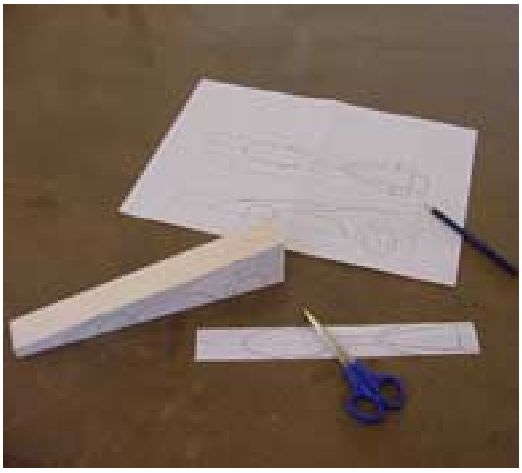
Let's race



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 continue the development of students' understandings of the basic principles of 'working technologically' within detailed design specifications, as they design and develop a dragster to enter the Queensland CO_2 Dragster Competition.

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
Introduce the competition. Investigate the methods of propulsion. Devise research and development plans.	Envision a range of dragster design options. Test materials and processes. Prepare dragster specifications and production plans. Prepare detailed working drawings. Produce dragsters.	Run school dragster competition. Evaluate the dragsters. Evaluate personal and team practices.

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Core learning outcomes

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

Technology Practice

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 6.1 Students formulate detailed plans for gathering knowledge, ideas and data and validate choices of information, sources and methods.

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 6.2 Students generate design ideas and communicate these in design proposals that indicate various options and incorporate management strategies.

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

TP 6.3 Students negotiate and refine production procedures in making quality products that meet detailed specifications.

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.

TP 6.4 Students identify methods for evaluating commercial or industrial products and processes and use these to judge the appropriateness of their own processes and products.

Information

INF 5.1 Students explain how changes to sources, forms and management of information affect design and production decisions.

INF 6.1 Students analyse issues related to the ownership and control of information in societies.

INF 5.2 Students compare and select techniques for processing, managing and presenting information for specific users.

INF 6.2 Students use specialised techniques for managing and organising the presentation of information to meet detailed specifications.

Materials

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

MAT 6.1 Students incorporate in their design proposals ideas about the impacts of particular materials used in products.

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

MAT 6.2 Students use specialised equipment and refined techniques to make quality products to detailed specifications.

Systems

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

SYS 6.1 Students explain principles underlying complex systems in terms of structures, control and management.

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

SYS 6.2 Students devise ways to manage and monitor the operation of complex systems.

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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

The activities in this module are designed to provide opportunities for students to demonstrate Levels 5 and 6 learning outcomes from the Technology Practice, Information, Materials and Systems strands. 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 prepare additional sets of anticipated evidence derived from the related learning outcomes at different levels. They may also 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 the availability of materials and resources.

Advice to teachers

This module illustrates how competitions can be used to provide opportunities for students to demonstrate Technology learning outcomes. The ideas outlined are transferable to similar competitions — for example, Australia's Spaghetti Bridge and Mousetrap Racer competitions — and competitions sponsored by universities and professional associations, such as the Institute of Engineers.

The Queensland CO_2 Dragster Competition is run at state, national and international levels. Students will need to follow the competition rules and regulations (production specifications) or they will not be able to race their models. Use the state competition date to set a date for the school's competition. Students need to be aware of the school competition date at the beginning of the unit so that they can plan suitable project timelines.

Students will need to have opportunities to develop knowledge and skills related to woodworking. To demonstrate Level 6 Materials learning outcomes, students need opportunities to investigate, test and evaluate a range of materials — for example, balsa, milky pine, hoop pine, and medium density fibreboard (MDF).

Extension activities might include design challenges related to planning and conducting the school competition, designing and using a competition racetrack, designing and producing the medals and certificates for the competition.

Resources

Students' creativity in demonstrating core learning outcomes in this module should not be limited by the range and scope of resources and equipment provided by the teacher. A variety of resources should be collected over time and should be safely stored and made available to students as required.

A comprehensive list of resources and suppliers is provided in the reference section of the module. The minimum resources required for this module include race track, starting and finishing gates, timing device, CO_2 cylinders, timber blanks for dragster body, axle material and wheels that conform to competition specifications.

Teachers should select suitable scenes from videos such as *The Fast and the Furious* and *Jet Car* for use in the introductory activities.

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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.

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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 and identify anticipated evidence of students' demonstrations of these learning outcomes. It is important, however, that the integrity of the processes and concepts within key learning areas is maintained.

This module has links to the Science key learning area.

Contributions to the cross-curricular priorities

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

- **literacy**, as students interpret and use technical language specific to engineering and manufacturing dragsters
- **numeracy**, as students record and interpret numerical data during test runs
- **lifeskills**, as students work cooperatively and share limited resources
- **a futures perspective**, as students envision new approaches to building dragsters, evaluate options and select preferred options.

The 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

- understands principles used to design and develop a CO_2 dragster
- understands the nature of materials used in the production of dragsters

Complex thinker

- appreciates the value and potential of participating in product development
- makes decisions and justifies choices in realising designs

Active investigator

- considers potential impacts of design ideas and production processes on people or environments
- tests the suitability of materials for specific purposes and experiments with techniques for manipulating and processing materials

Responsive creator

- uses imagination, originality, intuition, enterprise and aesthetic judgement when meeting design challenges
- envisions, generates and refines a range of potential solutions and innovative designs

Effective communicator

- comprehends information presented in various forms
- uses accepted standards and forms for measurement, calculation and written and visual presentations

Participant in an interdependent world

- becomes creative, self-motivated and capable of transferring skills to a range of contexts
- works individually and collaboratively with confidence and initiative
- shares equipment and resources

Reflective and self-directed learner

- critically evaluates processes and products and searches for improvements and further opportunities
- reflects on personal practices to better manage time and resources when 'working technologically'
- displays self-motivation and perseverance in seeing projects through to completion.

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Assessment strategies

The assessment opportunities outlined in this 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 opportunities.

Suggestions for gathering information about student learning are provided in the activities section of this module. The table below provides descriptions of anticipated evidence that teachers might gather to support their judgments about students' demonstrations of learning outcomes and suggests sources of evidence. Table is neither exhaustive nor mandatory. Once sufficient evidence has been collected, judgments can be made about students' demonstrations of learning outcomes. *[Table spreads over three pages.]*

Core learning outcomes	**Anticipated evidence**	**Sources of evidence**
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.	Gather, organise and compare information from a range of sources, including interviewing past competitors, Internet searches and a scan of existing CO_2 dragster designs. Examine existing CO_2 dragsters with a view to enhancing designs or developing innovative ideas. Prepare a rationale for a new or improved design that draws on research to justify design features.	Anecdotal records: • records of student–teacher interviews about their research and development plans • observations of students' participation in activities Technology project folios: • research and development plans • research summary
TP 6.1 Students formulate detailed plans for gathering knowledge, ideas and data and validate choices of information, sources and methods.	Prepare a plan to gather information. Use information gathered to justify design choices. Validate information gathered about materials, processes and systems by cross-referencing data from a range of sources. Use technical data and tests of materials to choose design options that satisfy design considerations.	
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.	Generate a range of thumbnail sketches. Select preferred options and prepare product specifications and production plans. Identify factors that influenced design choices in product specifications.	Technology project folios: • notes about decision making • thumbnail sketches • annotated developmental sketches • annotated working drawings • product specifications • draft production plans Anecdotal records: • records of student–teacher interviews • observations of students' participation in activities
TP 6.2 Students generate design ideas and communicate these in design proposals that indicate various options and incorporate management strategies.	Prepare thumbnail sketches to capture initial design ideas. Annotate more detailed sketches with design decisions. Prepare accurate full-size front and top view working drawings of preferred designs. Prepare a detailed production plan to make the design using available resources.	

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Core learning outcomes	Anticipated evidence	Sources of evidence
TP 5.3 Students meet predetermined standards as they follow production procedures to make quality products.	Identify competition requirements in design specifications. Specify criteria for evaluating standards and outline how criteria will be met. Follow production procedures to ensure quality products.	Anecdotal records: • observation of students' communication, collaboration and negotiation during activities Technology project folios: • annotated production plans Dragsters produced by students
TP 6.3 Students negotiate and refine production procedures in making quality products that meet detailed specifications.	Consider and discuss management and implementation of production processes and negotiate procedures that streamline production. Follow identified procedures and detailed specifications to achieve quality products.	
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.	Present dragster specifications and production plans to others for feedback. Conduct test runs to determine product suitability and effectiveness. Use feedback from test runs and consultation to enhance and modify dragster designs and production processes.	Technology project folios: • records of decision making • evaluation reports on dragster performance
TP 6.4 Students identify methods for evaluating commercial or industrial products and processes and use these to judge the appropriateness of their own processes and products.	Develop criteria to judge the appropriateness of the dragster design and production plan. Evaluate the suitability of production methods to the work environment. Compare production plans to commercial production methods. Assess the performance of the product by testing.	
INF 5.1 Students explain how changes to sources, forms and management of information affect design and production decisions.	Use spreadsheets to record and manipulate research and test-run data. Explain how the use of spreadsheets affected the management of research and test-run data.	Anecdotal records: • observations of students' participation in discussions • observations of students' presentation of research and test-run results Technology project folios • dragster designs
INF 6.1 Students analyse issues related to the ownership and control of information in societies.	Examine ethical issues related to access to and ownership of information and ideas that impact on participation in the competition.	
INF 5.2 Students compare and select techniques for processing, managing and presenting information for specific users.	Compare and select techniques for processing, managing and presenting research and test-run data, design specifications, working drawings, production plans, and evaluations.	Technology project folios: • tables or printouts of research and test-run results recorded in spreadsheets and databases • research summaries • product specifications • thumbnail sketches • annotated developmental sketches • working drawings • production plans • evaluation reports
INF 6.2 Students use specialised techniques for managing and organising the presentation of information to meet detailed specifications.	Generate and select information relevant to the project. Use specialised software and equipment to organise, manipulate and present ideas — spreadsheets, databases, project management, graphics manipulation, cad and flowchart software, scanners and digital cameras.	

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Core learning outcomes	Anticipated evidence	Sources of evidence
MAT 5.1 Students compare and contrast materials according to their characteristics to determine how effectively the materials meet predetermined standards.	Prepare product specifications that identify required standards. Test the mass and strength of materials to determine their suitability for meeting required standards. Select materials based on their properties — wood axles create more friction than metal axles.	Anecdotal records: • observation of students' participation in activities Technology project folios • notes about decision making • analyses of the results of materials tests • product specifications • production plans • product evaluation report
MAT 6.1 Students incorporate in their design proposals ideas about the impacts of particular materials used in products.	Balance considerations of availability, cost, and functionality, for example, when selecting suitable materials. Combine materials to enhance their characteristics — reduce friction by adding a lubricant.	
MAT 5.2 Students operate equipment and apply techniques for manipulating and processing materials to meet predetermined standards.	Specify standards and equipment and techniques for manipulating materials to meet these standards. Select and use suitable equipment and techniques to achieve required standards.	Anecdotal records: • observations of students manipulating materials Technology project folios: • notes about decision making • results of tests of materials and processes for manipulating them • production plans
MAT 6.2 Students use specialised equipment and refined techniques to make quality products to detailed specifications.	Modify work practices in response to discussions about workplace, health and safety issues, available resources, techniques required. Match equipment and techniques to desired specification to enhance product quality. Check quality to ensure detailed production specifications are met.	
SYS 5.1 Students explain the structures, controls and management of systems and subsystems.	Use annotated diagrams in design proposals to identify subsystems in the dragster design. Describe processes for controlling and managing production processes.	Technology project folios: • consultation and test results • annotated sketches • annotated product specifications • annotated production plans • working drawings • product evaluation reports
SYS 6.1 Students explain principles underlying complex systems in terms of structures, control and management.	Draw relational diagrams to show the structure, control and management of the dragster competition. Conduct test runs to identify and eliminate faults in the dragster design and to refine and optimise its performance. Fine-tune the production plans.	
SYS 5.2 Students incorporate control and management mechanisms in systems that include subsystems.	Design, trial, refine and use systems that include subsystems. Use various control and management strategies in the design and use of systems.	Technology project folios: • consultation and test results • annotated sketches • annotated product specifications • annotated production plans • working drawings • product evaluation reports
SYS 6.2 Students devise ways to manage and monitor the operation of complex systems.	Measure (and adjust if necessary) factors that influence the engineering of their dragster and the administration of the competition. Design a fault-finding methodology. Develop ways to test the efficient and effective operation of the system using, for example, trial and error, bench testing and consultation.	

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Background information

Terminology

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

compression strength
deflection
density
developmental sketches
drag
dragster
elasticity
gigapascals (GPa)
grain
hardness
indentation
Janka hardness test
jet-powered land speed record vehicles (LSRV)
kilograms per cubic meter (kg/m^3)
lbf or newtons (N)
load
maximum crushing strength (MCS)
megapascals (MPa)
modulus of elasticity (MOE)
modulus of rupture (MOR)
oven-dry weight
pounds per cubic foot (lb/ft^3)
production specifications
pounds per square inch (psi)
production specifications rupture
sketches
specific gravity
specified moisture content
stress
thumbnail sketches
top fuel dragsters
working drawings

School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module. Safety policies may be of particular relevance to the activities that follow.

In this module, teachers should consider safety issues relating to:

- risk assessment
- approved starting mechanism for firing cylinder
- dragsters must be checked against production specifications and be passed for racing
- spectators should be kept well clear of either side of the track during racing
- race should be conducted in a well-ventilated area
- used cylinders should be glued into power plant housing to prevent racing in uncontrolled conditions.

It is essential that teacher demonstrations and student activities are undertaken according to procedures developed through appropriate risk assessments conducted at the school.

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 the Queensland CO_2 Dragster Competition
- work individually or in groups to develop a competitive entry
- 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 designs and models.

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.

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Activities

Introductory activities

Design challenge
Design and develop a dragster to compete in the Queensland CO_2 Dragster Competition.

Focus

The following motivational activities introduce students to the competition. Students begin to investigate the design challenge and devise a plan to gather information, ideas and data.

Resources

Video of drag or street racing, such as The Fast and the Furious (PG)

Video of jet-powered racing, such as *Jet Car* (unrated)

CO_2 race track to demonstrate a race

Copies of the competition rules (production specifications) the competition website

Teaching considerations

When demonstrating the use of CO_2 dragsters and racetrack, safety precautions include:
- using the starting gates to fire the CO_2 cylinders (do not demonstrate how to use a hammer and nail to pierce the cylinder, as this is not a safe or satisfactory method)
- ensuring that students stand at least one to two metres from the edge of the racetrack during races
- gluing the used cylinders into the cars when the race is finished to prevent them from being used again

Introduce the competition

Technology Practice (Investigation), Information, Systems

Students view race scenes from a video such as *The Fast and the Furious*.

Discuss competition requirements and set a date for the school competition. Discuss competition rules and ethical issues related to intellectual property and ownership of ideas and designs. Discuss how access to information might impact on students' abilities to participate in the competition. Negotiate class guidelines for participation and sharing information and ideas.

Set up a competition racetrack and demonstrate CO_2 dragsters racing using models developed by teachers or other students.

Students work in pairs or small groups to:
- identify the components of the race as a system — competition rules, dragster specifications, dragsters, starting gates, racetrack, race process
- reflect on the performance of the dragsters and discuss possible factors that impact on the performance of components
- prepare a graphical representation of the race as a system with inputs, processes and outputs.

Investigate the methods of propulsion

Technology Practice (Investigation), Information, Systems

Students develop their understandings of methods of propulsion. They view scenes from a video such as *Jet Car*, that illustrate the difference between top-fuel dragsters that race on a quarter-mile racetrack, jet-powered vehicles and rocket or jet-powered land speed record vehicles (LSRV) racing in deserts or dry lakebeds. Their understandings of methods of propulsion will influence their designs. Many of the features of top-fuel dragsters — large intakes and exhaust pipes that burn huge amounts of fuel and spoilers that force the wheels onto the track to improve traction — will increase the drag and slow their dragster down.

Students work in groups to investigate the different methods of propulsion — one converts fuel into mechanical energy and uses this to drive a set of wheels, the other converts fuel into expanding gas released through an opening. This can be compared to the way the CO_2 cylinder is used to push the dragster along. A good starting point for initial investigation is an Internet search using key words and phrases, such as dragsters, LSRV (e.g. Aussie Invader III, Thrust SSV), CO_2 dragsters or CO_2 cars or CO_2 racers.

Students develop a research summary including diagrammatic representations of the CO_2 dragster system and the race system. Students present their findings to the class and include the summary and diagrams in their Technology project folios.

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Devise research and development plans

Technology Practice (Investigation, Ideation), Materials, Systems

Students review the competition rules to determine production specifications. Specifications are provided for:

- dragster body
- axles, axle holes and wheelbase
- spacers, washers and clips
- power plant (CO_2 cartridge hole)
- screw eyes
- wheels.

Students brainstorm factors that need to be considered in designing their dragster and create a concept map. These will include production specifications, drag or aerodynamics, friction and mass.

Students formulate a research and development plan, which should outline plans for:

- researching dragster designs further
- investigating factors impacting on design effectiveness and efficiency
- investigating the properties of materials and testing their suitability for design purposes
- investigating the assembly, optimisation and control of systems — for example, that the performance of the axle assembly, as a subsystem of the dragster, can be optimised to enhance overall performance of the dragster
- trialling a range of design options.

The plan might also include students' suggestions for testing or trialling:

- body and axle materials
- axle assemblies that reduce friction
- processes for finishing the surface including filling, paint brushing, spray or air-brushing
- processes used to construct and assemble the dragster.

Interview students or groups about their research and development plans. Provide opportunities for students to discuss their plans with others and refine them according to feedback received. Feedback and design decisions should be recorded in their Technology project folios.

Assessment

Sources of evidence could include:

- observations of students' participation in activities
- research summaries
- research and development plans
- student–teacher interviews.

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Developmental activities

Focus

The developmental activities focus on the design and production of dragsters.

Resources

Examples of thumbnail sketches

Teacher resource 1 (Wood strength)

Samples of a range of timbers for dragster bodies and materials for axle assemblies

Descriptions of processes that can be used to test materials and assemblies

Materials and equipment for finishing surfaces (including fillers, paint brushes, spray or air-brushing equipment) and for manipulating and combining materials

A4 sheets of 5mm graph paper for developmental sketches

Access to computers and spreadsheet and CAD software (optional)

Teaching considerations

During the developmental stage of the project, teachers will facilitate rather than direct the project. They should ensure the participation of all students and offer advice or direction when necessary.

Testing engineering factors is best done in the workrooms. Make available as many resources possible. This should allow students to generate new and innovative ways of building their dragster.

Teacher resource 1 describes a number of methods that can be used to measure and compare the strength of wood, and an example of a table that allows students to compare properties such as the specific gravity, bending strength or stiffness of a range of woods.

Envision a range of dragster design options

Technology Practice (Ideation), Information

Show students examples of thumbnail sketches — small, quick sketches. If necessary, demonstrate simple sketching techniques. As they research, students consider what their dragster might look like and draw thumbnail sketches of their initial ideas.

Students work in pairs or small groups to discuss and evaluate their thumbnail sketches. They select two or three of their best designs to be developed into more detailed sketches. Students:
- prepare three or four half-size developmental sketches on A4 graph paper
- annotate their developmental sketches with suggestions for materials and processes and identify the engineering factors that need to be considered
- interview students who have participated in previous competitions, parents/carers or community members with specialist knowledge about their proposed designs.

Test materials and processes

Technology Practice (Ideation, Investigation), Information, Materials, Systems

Introduce technical terms related to comparing the properties of materials. Provide opportunities for students to:
- identify the materials commonly used to produce CO_2 dragsters
- undertake tests or trials of materials and processes to assess their suitability
- record, compare and analyse the results of research and tests
- annotate their sketches with analyses of these results.

Students ascertain the suitability of materials by collecting and comparing data related to the properties of materials or by comparing the results of tests of wood samples. Students record data from their research or tests in spreadsheets and generate graphs to compare data. Printouts of tables and graphs and analyses of data should be recorded in their Technology project folios.

Provide students with a variety of timbers or materials. Help them to devise and carry out tests to measure mass and strength of each of the timbers or materials. These include balsa, milky pine, hoop pine and jelutong. To test the suitability of materials, students might cut pieces of different materials of the same size, then calculate the mass per cubic metre. They might also test the breaking strength of pieces of different materials that are of the same cross-section and length to compare their strength.

Students can optimise systems by fine tuning the functioning of system components. Axle assemblies need to be designed to minimise friction. Students can test how materials can be combined to reduce the friction in axle assemblies — for example, adding a lubricant to the axle.

[Continues on the next page.]

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Resources	Teacher resource 2 (Example production procedure) A range of timbers for dragster bodies and materials for axle assemblies Materials and equipment for finishing surfaces (including fillers, paint brushes, spray or air-brushing equipment) and for manipulating and combining materials Developmental sketches A3 sheets of 5mm graph paper for working drawings Access to computers and spreadsheet and CAD software (optional)
Prepare dragster specifications and production plans Technology Practice (Ideation, Production), Information, Systems	Students: • select their preferred design • review competition guidelines • finalise product specifications (based on the competition guidelines) • develop a production plan for making a quality dragster that meets the competition production specifications. The production procedure should clearly outline the steps involved in the making of the CO_2 dragsters. Students should include suggestions for managing and monitoring the production process as they trial and modify their dragster to make it go as fast as possible. An example production plan is provided in Teacher resource 2. Students should also prepare product performance criteria. Interview the students about their specifications and production plans. Provide opportunities for students to discuss their specifications and plans with others and refine them according to feedback received. Feedback and resultant decisions should be recorded in their Technology project folios.
Prepare detailed working drawings Technology Practice (Ideation), Information	Students prepare full-size top- and side-view working drawings of their selected design on 5mm A3 graph paper. It is very important that these drawings are accurate and symmetrical. Some students might like to produce their working drawings using CAD software. First, students draw the top and side views of the block of wood on the graph paper. Then they transfer their design from their developmental sketches to the working drawing views of the block. Copies of the working drawings will be glued to the wood blank and used to cut out the body of the dragster. Students use the competition production specifications as a checklist to ensure that their design meets competition requirements. They should annotate their working drawing to indicate that each specification has been considered. For example, students measure the wheelbase and annotate the drawing with the measurements.
Produce dragsters Technology Practice (Production), Materials, Systems	Students refine their production procedures and use specialised equipment and refined techniques to ensure that their dragster meets the detailed production specification outlined in the competition rules. They: • interview people with specialist knowledge or undertake Internet research to identify methods for evaluating commercial or industrial products and processes • develop criteria for judging the appropriateness of their dragsters and production processes • use a range of specialised equipment and techniques to make their dragsters. Students should undertake these tasks in a workroom where they have access to the necessary materials, tools and equipment and processes. Allow only two lessons for painting. Use spray paints and set up dowel and blocks in a well-ventilated area. Students will take varying amounts of time to produce their dragster. Some students may wish to undertake design challenges related to planning and running the competition.
Assessment	Sources of evidence could include: • observations of students' participation in activities • analyses of research and test results in Technology project folios • annotated sketches • product specifications, working drawings and production plans • dragsters.

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Culminating activities

Focus

In the culminating activities, students race their dragsters and evaluate their performance.

Resources

CO_2 competition racetrack

Manual starting and finishing gates

Timing device

Dragsters

Certificates and medals

Teaching considerations

Organise certificates or medals for participants and place getters. Consider safety issues in setting up and running the school dragster competition. Before allowing students to take their dragsters home, glue used CO_2 cylinders into the power plant hole with five minute epoxy resin. This prevents the dragsters from being used without appropriate supervision and proper equipment.

Run school dragster competition

Systems

Assist students to plan, set up and participate in a school dragster competition. Encourage students to undertake a risk assessment for the activity and propose risk management strategies.

Run the competition.

Evaluate the dragsters

Technology Practice, (Evaluation), Information, Materials, Systems

Following the competition, evaluate the dragster using the predetermined product performance criteria.

Prepare a product evaluation report that assesses:

- aesthetic, economic and environmental appropriateness of the dragster design
- contribution of system components to the effectiveness and efficiency of the dragster
- processes used to design and produce the dragster.

Evaluate personal and team practices

Technology Practice, (Evaluation), Information, Materials, Systems

Conduct self- and peer-evaluations of their practices during the project and identify aspects that they are pleased with and aspects that require improvement.

Students should review and evaluate knowledge and skills developed during the design challenge and the effectiveness of:

- presentation of designs and project related information including thumbnails, sketches, test results and working drawings
- processes undertaken during the design challenge
- individual and group work practices
- individual and group communication processes.

Assessment

Sources of evidence could include:

- Technology project folios
- quality of the finished dragsters
- performance of dragster in the competition
- product evaluation reports.

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Wood strength

Teacher resource 1

A number of methods can be used to measure and compare the strength of wood. The most commonly used strength criteria are described below.

Density is the wood mass per volume. Density is expressed as kilograms per cubic meter (kg/m^3) or grams per cubic centimetre (g/cc) at a specified moisture content, generally quoted at 12% moisture content for reference purposes. Density is the single most important indicator of strength in wood: a wood that is denser (i.e. more wood substance per unit volume) will generally tend to be stronger than a less dense one.

Hardness is a measure of wood's resistance to indentation. It is most commonly measured by the Janka hardness test which requires a steel ball (diameter 11.28mm) being pressed into a wood sample until it has penetrated to a depth of half its diameter. Hardness is measured in newtons (N).

Maximum crushing strength (MCS) or compression strength is the maximum stress sustained by a piece of wood when pressure is applied parallel to the grain. MCS is normally measured in megapascals (MPa).

Modulus of elasticity (MOE) or stiffness of wood is a measure of its ability to resist deflection under load. The modulus of elasticity is normally measured in megapascals (MPa).

Modulus of rupture (MOR) or bending strength is the maximum short-term load carrying capacity of a piece of wood. It is generally used in tests of bending strength to quantify the stress required to cause failure. It is reported in units of megapascals (Mpa) or gigapascals (GPa).

Specific gravity of wood is the ratio of an oven-dry weight of a wood sample to the weight of water (whose volume is equal to the volume of the wood sample at a specified moisture content). Specific gravity is often used in place of density to standardise comparisons of wood species — as with density, the higher the specific gravity, the denser the wood, and the stronger it tends to be. At a moisture content of 12%, most woods have a specific gravity between 0.3 to 0.8 (water has a specific gravity of 1.0).

The information below is an example of the tabulated results of data found to compare the specific gravity, modulus of elasticity, modulus of rupture, and working properties of common materials used in the manufacture of CO_2 dragsters.

Material	Modulus of elasticity (megapascals)	Modulus of rupture (bending strength) (megapascals)	Specific gravity	Working properties
Basswood	10 100	60.0	0.37	Easy to work by hand and machine tools; premier carving wood
Balsa	3 200	22.7	0.10 to 0.17	Very easy to work with sharp, thin-edge power or hand tools; dull cutters give woolly finish
Milky pine	7 300	51.6	0.34 to 0.40	Very easy to work by hand and machine tools; cuts smoothly
Hoop pine	10 800	75.8	0.42	Easy to work by hand and machine tools
Jelutong	8 100	50.4	0.36	Easy to work by hand and machine tools but may gum the cutter; excellent for carving

Adapted from: www.windsorplywood.com

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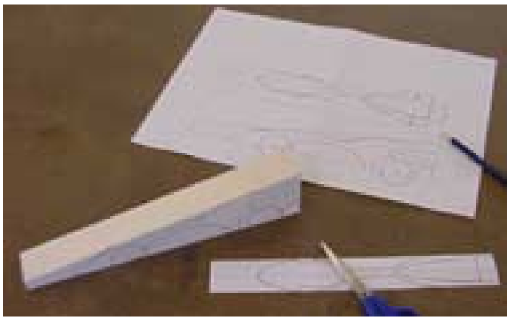
Example production procedure

Teacher resource 2



Glue templates to blank

Use a photocopy of the working drawings as a template for cutting and shaping the wooden blank into a dragster body.

Cut out the front view and top view.

Glue the views to the wooden blank. Line up the back and base of the template and the blank.

NB. Because the top view is glued to the sloping surface on the blank, it will be slightly shorter.

Set up drill and make axle holes

Set-up a jig to drill the hole for the power plant (CO_2 cylinder). For best results use a 3/4-inch bit[1].

Drill the hole for the power plant.

Use a drill press to drill the front and rear axle holes in the position shown on the working drawing.

Accuracy is important. Misaligned holes will cause friction, resulting in a slow dragster.

Cut dragster body

Cut out the side view using a bandsaw or scroll saw. A coping saw can also be used but the results are not as accurate.

This process will cut pieces out of the top view. Save all the pieces. They will be used in the next step.

Use masking or sticky tape to reassemble the blank (and recreate the top view).
Cut out the top view of the dragster.

Shape and sand dragster body

Smooth out the shape using, for example, a disk sander, spindle sander, files and sandpaper.
Use drill bits, chisels and/or hobby knives to hollow out the body of the dragster.

Once you are happy with the shape, use fine sandpaper (particularly on balsa) to give the body of your dragster a smooth finish ready for painting.

[1] The competition guidelines suggest a 3/4-inch drill bit

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Paint dragster body

Insert 3/4-inch (about 19mm) dowel into the power-plant hole to hold the body while painting. For the best surface finish, apply a primer first and, when dry, sand with 400 grit sandpaper.

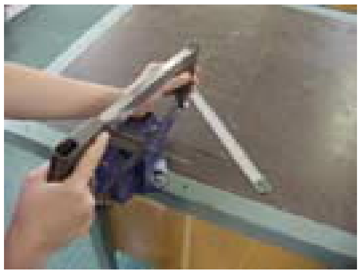
Reapply the primer until a smooth surface is achieved.

Paint can then be applied by spray (preferred) or by brush with a very light sandpaper between coats. Three or four light coats are better than one heavy coat. A smooth high gloss finish results in less drag and therefore a faster dragster.

Prepare axle assembly

Cut the axle material to the required length using a hacksaw and metal vice. It is very important to keep the axle material straight, a small bend in the axle results in wheel wobble, friction and a slow dragster.

Remove the burr on the ends of the axles with a file and lightly sand with 400–800 grit sandpaper to remove imperfections.



Assemble dragster

Assemble the dragster by inserting the axles and adding a washer between the wheels and the dragster to reduce friction.

Attach the wheels, checking that the rear wheels are on the correct way.

Position the screw-eyes along the centreline of the dragster body, either in front of, or behind, the axles. The screw-eyes must be parallel to the race surface. Inaccuracy will result in friction between the fishing line and the screw-eyes. Coat the screw-eye threads with a little glue. This will hold them in place.
Complete the dragster assembly by adding decals (stickers), pin strips and painting the wheel hubs.

Test your dragster

Finally, test your dragster.

Check the wheels are smooth and roll freely, and the screw-eyes are aligned.

Roll your dragster along the floor and check it rolls in a straight line. Adjust if necessary.

Let's race!

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Acknowledgments and support materials

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Doug Buchan, Head of Department, Cannon Hill Anglican College, Brisbane

Years 4 to 10 students at Cannon Hill Anglican College for trialling the activities.

Print

Holledge, K 1995, 'CO_2 dragster', *Journal of the Industrial Technology and Design Teachers' Association of Queensland*, vol. 33, no. 4, November 1995.

Electronic

Video

The Fast and the Furious 2001, motion picture, Columbia Tri-star Home Entertainment Australia. (This video may be deemed unsuitable due to language in the film and should be assessed as part of the risk analysis.)

Jet Car (video), Main Event Video

Websites

(All websites listed below were accessed in September 2002)

CO_2 Racers: World Wide Competition — A Project in Design, Make and Appraise, www.bundabershs.qld.edu.au/co2-drag/index.htm

Re-engineering Australia Forum, www.rea.org.au

INTAD: Industrial Technology and Design Teachers, www.intad.asn.au

Season 2002–2003 F1inschools.com, www.f1inschools.com/

How Fast Is Fast? CO_2 Racing Resources, www.cooz.com/co2

TEP: Technology Enhancement Programme, www.tep.org.uk

DATA: The Design and Technology Association, www.data.org.uk/

Pitsco Inc. PITSCO: Leaders in Education, www.pitsco.com

WoodBin, Woodbin, www.woodbin.com/ref/wood/strength_table.htm

Windsor Plywood, www.windsorplywood.com

Resources

Tools and equipment

The following tools and equipment are useful in the production of CO_2 dragsters. Models that can be easily transported between workrooms are available. This makes them suitable for use in primary and secondary Technology classes.

- 230mm bandsaw
- bench drill press
- oscillating spindle sander.

The dragsters are much easier to make using a bandsaw, rather than a coping saw. A bench drill press is used to accurately drill the axle holes. Students can use files, rasps and sandpaper to shape the bodies of the dragsters, but spindle sanders are very popular. Hacksaws and metal vices are also useful.

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Materials

The components for the CO_2 dragsters and the equipment necessary to run the CO_2 dragster competition are available from the following suppliers:

Wheels, manual starting kit and timing devices

G.K.M. Holledge, 5 Reek Court, Bargara Qld 4670

Tel/Fax: (07) 4159 1624

ABN 31 359 987 730

Balsa timber blanks

40mm x 40mm x 915mm (Glue together, cut 3 x 300mm long, each blank makes two dragsters)

Scott & Co Pty Ltd, 15 Creswell Street, Newstead Qld 4006

Tel: 07) 3252 5817. Fax: (07) 3252 1328

Milky pine timber blanks

420mm x 80mm x 40mm (One blank makes two dragsters)

Tropical Forest Timbers, Cairns

Tel: (07) 4051 1888. Fax: (07) 4051 1196

CO_2 cylinders

Lark Sales Pty Ltd, P.O. Box 520, Pymble NSW 2073

Tel: (02) 9144 3284 (02) 9144 7192

Fax: (02) 9144 4526

Email:mail@lark.com.au

Balsa timber blanks

300mm x 100mm x 50mm (One blank makes two dragsters)

Aspen Timbers, Maryborough

Freecall:1800 632 166. Fax: (07) 4121 2183

Hoop pine blanks

300mm x 93mm x 42mm (One blank makes two dragsters)

Lindsay Meyers Pty Ltd, 11 Grice Street, Clontarf Qld 4019

Tel: (07) 3284 5281, (07) 3284 9130

Fax: (07) 3283 3352

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

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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