Designing with plastics

Strand	Organiser	Level						
		1	2	3	4	5	6	B6
Technology Practice	*Investigation*				■	■		
	Ideation				■	■		
	Production				■	■		
	Evaluation				■	■		
Information	*Nature*							
	Techniques							
Materials	*Nature*				■	■		
	Techniques				■	■		
Systems	*Nature*				■	■		
	Techniques				■	■		

Purpose

The activities in this module are designed to introduce students to the basic principles of designing with plastics. Students develop understandings about the nature of plastics, investigate everyday uses of plastics, develop skills for manipulating plastics, and design and create a plastic product to satisfy a need, want or opportunity.

Overview

The following table shows the activities in this module and the way in which these are organised into introductory, developmental and culminating phases.

Introductory	Developmental	Culminating
Use consultative methods to investigate plastics: • types of plastics • properties of plastics • uses for plastic products. Research plastic-manufacturing processes. Investigate impacts and consequences.	Workplace health and safety. Work with plastics: • shaping plastics • edge treatment and forming plastics • joining and forming plastics • injection-moulding processes. Investigate methods for assuring quality and evaluating products.	Identify an opportunity for designing and developing a plastic product. Consider design requirements and prepare a design brief. Envision and communicate a range of ideas. Test and seek feedback on design ideas. Generate product specifications and production plans. Produce and refine a plastic product. Evaluate design ideas, production plans and products.

Core learning outcomes

This module focuses on the following core learning outcomes from the *Years 1 to 10 Technology Syllabus*:

Technology Practice

TP 4.1 Students use consultative methods to gather knowledge, ideas and data when researching alternatives within design challenges.

TP 5.1 Students analyse links between the knowledge, ideas and data gathered to meet design challenges and the design and development of new and improved products.

TP 4.2 Students generate design ideas through consultation and communicate these in detailed design proposals.

TP 5.2 Students generate design ideas and communicate these in design proposals that indicate an understanding of factors influencing production of the option(s) they have selected.

TP 4.3 Students identify and make use of the practical expertise of others when following production procedures to make products for specific users.

TP 5.3 Students meet predetermined standards as they follow production procedures to make quality products.

TP 4.4 Students gather feedback to gauge how well their design ideas and processes meet design challenges and how effectively products meet the needs of specific users.

TP 5.4 Students use predetermined criteria to judge how well processes and products meet the needs of specific users, and recommend modifications or improvements.

Materials

MAT 4.1 Students explain how characteristics of materials affect ways they can be manipulated.

MAT 5.1 Students compare and contrast materials according to their characteristics to determine how effectively the materials meet predetermined standards.

MAT 4.2 Students employ their own and others' practical knowledge about equipment and techniques for manipulating and processing materials in order to enhance their products.

MAT 5.2 Students operate equipment and apply techniques for manipulating and processing materials to meet predetermined standards.

Systems

SYS 4.1 Students identify and explain the logic of systems and subsystems.

SYS 5.1 Students explain the structures, controls and management of systems and subsystems.

SYS 4.2 Students incorporate feedback to refine and modify systems and/or subsystems.

SYS 5.2 Students incorporate control and management mechanisms in systems that include subsystems.

Core content

The core learning outcomes are the focus for planning learning activities and assessment tasks. Students will engage with core content (see pp. 37–40 of the syllabus) when they are provided with opportunities to demonstrate core learning outcomes. While the content is listed in strands for organisational convenience, no one part of that content is to be viewed as discretely associated with a single strand.

The organisation of content within a strand should not be considered hierarchical. Any of the content can be addressed at any appropriate level; not all of the content need be addressed at every level. Core content should be selected to suit students' needs, interests and abilities and to take account of their prior knowledge and experiences.

The core content should be studied in a range of contexts. These could include personal and global contexts, as well as contexts of agriculture, business, communities, home and family, industry, leisure and recreation, and school.

Using this module

Many students may be unfamiliar with using plastics. The activities in this module are designed to provide opportunities for students to demonstrate Levels 4 and 5 Technology Practice, Materials and Systems core learning outcomes. These activities can also provide opportunities for students to develop and demonstrate the related learning outcomes at other levels. In order to do this, teachers will need to develop additional sets of anticipated evidence derived from the related learning outcomes at different levels. They may need to modify aspects of the activities.

This module includes a variety of sequenced activities requiring varying amounts of time. Teachers can modify the design challenge and related activities depending on the local contexts, particular needs and prior knowledge of students, and availability of materials and resources. For example, teachers might choose to focus on those activities that provide opportunities for students to develop and demonstrate outcomes from the Technology Practice and Materials strands.

Advice to teachers

Management

Students' experiences with working cooperatively and managing projects will vary. Teachers should provide opportunities for students to:

- share and organise tools and equipment
- manage their work area safely
- realise and accommodate the limitations imposed by the availability of time, money, resources and skills
- develop production plans for completing tasks within set timeframes
- understand the importance of considering the whole project management process.

Workplace health and safety

The design challenge and activities in this module will require students to use simple workshop hand tools, power equipment and developed materials. Teachers should refer to the relevant appliance or equipment manual for operating instructions.

Under workplace health and safety regulations, teachers are obligated to complete a risk assessment form for many of the following activities. Teachers need to identify potential hazards and use strategies to minimise risk to students and others.

Enhance students' awareness of risks and health and safety requirements by involving them in the risk-assessment process. This might include asking students to complete a risk-assessment form and to record information in their Technology project folios about health and safety issues and risk-management strategies they have considered and used.

Contexts

Individual preferences and identified needs will determine the context and requirements of the design brief. Working with plastics can be combined with metalwork, and metal fabrication and engineering. Students might choose to explore one or more of the following contexts:

- school — fund-raising, grounds, open days, school camps
- home and family — food preparation, gardening, jewellery, recycling, toys
- leisure and recreation — camping, fishing, orienteering, playgrounds, games
- business and industry — small marketing, mass production, business ventures.

Appropriate-ness

As the project proceeds, students should consider, for example, the following aspects of appropriateness when making design decisions about the use of plastics:

- aesthetic appropriateness — students consider elements such as structure, form, colour and texture when determining the aesthetic appeal of their product
- economic appropriateness — students consider the efficient use of time, expertise and resources in determining the economic viability of their product
- environmental appropriateness — students consider the effects of using new, recyclable and non-recyclable plastics on people and environments and make decisions that balance positive and negative effects
- functional appropriateness — students test product performance against predetermined criteria to assess functional appropriateness of their product.

Resources

This unit requires the use of an injection moulder, a strip heater and an oven. Hercus PIM20 injection moulder, Woodfast strip heater and Labesse oven or similar machines can be used.

Generally, students' creativity in demonstrations of core learning outcomes should not be unduly limited by the range and scope of resources and equipment provided by the teacher. In this case, the nature of the equipment and materials to be used may require some limitations to be imposed. A variety of resources should be collected over time and be accessible for selection and use by students as required. Equipment should be safely stored and only made available under supervision to students as required.

Evaluation of a unit of work

After completion of a unit or units of work developed from this module, teachers collect information and make judgments about:

- teaching strategies and activities planned or selected to allow students to demonstrate the core learning outcomes
- future learning opportunities for students who have not yet demonstrated the core learning outcomes and to challenge and extend those students who have already demonstrated the core learning outcomes
- the extent to which activities matched needs of particular groups of students and reflected equity considerations
- the appropriateness of time allocations for particular activities
- the appropriateness of resources used.

Information from this evaluation process can be used to plan subsequent units of work to support future student learning. The evaluated units of work may also be adapted prior to their reuse. For further information, refer to the 'Curriculum evaluation' section of the sourcebook guidelines.

Links

Links to other key learning areas

Activities from this module can be used as part of an integrated unit that makes links to other key learning areas. When incorporating this module into an integrated unit of work, teachers can select activities that provide opportunities for students to demonstrate learning outcomes from other key learning areas. It is important, however, that the integrity of the processes and concepts within key learning areas is maintained.

This module has links to the following key learning areas:

- English
- Mathematics
- Science.

Contributions to the cross-curricular priorities

This module contributes to students' development of the cross-curricular priorities:

- **literacy**, as students interpret, evaluate and communicate technical information using combinations of text, symbols, diagrams and illustrations
- **numeracy**, as students collect, collate, graph, map and critique technological data and statistics; apply numerical terms and concepts in practical contexts; estimate and count; approximate, measure and calculate, time, length and mass; identify and use patterns and employ spatial concepts; visualise and construct three-dimensional structures from two-dimensional plans
- **lifeskills**, as students develop social, citizenship and self-management skills
- **a futures perspective**, as students envision a range of applications for plastics, evaluate options and select preferred options.

Valued attributes of a lifelong learner

The overall learning outcomes of the Queensland Years 1 to 10 curriculum contain elements common to all key learning areas and collectively describe the valued attributes of the lifelong learner. The following points indicate how various activities in this module might contribute towards the development of these attributes.

Knowledgeable person with deep understanding

- gains knowledge and conceptual understanding about technology practices, materials, information and systems through designing with plastics
- draws together knowledge from a range of areas.

Complex thinker

- evaluates the suitability of materials for a particular purpose
- determines how components of systems work together to achieve specific goals
- makes decisions and justifies choices in realising designs.

Active investigator

- explores implications of issues associated with appropriateness
- generates and accesses information from a variety of sources
- tests the suitability of materials for specific purposes and experiments with techniques for manipulating and processing materials
- works with and refines systems.

Responsive creator

- uses creative strategies to examine needs, wants and opportunities
- envisions and generates potential solutions
- explores techniques to create new effects.

Effective communicator

- communicates design ideas effectively
- composes design specifications and design proposals.

Participant in an interdependent world

- works individually and collaboratively
- negotiates with others.

Reflective and self-directed learner

- critically evaluates processes and products
- reflects on personal practices to better manage time and resources
- displays self-motivation and perseverance in seeing projects through to completion.

Assessment strategies

The assessment opportunities outlined in the module are examples of how to assess students' demonstrations of the identified learning outcomes. As often as possible, negotiate assessment with students and support a variety of ways of demonstrating the learning outcomes. Reflect with students on evidence gathered when making judgments about their demonstrations of learning outcomes. Some students may require more time and/or other contexts in which to demonstrate these learning outcomes. Other modules may provide such time and/or contexts.

Suggestions for gathering information about student learning are provided in the activities section of this module. The anticipated evidence column in the table below provides descriptions of what students may do in order to demonstrate the learning outcomes. The table is neither exhaustive nor mandatory. Once sufficient evidence has been collected, judgments can be made about students' demonstrations of learning outcomes.

[This table spreads over three pages.]

Core learning outcomes	Anticipated evidence	Sources of evidence
TP 4.1 Students use consultative methods to gather knowledge, ideas and data when researching alternatives within design challenges.	Access information prepared by people with specialist knowledge about plastics via interviews, websites and email. Consult with potential users to compare products and identify desirable features. Use interviews or surveys to gather opinions about design alternatives.	Anecdotal records: • observations of students' participation in activities and discussions • observations of students' participation in hypothetical scenarios • observations of students' oral presentations. Technology project folios: • surveys, interviews and consultation summaries • students' written evaluation reports • design briefs.
TP 5.1 Students analyse links between the knowledge, ideas and data gathered to meet design challenges and the design and development of new and improved products.	Interpret information about the nature of plastics and current uses of plastic products to: identify opportunities for creating new or improved products infer impacts and consequences of product development provide a rationale for their product that demonstrates links between research and their design choices.	
TP 4.2 Students generate design ideas through consultation and communicate these in detailed design proposals.	Select knowledge and ideas collected through consultation to inform their design ideas. Prepare a rationale for design ideas that draws upon consultation with 'experts' and potential users to justify design choices.	Anecdotal records: • observations of students' participation in activities and discussions • observations of students' oral presentations. Technology project folios: • design proposals.
TP 5.2 Students generate design ideas and communicate these in design proposals that indicate an understanding of factors influencing production of the option(s) they have selected.	Prepare detailed design proposals to communicate the designs ideas for a plastic product. Identify factors that influenced design choices in the rationale section of the design proposals.	

Core learning outcomes	Anticipated evidence	Sources of evidence
TP 4.3 Students identify and make use of the practical expertise of others when following production procedures to make products for specific users.	Seek advice from others about designing production procedures to meet predetermined standards. Manage resources and constraints and ensure safe practices. Produce products that meet user specifications.	Anecdotal records: • observations of students' oral presentations • observations of students making set plastics products and products of their own design. Technology project folios: • predetermined standards in production procedures. Final products.
TP 5.3 Students meet predetermined standards as they follow production procedures to make quality products.	Identify required standards in design proposals. Specify criteria for evaluating standards and outline how criteria will be met. Follow or refine production procedures to ensure quality products.	
TP 4.4 Students gather feedback to gauge how well their design ideas and processes meet design challenges and how effectively products meet the needs of specific users.	Gather feedback to determine the effectiveness of designs and products. Use feedback from potential users to inform modifications to designs and products. Reflect on the effectiveness of their designs and production processes. Report on reflections and make recommendations about modifications.	Anecdotal records: • observations of students' participation in consultation and evaluations. Final products. Technology project folios: • consultation summaries • product evaluation reports.
TP 5.4 Students use predetermined criteria to judge how well processes and products meet the needs of specific users, and recommend modifications or improvements.	Specify criteria for evaluating the effectiveness of products. Use predetermined criteria to evaluate products and identify possible ways of modifying or improving the design.	Anecdotal records: • observations of students negotiating and analysing predetermined criteria • observations of students' participation in evaluations. Final products. Technology project folios: • criteria devised by students • consultation summaries • product evaluation reports.
MAT 4.1 Students explain how characteristics of materials affect ways they can be manipulated.	Explain how the properties of different types of plastics affected their choice of methods for manipulating them. Base their justifications for features of their proposed designs on their understandings of the properties of plastics and processes for manipulating them.	Anecdotal records: • observations of students' participation in research and discussions. Technology project folios: • research reports • product rationales • results of materials tests and production trials • product evaluations. Set products and products of their own design.
MAT 5.1 Students compare and contrast materials according to their characteristics to determine how effectively the materials meet predetermined standards.	Identify required product standards in their design proposals. Compare and contrast the properties of plastics to determine their suitability for meeting required standards. Describe how plastics can be manipulated to meet required standards.	

Core learning outcomes	Anticipated evidence	Sources of evidence
MAT 4.2 Students employ their own and others' practical knowledge about equipment and techniques for manipulating and processing materials in order to enhance their products.	Seek advice and draw on their own knowledge to determine which equipment and techniques can be used to manipulate plastics to meet their design specifications. Use equipment and techniques to manipulate plastics with precision to produce quality products.	Technology project folios: • production plans • self-evaluation. Anecdotal records: • observations of students' participation in activities. Set products and products of their own design.
MAT 5.2 Students operate equipment and apply techniques for manipulating and processing materials to meet predetermined standards.	Select and use suitable equipment and techniques to achieve required standards.	
SYS 4.1 Students identify and explain the logic of systems and subsystems.	Identify systems and subsystems and explain the purpose of system components. Assemble and control systems.	Anecdotal records: • observations of students' discussions about production processes. Technology project folios: • production plans. Anecdotal records: • feedback sheets. Final products.
SYS 5.1 Students explain the structures, controls and management of systems and subsystems.	Illustrate the structures of systems and subsystems in design proposals. Describe processes for controlling and managing systems and subsystems.	
SYS 4.2 Students incorporate feedback to refine and modify systems and/or subsystems.	Document how systems and subsystems enhance the efficiency or effectiveness of production processes. Modify production processes in response to feedback or evaluation of trials or field-tests.	Technology project folios: • production plans • quality control mechanisms in production processes • evaluation of production processes.
SYS 5.2 Students incorporate control and management mechanisms in systems that include subsystems.	Design, trial and refine production processes with subsystems. Use various control and management strategies in the design and use of production processes.	

Background information

Terminology

In this module, students have opportunities to become familiar with and use the following terminology:

cavity	heating chamber	pigment
charge	hopper	plunger
cut-off	injection nozzle	prototype mould
de-flashing	insert	purging
density	melt-flow index	rib
density test	mould	sandwich mould
die	mould release	sprue gate
dimensional stability	moulding shrinkage	thermoplastic
draft	multi-cavity mould	thermosetting plastic
extrusion	opaque	transparent
flash	parting (or flash) line	vent
flexible moulds	pattern	

A glossary of terms is provided in the 'Teacher resource 1' section later in this document.

School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module.

Safety policies are of particular relevance to the activities that follow. Activities undertaken in this module must be planned and conducted with due regard for the safety of all concerned. The legal requirements to do so are described in the documents listed below.

Teachers and students must follow safe work practices in a designated area free of avoidable hazards. They must be provided with appropriate safety equipment. Students should not participate in activities until they have been advised of the risks involved and provided with demonstrations of correct procedures. Staff and facilities must have current accreditation or certification for proposed activities and relevant materials safety data sheets (MSDS) must be available and used to identify risks and precautions. Whenever specific tools or equipment are used, their 'safe' use is as described in the manufacturer's instructions.

The standards for establishing and maintaining a safe workplace in Queensland are set by the *Workplace Health and Safety Act 1995*. This Act provides for a number of regulations, advisory standards and codes of practice that apply to specific industries, including *Workplace Health and Safety Regulation 1997* and *Workplace Health and Safety (Miscellaneous) Regulation 1995*.

The Department of Education has developed policy related to risk assessment and risk management. The *Department of Education Manual* (1999–2001), published by Education Queensland, includes a number of general requirements for teachers. The following modules are specific for planning courses of study in industrial technology and design. The *Department of Education Manual* can be found on Education Queensland's web page at http://education.qld.gov.au. Teachers in other school systems may find these modules useful references.

DOEM modules of particular relevance to the activities in this sourcebook module include:

Fibre — Reinforced Plastics and Thermoset Resins (HS-10-32)

Fixed Machines (HS-10-27)

Maintaining a Safe Workshop (HS-10-21)

Portable Electrical Power Equipment (HS-10-28)

Working Thermoplastics (HS-10-29)

In this module, teachers will need to consider safety issues related to the use of an injection moulder and the moulding process. Safety requirements related to the use of injection moulders are usually provided with their user manuals.

Equity considerations

This module provides opportunities for students to increase their understanding and appreciation of equity and diversity within a supportive environment. It includes activities that encourage students to:

- be involved in roleplaying hypothetical situations related to the development and use of plastics
- work individually or in groups to produce a plastic product to meet a need, want or opportunity
- value diversity of ability, opinion and experience
- value diversity of language and cultural beliefs
- support one another in their efforts
- become empowered to communicate freely
- negotiate and accept changes to their designs and production procedures.

It is important that these equity considerations inform decision making about teaching strategies, classroom organisation and assessment.

Some students with disabilities may need assistance with some activities. Advice should be sought from their support teachers.

Activities

Introductory activities

Focus

During the introductory activities, students:

- investigate the types of plastics in everyday use
- research plastic products and methods used to produce them
- investigate the impacts and consequences of developing, using, recycling and disposing of plastics.

Teaching considerations

If possible, organise representatives of local industries that manufacture, process or use plastic products to participate in the project as guest speakers or mentors.

Resources

Access to the Internet.

Guest speakers and mentors.

Examples of plastic products.

Activity 1

Use consultative methods to investigate plastics

Technology Practice (Investigation), Materials

Introduce the project and outline the activities for the unit of work. Explain that the purpose of the introductory and developmental activities is to investigate the properties of plastics and learn techniques for manipulating plastics to prepare students to undertake a design challenge.

Discuss the requirements of the target learning outcomes, anticipated evidence and potential sources of evidence with students.

Students learn about the nature of plastics by:

- collecting examples of plastic products
- researching the properties of different types of plastics
- investigating the purpose of plastic recycling codes
- creating a decision tree for identifying plastics
- analysing plastics products.

Students undertake market research to help them to identify possible market niches for a plastic product. Students might:

- survey people of varying ages to identify how they use plastic products to meet needs and wants
- gather information from books, videos, CD-ROMs and the Internet about the types of plastics used in everyday products and the properties of these types of plastics, including for example, standard symbols used to code recyclable plastic products and tests used to identify plastics
- brainstorm potential enhancements to existing plastics products and new uses of plastic products
- prepare a table summary of their market research about uses and potential uses of plastic products.

MARKET RESEARCH			
Product	Type of plastic	Properties of plastic	Potential enhancements or new uses

Activity 2

Research plastic-manufacturing processes

Technology Practice (Investigation), Materials, Systems

Students research methods used to manufacture plastic products. Remind students to use correct technical terminology when describing products and processes. They:

- develop a set of questions to guide their research
- record research notes and a list of references in their Technology project folios
- prepare a research summary
- draw diagrams to illustrate their understandings of manufacturing processes.

Provide opportunities for students to enhance their understandings of plastics and the processes associated with plastics. For example, they could listen to guest speakers, interview members of their local community with specialist knowledge, view relevant videos and television programs, and undertake research on the Internet and in the library.

[Introductory activities continue on the next page.]

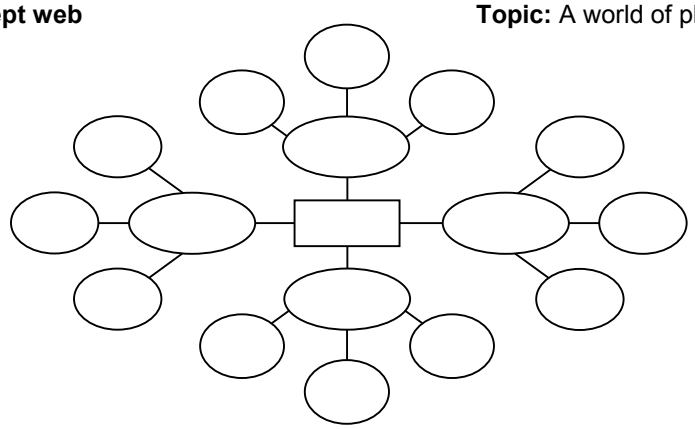
Activity 3

Investigate impacts and consequences

Technology Practice (Investigation), Materials

Students share and reflect on the results of their research about different types of plastics and their uses. In groups, students create concept webs to identify possible impacts and consequences of developing, using, recycling and disposing of plastics.

Concept web **Topic:** A world of plastics



Students negotiate a list of topics or questions about impacts and consequences of developing, using, recycling and disposing of plastics for class consideration and discussion.

Links to The Arts, English and SOSE

Devise or negotiate one or more hypothetical scenarios that would allow students to further explore the identified issues. Examples include:

- A plastics factory is going to be built in your local area. (local council debate)
- A new form of plastic has been developed for replacing human tissues. It has the potential to extend human life indefinitely. (medical ethics forum)
- You are investigating a range of options for mass-producing a new invention. (mock business meeting of potential manufacturers)

Identify stakeholders in the scenario who hold different perspectives. Define and assign roles. Students research probable perspectives of their roles.

Provide opportunities for students to act out the hypothetical scenarios in class time. Ask students who are observing to look for evidence that the speakers have considered a range of aspects of appropriateness. Ask students to reflect on the perspectives taken by each role.

Hypothetical scenario:				
	Role 1	*Role 2*	*Role 3*	*Role 4*
Aesthetic				
Cultural				
Economic				
Environmental				
Ethical				
Functional				
Social				

Assessment

Sources of evidence could include:

- Technology project folios
- market research tables and manufacturing processes research summaries
- observations of students' participation in class discussions and roleplay in hypothetical scenarios.

Developmental activities

Focus

During the developmental activities, students are provided with opportunities to gain understandings of the properties of plastics and develop skills to manipulate and process plastics.

Teaching considerations

Students use a wide variety of equipment and resources for these activities. These include injection moulder, strip heater and oven or similar equipment. Using equipment such as this provides students with opportunities to explore aspects of plastics manipulation in detail. Teachers should ensure that students follow operating procedures correctly.

Resources

Injection moulder, strip heater and oven or similar equipment.

Plastics.

Technology project folios.

Teacher resource 1 and Student resources 1 and 2.

Activity 4

Workplace health and safety

Technology Practice (Production)

Explain that the following activities are designed to introduce a range of materials, equipment and techniques. Remind students to reflect on what they have learnt at the end of each session and record details of the techniques used in their Technology project folios for future reference.

Describe the tasks to be undertaken. Introduce and explain the purposes of the equipment that will be used. Stress that the management of materials and equipment will impact on design solutions.

Discuss possible risks and safety precautions. Explain the purpose of the risk assessment form. Provide each student with a copy of the form and ask students to work in pairs to complete it. Discuss students' responses and complete a risk assessment form in consultation with students. Provide all students with a copy of the completed form. Students should include their draft form and the final version in their project folios.

Activity 5

Work with plastics: shaping plastics

Technology Practice (Production), Materials

Demonstrate the correct and safe use of equipment and techniques to shape plastics — cutting out a shape or initials to be vacuum formed; drilling; using a coping saw; filing; using a sanding disk and scroll saw.

Provide opportunities for students to develop and refine their skills by making, for example, a key ring. Identify and discuss criteria for evaluating finished products. Ask students to evaluate their products and processes at the end of each session and record their evaluations and suggestions for improvements in their Technology project folios.

Discuss how these techniques could be combined or adapted to produce new effects. Encourage them to experiment with a range of techniques for shaping plastics.

Activity 6

Work with plastics: edge treatment and forming plastics

Technology Practice (Production), Materials

Demonstrate the correct and safe use of oven and strip heater applications and describe the polishing procedure for acrylic edges.

Provide opportunities for students to develop and refine their skills. Students can, for example, make a small photo holder and using a strip heater, and filing and polish the edges. Identify and discuss criteria for evaluating finished products.

Students evaluate their products and processes at the end of each session and record their evaluations and suggestions for improvements in their Technology project folios.

Activity 7

Work with plastics: joining and forming plastics

Technology Practice (Production), Materials, Systems

Discuss and demonstrate the correct and safe use of the following equipment and techniques to joining and forming plastics:

- joining — for example, by using ethylene dichloride
- vacuum forming — basic processes; industry applications.

Provide opportunities for students to develop and refine their skills by, for example, making up and vacuum forming initials. Discuss criteria for evaluating finished items.

Students evaluate their products and processes at the end of each session and record their evaluations and suggestions for improvements in their Technology project folios.

[Developmental activities continue on the next page.]

Activity 8

Work with plastics: injection-moulding processes

Technology Practice (Production), Materials, Systems

Provide students with Student resources 1 and 2 or similar information and task.

Demonstrate the correct and safe use of injection-moulding processes using a sandwich mould.

Discuss the materials required, injection-moulding processes and typical uses of these processes. Show students examples of products and highlight features that indicate whether it is a quality product. Working in pairs, students devise product evaluation criteria.

Provide opportunities for students to cut out acrylic shapes and cast with an injection moulder.

At the end of the process, students work in pairs to evaluate their products and processes. Students record their evaluations and suggestions for improvements in their Technology project folios.

Activity 9

Investigate methods for assuring quality and evaluating products

Technology Practice (Investigation, Production)

Students consult with people with specialist knowledge related to quality control or product evaluation to investigate methods of assuring quality and evaluating products. These processes do not have to be specific to plastics.

Students might invite industry representatives to visit the school, visit local industries that produce or use a range of plastics, collaborate electronically using email, or invite family and interested community members to participate.

Students devise interview questions and negotiate interview times. They conduct interviews in pairs, taking turns at the roles of interviewer and recorder, and present their findings in table form.

INDUSTRY SCAN SUMMARY		
Product	*Product evaluation methodology*	*Quality control mechanisms*

Students write to industry representatives thanking them for participating in the project.

Assessment

Sources of evidence could include:

- Technology project folios
- risk assessment forms
- industry scan summaries
- evaluation criteria devised by students
- students' evaluation of products and processes
- products.

Culminating activities

Focus

Design challenge
Use the workshop resources and the supplied materials to design and make a plastic product that meets an identified need.

Teaching considerations

Students may require varying amounts of assistance and time to complete their projects. This should be considered when timetabling of the use of workshop facilities, equipment and resources.

Resources

Sketching and modelling materials.

Injection moulder, strip heater, oven and other equipment for manipulating and processing plastics.

Plastics.

Technology project folios.

Activity 10

Identify an opportunity for designing and developing a plastic product

Technology Practice (Investigation)

Students:

- describe how consultation with users can inform product development
- consult with family and peers to identify an opportunity to satisfy a need or want or extend a human capability
- formulate an investigation plan to inform the product development
- undertake further research and consultation to clearly identify product requirements and design options
- record the process in a Technology project folio.

Activity 11

Consider design requirements and prepare a design brief

Technology Practice (Ideation)

Students work individually or in groups to prepare a design brief that:

- identifies the need, want or opportunity
- clearly defines the purpose and function of the proposed product
- lists potential materials
- identifies considerations and constraints.

Interview each student or group of students about their design brief.

Activity 12

Envision and communicate a range of ideas

Technology Practice (Ideation)

Students:

- brainstorm a wide range of possible solutions
- evaluate options by considering aesthetic, cultural, economic, ethical, functional and social appropriateness
- visualise the potential forms of products and produce a set of thumbnail sketches of potential designs.

Some students may have difficulty sketching a large number of thumbnails. Help them to devise a thumbnail matrix. Ask them to change one attribute of their design at a time to generate a range of alternatives.

Example thumbnail matrix

Thumbnail sketches for candle holders					
Change one attribute at a time to generate a set of thumbnail sketches. Remember not all designs will have every attribute. Change the size, shape, number or angle of attributes.					
Base					
Stem					
Candle well or spike					
Handle					

Activity 13

Test and seek feedback on design ideas

Technology Practice (Ideation, Evaluation)

Students collaborate to develop a range of design alternatives. They:

- plan and organise a process for consultation
- sketch or model a number of their design ideas
- present their design ideas for consultation
- record suggestions for modifying design ideas in the Technology project folios.

Students use feedback from consultation to select their preferred design option.

Activity 14

Generate product specifications and production plans

Technology Practice (Ideation, Evaluation), Materials, Systems

Students generate product specifications and production plans for their preferred design. They might need to test the suitability of materials and processes for making the proposed product. This process might take more than one lesson.

Product specifications should include scaled working drawings from a range of views that are annotated with correct technical terms, product dimensions, materials and techniques for manipulating them.

In generating their production plans, students should consider efficient use of limited time and resources. Students should also consider how they will develop or access knowledge and expertise related to the task and incorporate consultation mechanisms.

The production plans should identify and explain a system for manufacturing a plastic product. The manufacturing system should include steps of the production process and outline the roles and responsibilities of participants in the process. The plans should include explanations of the structures, controls and management of their manufacturing system. Students should indicate how they will gather feedback and use it to refine and modify their product or production process.

Encourage students to modify product specifications and production processes through collaborative negotiation. Remind them to collaborate with their peers or others with specialist knowledge to seek advice before commencing production and at regular intervals throughout the production process.

Interview each student or group of students to discuss their design specifications before they begin production. The evaluation criteria can be devised by students or negotiated with the teacher at this point.

Activity 15

Produce and refine a plastic product

Technology Practice (Production), Materials, Systems

As they produce their product, students have opportunities to trial, compare and contrast techniques for manipulating and processing plastics. They enhance their practical knowledge and skills.

Entries in their Technology project folios should:

- demonstrate how their ideas evolved
- highlight special features of their product and explain why they were included
- record decisions made to modify their designs or production plans in response to feedback, product evaluations, opportunities or constraints.

Activity 16

Evaluate design ideas, production plans and products

Technology Practice (Evaluation)

Students evaluate their products against the predetermined criteria and their original ideas. This can involve a field test of their product or consultation with a group of potential users. Students might conduct mock business meetings where they present their product and seek feedback or support from potential manufacturers or financial backers and negotiate modifications to their product.

They should record their evaluation reports or meeting summaries in their Technology project folios. Students work in pairs or, where appropriate, in groups to evaluate personal and group performances.

Assessment

Sources of evidence could include:

- interviews with students and observations of their participation in activities
- design briefs
- design specifications and production plans
- final products
- product evaluation reports and summaries of mock meetings
- self- and peer-evaluations of personal and group performances.

Glossary of terms

Teacher resource 1

cavity	The hollowed-out shape of a mould that forms the outer surface of the moulded part.
charge	The measured weight of material used to fill/load a mould at one time during one cycle.
cut-off	The line where two halves of a mould meet. Sometimes called flash line (or parting line).
de-flashing	The process of removing unwanted material from a moulded product. Usually associated with excessive material that has formed at the cut-off/parting line of a mould.
density	Weight per unit volume of a substance measured as grams per cubic centimetre (gm/cc).
density test	Comparison of plastics materials with water expressed as 1.0. Materials categorised as less than 1.0 will float. Materials categorised as greater than 1.0 will sink.
die	A hollow device for forming materials, often in more than one part.
dimensional stability	The ability of a plastics material or part to retain its exact shape after moulding.
draft	The angle of taper or clearance that allows ease of removal of a moulded part from the mould.
extrusion	The process of forcing melted plastics through an opening in a continuous way.
flash	Excess plastic attached to the moulded part of the parting (or flash) line of the mould.
flexible moulds	Moulds made from elastic, rubber-like substances. They are usually stretched to remove the moulding.
heating chamber	That part of an injection-moulding machine in which the granulated feedstock is converted to hot melt.
hopper	The container holding granulated moulding materials.
injection nozzle	The hollow metal nose screwed into the end of the heating cylinder of an injection-moulding machine.
insert	A metallic or other material part, moulded into position or added later by pressing into place in a moulding.
Melt-flow index	A number that reflects the flow capacity of plastics materials in relation to the temperature applied.
mould	A hollow form for giving shape to something in a molten or plastic state.
mould release	A lubricant used to coat the cavity of a mould to ease the removal of the moulding from the mould.
moulding shrinkage	The difference in size between the finished moulded product and the mould.
multi-cavity mould	A mould with two or more cavities that produces more than one moulding per moulding cycle.
opaque	A material that does not transmit light.
parting line	The position where two halves of a mould meet.
pattern	A model or form used to make a mould.
pigment	A colouring agent mixed with plastics materials prior to processing to give uniform colour.
plunger	The part of an injection-moulding machine that applies pressure upon the solid material to push it into the chamber and in turn forces the melt out the nozzle.
prototype mould	A mould used to gain information about design prior to the construction of a permanent mould.
purging	The process of cleaning different types of materials or different coloured materials from the cylinder of an injection-moulding machine.
rib	A reinforced part of a moulded product.
sandwich mould	A three-part mould where a die is sandwiched between two outer moulds.
sprue gate	The passageway through which the melt flows from the nozzle to the mould cavity.
thermoplastic	A plastic that gets soft when heated and can be changed into different shapes.
thermosetting plastic	A plastic that solidifies when heated.
transparent	Transmits light.
vent	A shallow channel or small hole in a mould to allow air to escape as the melted plastic enters.

About plastics

Student resource 1

PLASTICS INFORMATION CARD

Plastic is an artificial material. Its characteristics and properties are different to those of wood and metal.

There are many different types of plastic. Each one has a different set of properties. This means that each type is suitable for different purposes.

Plastics can be divided into two groups:

Thermoplastic — a thermoplastic is one that gets soft when heated and can be changed into different shapes.

Thermosetting plastic — thermosetting plastics become solid when they become hot.

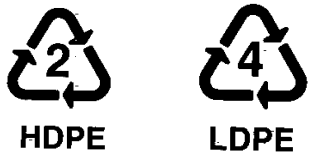
POLYETHYLENE AND INJECTION MOULDING

Polyethylene is a thermoplastic. It was first produced by I.C.I. in 1933. It has very high resistance to a wide range of chemicals, outstanding electric properties, and is the 6lightest of all plastics with the exception of foam.

Applications of polyethylene

Polyethylene is used to produce buckets, bowls, food wrap, plastic bags, television cables, drink bottles and machine6 parts.

A plastics coding system was introduced by the Plastics Institute of Australia. The coding symbols indicate that the product can be recycled. They can also be used to identify the type of plastic used to make a product.



Examples of plastics code symbols

High-density polyethylene is strong and doesn't easily break if dropped. It is used for producing items such as bottles, buckets and bowls.

Low-density polyethylene is more pliable. Common uses include plastic bags and food wrap, squeeze bottles, toys, drums and containers up to 1100 litres in capacity. It is used extensively in industry and agriculture for wire insulation, pipes, weather protection, dam linings, concrete curing and equipment protection.

The injection-moulding process

Low-density polyethylene is used in the injection moulder. Injection moulding is a high-speed process in which powdered or granular thermoplastics are heated, melted and forced under pressure into a mould (or die). The material in the mould then cools, forming a component that takes the shape of the mould cavity. New moulds are fitted to the machine when a new type of product is required.

Each mould can be used to make many thousands of mouldings. Lego™, for example, would be made by injection moulding.

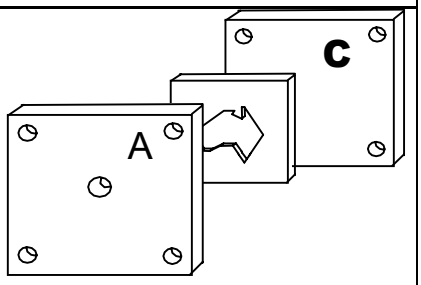
Injection-moulding exercise

Student resource 2

PLASTICS PROJECT CARD

Name:	**Class:**
Summary of project brief Students to develop basic skills related to injection moulding using low-density polyethylene.	**Project title** INJECTION-MOULDING EXERCISE

Procedure



1. Ensure the moulds (A and C) and die (B) are clean and the gate is free of all obstruction.
2. Sandwich the die between the moulds and ensure the gate is located over the centre of the die.
3. Insert the clamping screws and tighten firmly.
4. Place the mould, with the gate facing up, on the moving table of the machine.
5. Raise the table into position so that the injection nozzle fits into the sprue.
6. Open the control valve by turning the handle through 90° raising and turning through 90° again.
7. Rotate the injection handle anticlockwise to inject the plastic into the mould. The handle needs to be turned until a firm resistance is felt.
8. Return the injection handle to its original position.
9. Close the control valve.
10. Release the table and remove the mould.
11. Remove the clamping bolts and shear the die from the sandwich mould.
12. Remove the moulded object from the die.

What is the chemical name of the material have you used in this activity?

What new equipment have you used?

In terms of injection moulding, what does ‘flash’ mean?

List four examples of an injection-moulded product.

Acknowledgments support materials

Acknowledgments

Grateful acknowledgment is made to Malcolm Lee, Gympie State High School, and Doug Buchan, Cannon Hill Anglican College, for granting permission to use copyright material and for assistance in developing this module

Print

Caborn C., Mould I., and Cave J. 1999 *Design and Technology*, Nelson, Cheltenham, UK.

Websites

(All websites listed below were accessed in November 2002)

American Plastics Council, *Plastics Resource®: Information on Plastics and the Environment,* www.plasticsresource.com

Automation Creation, Inc., *MatWeb: Material Property Data*, www.matweb.com

Education Queensland, *Department of Education Manual*, http://education.qld.gov.au

Export911, *General References — Abbreviations of Plastics*, http://www.export911.com/ref/plasAbbr.htm

Export911, *General References — Applications of Plastics*, http://www.export911.com/ref/plasApp.htm

Export911, *General References — Origin of Commonly Used Plastics*, http://www.export911.com/ref/oriPlast.htm

Export911, *Protect Environment: Recycling*, http://www.export911.com/envi/plasCode.htm

Plastic Bottles Pty Ltd, *Plastics Coding System*, http://www.plasticbottles.com.au/recycle.htm

This sourcebook module should be read in conjunction with the following materials from the Queensland Studies Authority:

Years 1 to 10 Technology Syllabus

Years 1 to 10 Technology Sourcebook Guidelines

Technology Initial In-service Materials

Technology CD-ROM.

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