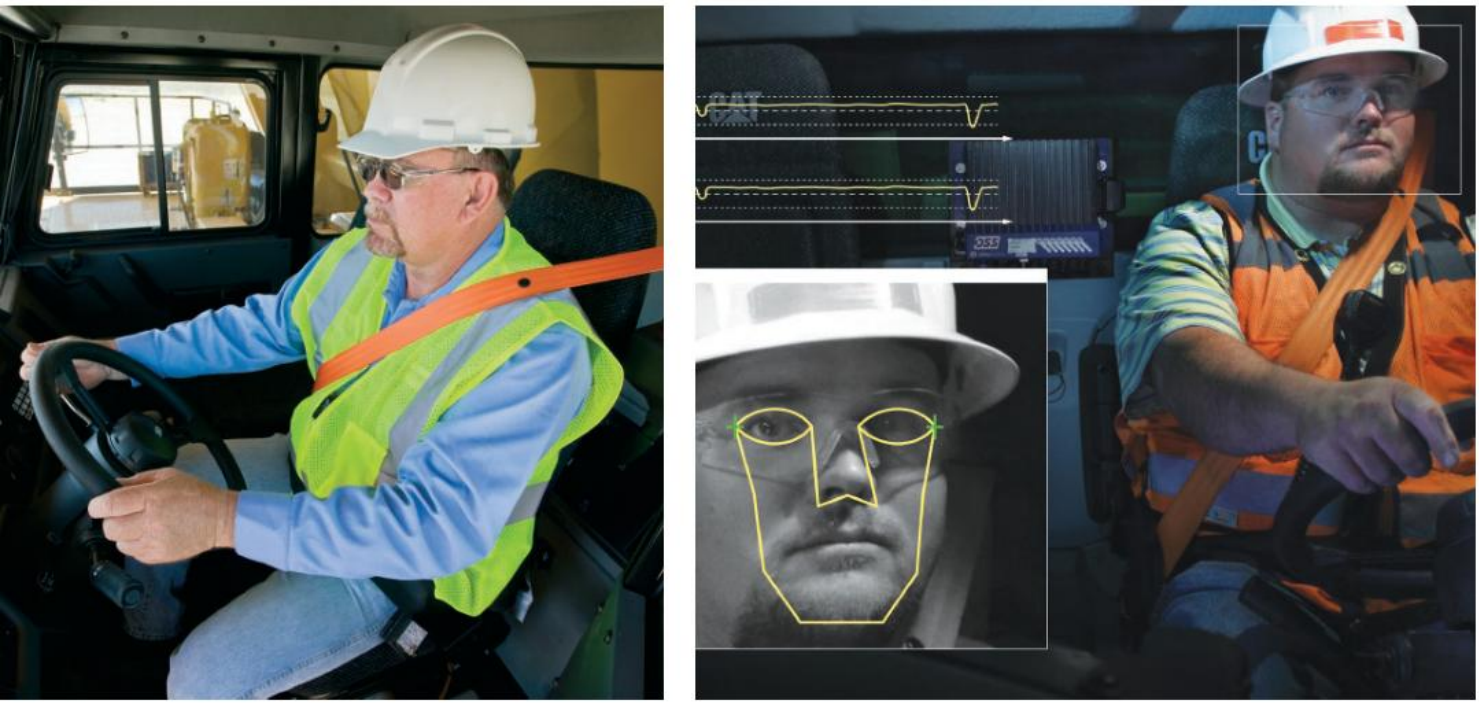


Figure 21.7 Seeing Machines' DSS In-Vehicle System

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ACTIVITY 21.4

1. Analyse the potential social or environmental costs and/or benefits of the DSS In-Vehicle System.
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 of systems that monitor workers and 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. 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 analysis of the resources used in the production of their MDP in this section. You may consider where all raw materials came from, how they were processed and transported to market, how manufacturers transformed these materials into saleable goods, how they impacted on the environment during the product's usage and finally, how the product was disposed of when no longer useful.

However, if you plan to construct a timber entertainment unit for your MDP, a life-cycle analysis of the production of plantation timber is not the only way to consider the environmental impact of the product. You need to look at the impact on the environment in which it is to be used. Will it blend in with the surrounding decor and colour scheme? Does it serve the purpose for which it was designed? Will it enhance the space and make life easier and more enjoyable for those interacting with it? Will it promote a sense of pride in workmanship for the designer? Will it create a focal piece or conversation starter?

Definitely examine the impact on the physical environment by considering all inputs (resources) and all outputs (wastage and pollution), but do not ignore the impact of environmental usage. 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.

21.5 Final evaluation with respect to the project proposal

Above all else, remember that your MDP was the solution to a problem in response to an identified need or opportunity. Clearly explain 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.



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Chapter summary

- Functional criteria and aesthetic criteria are separate, but related to each other. In identifying these two types of criteria, designers need to develop a close relationship with their clients and a thorough understanding of their needs.
- In order for designers to develop their ideas, 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, 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 evaluation to keep the project on track.
- When assessing the impact of the MDP on the individual, it is important to consider 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 effect on a group of people with a common interest.
- The environmental impact could affect a macro-environment (the world, its air and water) or a micro-environment like a bedroom or classroom.

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. What role do function and aesthetics play in your MDP?
2 Describe the testing that you conducted in your MDP. Explain the consequences of the testing.
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. Explain why.
6 Consider the impact of your MDP on the environment and suggest how you could reduce its environmental impact.
7 Name three products that have a negative impact on the environment.
8 '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?
9 Why is the development of models and prototypes an important part of the design process?
10 What are design solutions? How and when should they be tested?
11 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 Seeing Machines DSS In-Vehicle System 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 on the resources that you will use for the construction of your MDP. Critically analyse the environmental impact of your project. 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 range of designers working collaboratively to develop a product. A design team typically consists of a diverse range of talents and experiences coming together to share skills and expertise to develop the best possible end product. Engineers, material specialists, industrial designers, accountants and marketing representatives make unique contributions at different points throughout the development of a product. The situation is very different in the Design and Technology 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!

You are the designer, the manufacturer, the financial adviser, the advertiser and marketer, and sometimes even the client and end-user. Above all else, you are the project manager of your MDP. 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.

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.

Before you embark on the MDP journey, ask yourself the following questions:

- What do I need to do?
- How much time do I have?
- How much will it cost and can I afford it?

These questions relate to the three key areas of project management, which are:

- the action plan
- the time plan
- the finance plan.

22.2 Action planning

Creating a list of all the possible actions required to take your MDP from initial concept through to finished product may seem beyond your ability in the early stages of the project. While you should have identified a need or opportunity, you have not yet worked out all the details about what you will use to resolve the problem. A brainstorming session is a good way to begin developing your project action plan. If your MDP is based on the requirements of a client, it is important to carry out this brainstorming with the client present.

Begin with an overview or initial action plan that lists the major steps that will take place as you develop your project. 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 the project develops, refine your action plan to show the acquisition of knowledge and understanding gained from

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research and testing. For example, initial research may reveal that the most appropriate material for your project, an outdoor setting, is one that is durable, relatively lightweight, and resistant to weathering and UV damage. You can show design development by modifying or adding to your initial action plan, refining broad actions into a series of specific actions in the form of tests, which will inform the future direction of the project.

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 end product. 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 of knowledge or ideas that are not suitable, practical or achievable. For example, a client has selected fabric for a garment that will not perform as desired. The designer can guide the client to consider a more appropriate fabric.

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.



Figure 22.1 Discussions with the client will help a designer meet the identified need.

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.

SWOT analysis an analysis of the strengths, weaknesses, opportunities and threats associated with an idea or a product

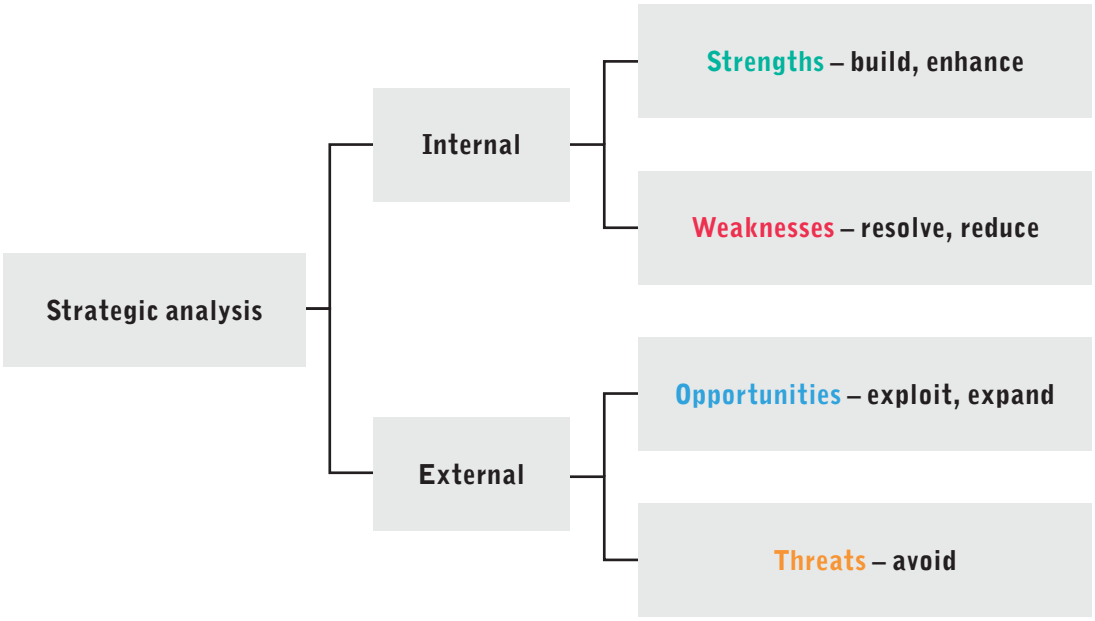


Figure 22.2 A SWOT analysis

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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 **prerequisite** steps that need to be carried out before they 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.

prerequisite
a prior condition or thing needed before something else can happen

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. 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 your MDP within the given time frame. When formulating your time plan, break the project down into smaller sections. Considering the three sections of the folio may be an obvious starting point (see Table 22.1).

Table 22.1 The three sections of the design folio

Project proposal and project management	• Identify and explore the need. • Carry out initial research. • List areas to be investigated and research to be undertaken. • Formulate action, time and finance plans. • Carry out ongoing evaluation on progress to date.
Project development and realisation	• Document idea generation and show design development of initial ideas. • Explore existing ideas for inspiration and to demonstrate degree of difference. • Consider design factors relevant to the development of the project. • Conduct a series of relevant tests to determine the selection of appropriate tools, materials, techniques and design solutions. • Conduct relevant research to assist in the development of the MDP. • Apply conclusions from research and testing. • Justify ideas and resources used. • Complete a quality product.
Project evaluation	• Record and apply evaluation throughout the design project. • Analyse and evaluate the functional aspects of design. • Evaluate the project's impact on the individual, society and the environment. • Relate the final product, system or environment to the project proposal.

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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 only use the folio headings in your action plan. Make it real, showing how you were the designer, manager and producer of your MDP. List 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 the practical hands-on development and application of skills that occurred throughout the process.

Creating a time/action plan

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. Write the allocated time in days or weeks beside each step. You need to develop a time scale and method for displaying your time/action plan that is meaningful to you and that will help you achieve your goals.

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 time to a task, record the actual time taken to complete the task, then justify why there is a difference between the two (projected time versus actual time taken). 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.

There are two types of actions that need to be considered when creating your plan. Some actions require prerequisite 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.

Figure 22.3 Sample of a time/action plan



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Figure 22.4 An overview time/action plan

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Just like your action plan, 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. It is a comparison between planned stages with estimated times and what actually occurred. You will **deviate** from your time plan and make changes along the way. Some things will take longer than expected. You may need to modify your design after your research and testing. Some steps may be eliminated because you may have discovered a more effective way of doing something.

Sometimes illness and workload from other HSC subjects will get in the way of your progress.

Problems encountered that result in changes to your time/action plan should be seen as a way 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 have occurred.

The method used to document your time/action plan is up to you. Many 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 differently coloured bars. They also allow quick comparison of the time allocated to tasks and the proportion of the entire project dedicated to different steps.

ACTIVITY 22.2

Using the actions you established in Activity 22.1, where you planned the after-party, create a Gantt chart to use as a time-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 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 a logical, sequential order.
2. Some actions can occur at the same time as others.
3. Some actions cannot occur until a previous step has been completed.

deviate to move away from an established route

Finance plan

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. Your MDP is no different. Considering all costs, setting financial goals 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 successful 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:

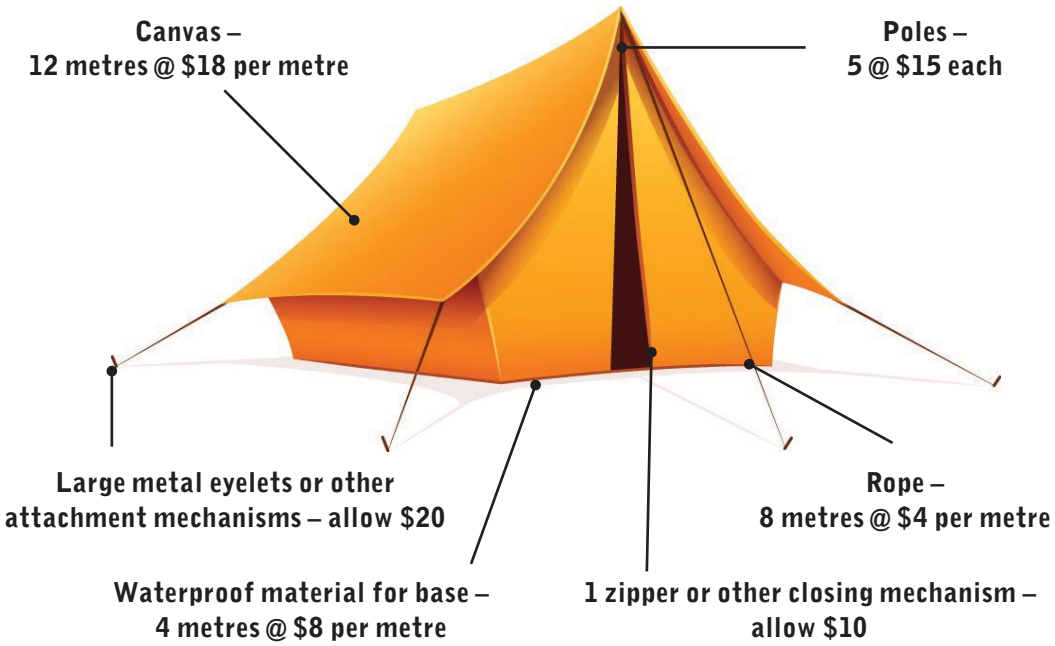


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- Discuss the project budget with the client or determine how much you can afford to spend on the development of your MDP.
- Source materials that are of good quality but also realistically priced.
- Keep all purchase receipts for documentation.
- 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.
- Conduct ongoing evaluation to weigh up options, document choices and justify decisions.

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 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 is sometimes called making a guesstimate and may be accompanied by an initial rough sketch to show resources you expect to use.

Figure 22.5
A guesstimate



Total – $385

Evaluation: That is a lot more than I expected. I may need to find less expensive materials or make it smaller.

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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, justify your decisions and record them as ongoing evaluation.

Remember, your role is to manage your financial resources effectively. 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. These changes may include the following:

- Prices may increase between when you initially investigate and 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 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. 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.

A spreadsheet should be set up to standard conventions. This is preferable to entering data into a table, as the formulas are **dynamic** and can calculate **cumulative** costs and display remaining funds with each entry. Table 22.2 shows possible column headings.

dynamic
able to adjust and change in response to changes

cumulative
increasing by a series of additions

Material/ resource	Supplier	Quantity	Unit cost	Projected total cost	Actual total cost	Reason for difference	Cumulative total

Table 22.2 Possible headings for your finance plan

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.



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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.

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. The sense of achievement you will feel by achieving a milestone will not only help keep your project on track, but will provide you with valuable motivation to continue on to the next stage.

Now that well-developed time, action and finance plans are established, the next phase is to evaluate and implement them.

1. Begin by 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. 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

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your progress in relation to what you planned to achieve. 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 or look 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 the manufacturing process is completed, 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. Poor finishing can have serious consequences on 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.

Figure 22.6 Balancing time and budgets is important, but so is the overall design.



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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.
- It is important to clearly identify what you have to do, how much time you have to do it and how much money you have available to spend.
- 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 attempt to stick to it.
- Keep all receipts for purchases related to the project and update your spreadsheet regularly.
- Set milestones to identify major developmental stages and maintain motivation.

Chapter summary tasks

1 Explain the use of an action plan, a time plan and a finance plan.
2 What is a Gantt chart?
3 What is a management plan?
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 preferable to listing expenses in a table?
9 Explain why formulas are used in the setting up of a spreadsheet.
10 Why are quality and innovation important factors to consider with 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 required in your design folio.

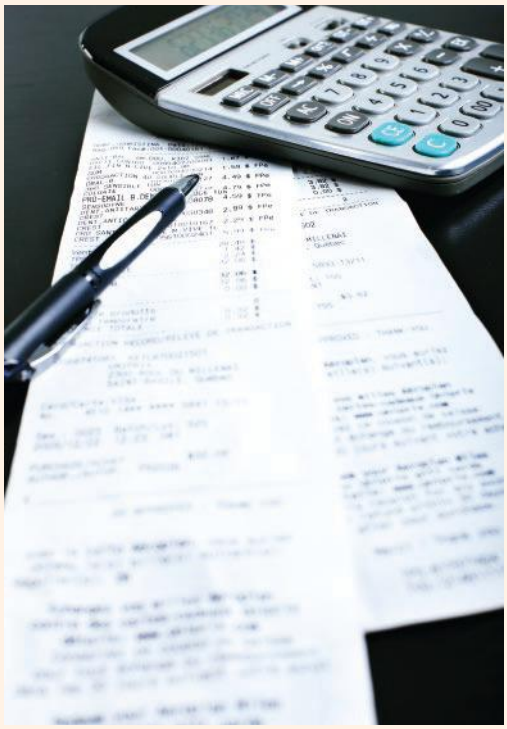


Figure 22.7

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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, political, economic and legal factors, 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 and solar power. Another area with much innovation is sources of energy. As the need for more sustainable energy practices escalates, you can anticipate much development in finding new ways to power our lifestyle. Medical research is a constant area of innovation with Australians at the forefront of research. Bushfire devastation has led to the development of safer materials and building designs. You may be particularly interested in mountain bike riding or sailing or textiles. You can investigate these areas to find innovative developments.

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 sites will often have current reports on innovations. The company that developed the innovation will also have a site and often government funding is involved and government sites will provide information. The Powerhouse Museum (see http://cambridge.edu.au/redirect/?id=159) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO, see http://cambridge.edu.au/redirect/?id=160) have sections devoted to innovation. 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.

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, you will need to 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 report, you will need to use clear language and technical terms where necessary. Images, charts and diagrams will enhance the communication of your findings.



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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 a large number of CDs and DVDs in the living room – you should at the very least research similar products in the major furniture outlets.

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.

misconception
an incorrect idea or assumption









Figure 23.1 A visit to a major furniture outlet can help you with your research.

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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 then 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, 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. But what criteria are used to select and justify the choice of material? The designer would be expected to ask the following questions to satisfy the design criteria:

- What is the garment intended to be used for? Will it be used for casual day wear, a cocktail party or formal evening wear?
- 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 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 dress 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.

Figure 23.2 Choosing the right fabric is part of the design process.

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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, and how best to visualise complex data and 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 space of 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 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?
- 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?



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- 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?

legible
clear and easy to decipher

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. 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 BOSTES 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.



Figure 23.3 A set of symbols or icons may be used to identify sections of your folio.



Figure 23.4 Photographs provide evidence of your work.



Figure 23.5 Graphs present data clearly.



Figure 23.6 An exhibit from the Powerhouse Museum



Figure 23.7 Kate Perrior created this garden aid as her MDP.

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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 the 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 carbon capture technology. 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 23.8

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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.

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 major design project (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.

Figure 24.1 Wood turning



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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.

prohibitive
of a price high enough to prevent something being used or purchased



Figure 24.2 High-end fashion often uses small-scale production techniques.

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 major design projects. 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.

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CASE STUDY 24.2

Bimota

This case study consists of an interview with the Italian motorcycle company Bimota.

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 and for 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.



Figure 24.3 A Bimota motorcycle

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.

Look up Bimota Australia for more information and images.

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

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.

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.

Electronic communication has enhanced the concept of team design, with people from across the globe collaborating on projects. A German company, Otto Bock, developed a battery-operated **bionic** limb. It can lift six times more weight, move three times faster and is 25 per cent lighter than other bionic arms. Kevin Harrison and his team of designers from Otto Bock worked with Dr David Wilson Brown, a prosthesis designer in Victoria. The German specialists developed the elbow, while the prosthesis specialists at Melbourne's Caulfield General Medical Centre developed the arm and hand. Teamwork was essential to the success of this project.

bionic
artificial, typically electronic, body parts

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.

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.



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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.

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.

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.

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 120000 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.



Figure 24.4 A childproof cap on a medicine bottle

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.

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

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now have the right to action if they identify a potential hazard and employers have the right to insist that employees follow safety rules.

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 WorkCover NSW. WorkCover responds to complaints, investigates 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*. Another part of WorkCover's 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.

Figure 24.5 WHS laws protect the health and safety of workers and students.



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.

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.

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WorkCover 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?



Figure 24.6 HAZCHEM signs

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: WorkCover, http://www.workcover.nsw.gov.au/formspublications/publications/Documents/hazpak_making_your_workplace_safer_guide_0228.pdf

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Figure 24.7 Examples of work hazards

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 must be 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).

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.

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.

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.

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 lockout 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.

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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.

Table 24.2 Hierarchy of controls for the removal and reduction of potential hazards

Source: WorkCover, http://www.workcover.nsw.gov.au/formspublications/publications/Documents/hazpak_making_your_workplace_safer_guide_0228.pdf



Figure 24.8 Examples of safe work equipment

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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 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.
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.

Material or equipment	Potential hazard	Safety protocol

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7 List 10 practical tasks that may be involved in the realisation of your MDP. In a table like the one below, compare your work methods with those adapted in industry.
8 Using the table completed to Question 7, conduct a risk assessment on each of the practical tasks.
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 (see http://cambridge.edu.au/redirect/?id=125), determine the level of fines applied to breaches of the *Work Health and Safety Act*.



Figure 24.9

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.
2 Carry out a life-cycle 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.

Work method	MDP	Industrial or commercial

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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, 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 lesson our carbon emissions. Carbon capture technology and biomass energy are technologies that will lead to a greener, cleaner environment. 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 the industry.

CASE STUDY 25.1

Spray-on skin for burns victims

This amazing technology came to the fore after the Bali bombings in 2002. This is an example of a catastrophic event being a key factor in the testing and development of an emerging technology. Dr Fiona Woods was the burns specialist at the Royal Perth Hospital when 28 horribly burnt patients became her responsibility. For many doctors, the treatment of burns and injuries on such a scale would be considered unmanageable. Fortunately for these patients, Dr Wood and scientist Marie Stoner had been working on a new treatment for burns victims – spray-on skin. This advanced technique was now in a position to be tested fully. It was an amazing triumph, with 25 of the near-death patients surviving. The spray-on skin technology, which had previously been met with scepticism internationally, has now been adopted around the world and become standard treatment for severe burns.

convergence
the movement of different technologies towards a unified, common use



Figure 25.1 Spray-on skin inventor Dr Fiona Wood

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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 about the distributive justice in allocating access to beneficial forms of technology.

ACTIVITY 25.1

Nanotechnology is the manipulation of matter on an atomic, molecular and supramolecular scale. Visit the How Stuff Works website (see http://cambridge.edu.au/redirect/?id=161) to find out how nanotechnology works. Visit the Nanotechnology Now website (see http://cambridge.edu.au/redirect/?id=162) 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.

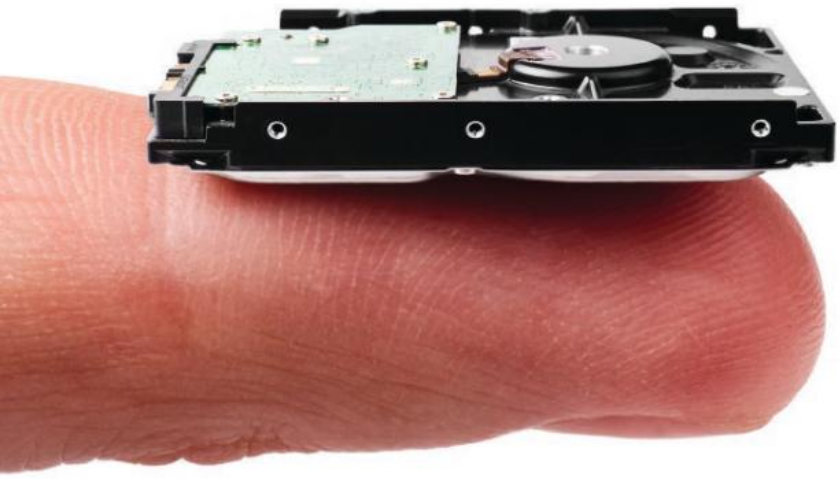


Figure 25.2
Nanotechnology

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.

The World Economic Forum in 2014 compiled a list of the most potentially influential technologies of the time. These included mining metals from the desalination of seawater and super-light cars made using carbon-fibre elements. The forum considered the capacity of each technology to have a real and positive impact on the world. At the top of its list are brain–computer interfaces, which build on existing technologies to enable us to type by monitoring our electrical activity in the brain. Can you imagine the consequences? Disabled people would be 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 on the list. Whether worn on the body, embedded in clothes or even under the skin, these devices can track information, such as heart rate and

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stress levels, giving people real-time feedback about their health. How will 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. 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.

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.



Figure 25.3 Wearable technology

CASE STUDY 25.2

The bionic arm

The design of prostheses has always been an innovative industry. The technologies associated with the industry are continually developing as advancements in technology lead to further advancements. A range of specialists like medical scientists, mechanical engineers, materials specialists, neuroscientists, robotic engineers, doctors and electrical engineers may have collaborated to further develop prostheses.

After almost eight years of research and testing, the US Food and Drug Administration approved the DEKA Arm System, a prosthetic controlled by signals from the brain. Unlike most current prostheses, the DEKA arm can perform such delicate tasks as zipping up a coat, unlocking a door with a key or handling an egg without breaking it.

The arm is controlled by electrical signals from electromyogram (EMG) electrodes. EMG electrodes detect electrical activity caused by the contraction of muscles close to where the prosthesis is attached. The electrodes send the electrical signals to a computer processor in the prosthesis, which translates them to a specific movement or movements.

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The EMG electrodes in the DEKA Arm System convert electrical signals into up to 10 powered movements, and it is the same shape and weight as an adult arm. In addition to the EMG electrodes, the DEKA Arm System contains a combination of mechanisms including switches, movement sensors, and force sensors that cause the prosthesis to move. The DEKA Arm System can be configured for people with limb loss occurring at the shoulder joint, mid-upper arm, or mid-lower arm. It cannot be configured for limb loss at the elbow or wrist joint.

ACTIVITY 25.3

Describe the emerging technologies that have impacted on the development of the DEKA Arm System. Predict further advancements in this technology.

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.



Figure 25.4 The DEKA Arm System developed for DARPA's Revolutionizing Prosthetics program by DEKA Integrated Solutions

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.

ACTIVITY 25.4

1. Discuss some of the innovations that led to the Nintendo Wii.
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.

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 wider range of scanning technology, such as MRI, CAT and PET

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Figure 25.5 Each of these technologies was an emerging technology at one time.

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.

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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 the two.
2 Read Case Study 25.1. Develop a list of any technologies you believe have been further developed because of an event.
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 CDs, DVDs and MP3 players 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.

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.
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

adorn make beautiful

aesthetics how something looks, particularly how visually pleasing it is

algorithm a set of steps used to solve a calculation or problem

appropriate suitable for an occasion or use

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 a list of requirements and specifications

cumulative increasing by a series of additions

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

cyclical process a continuous process, where particular states occur again and again

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

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

drivelines everything in the powertrain excluding the engine and transmission

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

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

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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

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

facia the dashboard area of a motor vehicle

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

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)

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

jarrah a durable hardwood from eucalyptus trees

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

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 (OOS) 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)

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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

prerequisite a prior condition or thing needed before something else can happen

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

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

sequential happening in a logical order or sequence

specifications 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 and therefore able to continue for a long time

sustainable fashion the movement promoting an environmentally sustainable fashion industry

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

trademark the name or other symbol used by a manufacturer to distinguish its products from those of competitors

tungsten lamp a lamp in which light is produced by a tungsten filament heated by an electric current

unambiguous has a 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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