DEPARTMENT OF EDUCATION
learners first

Engineering Design 2

Course Implementation Guide

Professional Studies

TECHNOLOGIES

Catholic Education Tasmania

INDEPENDENT SCHOOLS TASMANIA

Years 9 - 12 Learning

Tasmanian Government

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Course Implementation Guide
Engineering Design (EDN215122)

About this document

This course implementation guide supports the course document[1]. It supports teachers to create active and engaging learning experiences.

The Department of Education's A Pedagogical Framework has informed this resource.

Focus area support

This is a Professional Studies course.

Exposure to professional practice in Engineering Design occurs through:

- excursions and activities
- guest speakers
- case studies.

Links between professional practice expectations and the learner's work should be explicit.

Learning activities should:

- develop engineering discipline specific skills
- develop transferable skills key to the engineering profession. For example:
  - problem solving
  - analytical thinking
  - communication and presentation skills
  - interpersonal skills
  - project management.
- mirror professional expectations and working in a 'professional manner'.

Localisation and customisation

Localisation

For providers with low numbers:

- This course requires learners to collaborate with others. This may be with:
  - peers
  - community members
  - industry professionals.

[1] A 'course document' refers to accredited course information on the TASC website.

For providers in isolated areas:

- Course context should consider access to:
  - local resources and expertise
  - online opportunities to connect with other learners and industry experts.

For providers delivering access remotely:

- Online and in person opportunities to connect with:
  - Engineering Design learners on other sites
  - industry professionals.

Customisation

Opportunities exist to customise learning and content throughout the course. Examples of this include:

- providers choosing the engineering context(s) for the course delivery
- providers connecting to a particular context relevant to their local community
- learner agency – selection from a given range or negotiation of project topics
- embedding learning adjustments and differentiated classroom practice
- flipped classroom/blended learning opportunities.

Providers must include activities that enable the development of key knowledge and skills. The learning outcomes for each module identify these.

The use of real-world practical activities gives learners the opportunity to develop understanding of concepts.

Course delivery advice

Module	Indicative Times
Module 1 – Understanding the Engineering Design Process	50hrs
Module 2 – Engineering Solutions	50hrs
Module 3 – Negotiated Design Project	50hrs

Teaching and learning

Module 1: Understanding the engineering design process

The following learning outcomes are a focus of this module:

1. use design thinking to generate creative ideas in response to an engineering design challenge
2. apply an engineering design process in the development of prototypes
3. use project management strategies when working independently and collaboratively with others
4. apply an engineering design process to test, review and refine engineered solutions against success criteria

5. communicate engineering design decisions and solutions
6. describe the impact of existing, new, and emerging technologies on people and engineering practice.

Module 1: Teaching strategies

Design underpins all engineering solutions. This module uses problem-based and project-based learning strategies to introduce the principles of design thinking and engineering design processes.

Short engineering challenges and or an extended whole class activity support learning. Scaffolded tasks provide learners with strategies for problem solving, project management and metacognition. Working to a design brief within an engineering design process is pivotal.

Teachers could:

- model and communicate that mistakes progress learning and develop an innovator's mindset.
- introduce research skills through investigation of existing, new, and emerging technologies that affect engineering.

The process of design development and presentation of a final solution or product support this.

A team-based approach to solving problems through collaboration and peer feedback is encouraged.

Work requirements for this module include:

- an investigation of the impacts of existing, new, and emerging technologies. For example, the development of the mobile phone.
- a project presentation and completed production diary in response to an engineering design challenge.

Please refer to Appendix 3 of the course document for further detail.

Module 1: Examples of learning activities

The why for learners

These activities describe ways to engage and support learners to set meaningful goals and make connections.

Problem solving and critical thinking

Engage learners through authentic design briefs and challenges. For example:

- use scenarios that have real-world context and a set of discussion questions.
- use an interesting photo, picture or book and ask them to post questions and wonderings on a discussion board.
- reverse engineer a physical product (eg a hairdryer or torch, push toys). Learners follow a structured approach to safely disassemble the product. Where available, use manufacturer's instructions and manuals where available. Learners will need to:
  - use appropriate tools safely (eg screwdrivers, pliers, cutters, spanners and measuring equipment)
  - document each stage of the disassembly.
- investigate a disruptive technology (eg smart phone, the wheel, biro). Share with the class how these changed the way we live.
- research great engineering disasters and what could have helped to prevent the disaster.

Engage learners through mini design challenges. For example:

- Rapid prototyping (prototype – review – refine and iterate)
- Design and prototype footwear for overseas travellers in hot tropical countries where the Zika virus is present.
- Use a microcontroller, motors, and mechanisms to make a robot that moves like a living creature.
- Design a prosthetic for an athlete who does not have use of one of their legs. Learners can select the sport the athlete is to take part in.

Design

- Participate in a class debate on the topic - What is good design?
- Find images or drawings that represent each of the Design Elements and Design Principles
- Create and use a decision matrix to evaluate a design

The what and how for learner

These learning activities describe how to help learners grasp big ideas and key understandings and organise new information. They also describe opportunities to create, transfer and deepen knowledge and understanding.

Safety protocols

- Design, print and display posters that illustrate the safe and appropriate use of workshop equipment. Consider risk reduction and management. The teacher allocates learners different workshop equipment to research.

Design processes

- Interview a designer or engineer. Discuss clients they have provided solutions for, comparing the nature of the tasks and the methods used throughout the design process. Discuss the development of design brief details and documentation. Determine how these have influenced the designers' design process and decisions made.
- Create a design brief that addresses the problem/need/opportunity/situation. Use a template to support learners. Discuss how to develop evaluation criteria that include both qualitative and quantitative aspects.
- Design a simple device and pass it on to another class member to improve your design. Pass on again so that you have 3 different designs to test.
- Design a piece of furniture, inspired by a famous architect, to occupy a particular room or space in your school. Cardboard furniture design challenge.

Communication

- Keep a visual diary to display inspirational pictures with annotations and initial sketches.

Technical skills

- Use production skills (soldering, cutting coding etc.) to produce and test a prototype
- Create an instructional video of the computer-aided design (CAD) or computer aided-manufacturing (CAM) process for 3D printing for your school.
- Draw plans to scale for another class member to build.

Module 1: Focus area guidance

Exposure to professional practice

- engineering design challenges
- managing projects
- investigating existing, new, and emerging technologies.

Ideation, research, discovery, and integrated learning

- design thinking and engineering design processes.

Production and sharing replicating professional paradigm

- communicate with purpose
- solve problem
- prototype
- collaborate
- use a design journal

Module 1: Recommended resources

- Project-based learning infographic (website - Department of Education NSW)
- What is an engineer and what does an engineer do? - What is Engineering? (YouTube 4:17min)
- Types of Engineering (website)
- The future of engineering – What's ahead for engineering – and the world! (website – Engineers Australia)
- The Biggest Problems We're Facing Today & The Future of Engineering: Crash Course Engineering #46 (YouTube 10:24)
- Crash Course Engineering YouTube Playlist (46 episodes)
- Thinking like a designer! - How to solve problems like a designer (YouTube 4:50min)
- What is Engineering and What is Design? (website)
- Stanford d.school (website)
- Design Thinking: A Non-Linear Process (website – article)
- Engineering for Good - poster
- The Engineering Design Process: A Taco Party (website)
- The James Dyson Foundation (website and downloadable resources)
  - Inspiring the Next Generation of Engineers
  - Challenge Cards
  - Disruptive Designs
- Engineering Design Process (website)
- A brief overview of the 5 phase Design Thinking process (YouTube playlist)

0. Design Thinking & Doing
1. Empathize
2. Define
3. Ideate
4. Prototype
5. Test

- Ideation tools – (website) - round robin, opposite thinking, mash-up method, analogy thinking, rip and rap, brainstorm cards, collaborative sketching, storyboarding)
- Rapid prototyping Google Glass – Tom Chi (YouTube – 8:08min)
- Sketch like an Engineer #1 Intro to hand sketching (YouTube 8:08min)
- Sketch like an Engineer # 2 Orthogonal Drawing (YouTube 7:53min)
- Research existing, new and emerging technologies - opportunities for incorporating cross-curriculum priority – Aboriginal and Torres Strait Islander Histories and Cultures The Orb - Living Cultures (website) eg shelters, stone tools, fibres
- List of some Australian Inventions and Innovations (website)
- The Evolution of Kitchen Appliances Overtime (website)
- The Future of Making Things (PDF eBook APAC Student Project Showcase)
- Introduction to CAD: Learn Fusion 360 in 90 minutes (free account)

Module 2: Engineering solutions

The following learning outcomes are a focus of this module:

1. use design thinking to generate creative ideas in response to an engineering design challenge
2. apply an engineering design process in the development of prototypes
3. use project management strategies when working independently and collaboratively with others
4. apply a process to test, review and refine engineered solutions against success criteria
5. communicate engineering design decisions and solutions
7. describe the roles and responsibilities of engineers

Module 2: Teaching strategies

This module enables learners to deepen their knowledge of design and engineering processes. Application of learning in different and creative ways is a focus.

Use a variety of tasks to allow learners to show the key knowledge and skills outlined. Tasks should allow choice and flexibility while linking to the selection of strategies to progress toward achievement of specific standards. Involve learners in designing and constructing activities. Certain tasks are more suited to showing specific knowledge and skills. Tasks do not have to be lengthy or extensive to support demonstration of achievement.

Use worked examples to demonstrate to learners how to undertake a learning task and ways to progress. This can occur at different points in a learning experience (before, during and concluding). When introducing unfamiliar tools and equipment, model safe practices and maintenance procedures. Risk assessment and incident responses must be taught as appropriate to the workspaces and equipment used.

Feedback should be timely and specific and structured to support growth and achievement. It should support learners to reflect on and refine their understanding. Feedback can come from many audiences, including peers, community members and industry experts.

Work requirements for this module include:

- a poster or infographic that identifies the key characteristics of engineers, describing how they apply to the engineer's role in a particular engineering context. (eg civil engineering, software engineering).
- a learner selected engineering design project and accompanying design journal

Module 2: Examples of learning activities

The following learning outcomes are a focus of this module:

1. use design thinking to generate creative ideas in response to an engineering design challenge
2. apply an engineering design process in the development of prototypes
3. use project management strategies when working independently and collaboratively with others
4. apply a process to test, review and refine engineered solutions against success criteria
5. communicate engineering design decisions and solutions
7. describe the roles and responsibilities of engineers

The why for learners

These activities describe ways to engage and support learners to set meaningful goals and make connections.

Exploring engineering design

- Research what engineers do. What are their roles and responsibilities?
- Use an ideation strategy (eg mind mapping) to brainstorm solutions to a problem. For example, how could you redesign a building or product you use every day to work better for people with disabilities?
- Watch the TED Talk by Simone Giertz Why you should make useless things (YouTube 11:58). With a partner, brainstorm your own 'useless thing'. Share with the class. Facilitate a discussion in relation to the role of failure in innovation and the innovator's mindset.

The what and how for learners

These learning activities describe how to help learners grasp big ideas and key understandings and organise new information. They also describe opportunities to create, transfer and deepen knowledge and understanding.

Project ideas

- Use a micro:bit to create a prototype for a personal heart monitoring system. The system could use an accelerometer to detect the movement of the heart. It could also use a suitable sound output and an LED display to give heart rate information to the user.
- How might we reduce reliance on single-use plastic in our community? Principles of Design Thinking (Autodesk Design Academy – free account).
- Investigate, prototype and test the best wing design for a remote-controlled survey aircraft. (BP, the Science Museum and STEM Learning The Ultimate STEM Challenge).
- Design and construct a returning boomerang. Allow for the greatest flight distances relative to the accuracy of boomerang return (NASA The Great Boomerang Challenge).

Planning engineering design projects

- Interview a designer or engineer. Discuss clients they have provided solutions for, comparing the nature of the tasks and the methods used throughout the design process. Discuss the development of design brief details and documentation. Determine how these have influenced the designers' design process and decisions made.
- In teams, develop a design brief for the creation of an engineering solution. Identify evaluation criteria for the problem/need/opportunity/situation. Conduct research and document three different design options using annotated drawings. Using a table (docx - 72.31kb), evaluate each proposed design option and determine which option best meets the design brief. Produce a work plan detailing the production of the option for the preferred solution (VCAA).
- Discuss how both qualitative and quantitative data play an important role in Engineering. Discuss how both types of data can help to determine the effectiveness of the engineered solution developed.
- Conduct an experiment. For example:
  - how to make biodegradable plastic from banana peels
  - the best material to put in a sandbag to block water during a flood
  - what type of paper airplane flies the fastest and stays aloft the longest?
- Compare three different products that have the same primary function. Learners develop a set of evaluation criteria to compare the function, ease of use, safety and suitability of materials. They draw conclusions and present findings using presentation software. (VCAA)
- From a given product create a persona profile that identifies the user requirements. (eg a children's toy).

Implementing and managing engineering design projects

- Use computer-aided design (CAD) software (such as SketchUp or AutoCAD) to draft designs for parts of an engineered system. If possible, 3D print these parts and then refer to testing, modelling and the design brief to evaluate them for effectiveness. (VCAA).
- Use a Gantt chart to map the stages of a production plan in a sequence of steps or operations. Some free online Gantt chart templates are GanttProject and TeamGantt.
- Discuss, as a class, why testing is important to the engineering design process. Design and carry out a testing procedure. Guide learners through how to prepare a report to explain the probable reasons for a performance problem, failure or breakage in an engineering system. Watch the NASA YouTube clip entitled 'Repeatability' before discussing the importance of conducting tests several times to replicate results (adapted from (VCAA).

- Produce a 30 second video at the end of each lesson reflecting on team dynamics, things that went well, problems, etc.

Engagement with the engineering profession

- Take part in opportunities for work exposure such as industry career days, presentations from industry professionals, mentorship, industry developed competitions or design challenges.
- The following are examples of approaches to delivery which could enhance understanding of the vocational importance of engineering design (WJEC Level 1/2 Award in Engineering):
  - A health care facility supporting people with Parkinson's disease is looking for a design solution for a computer keyboard. Learners meet with representatives to discuss requirements and design a solution. They present their ideas with sketches and a 'mock-up' to potential users for feedback.
  - As a result of feedback from customers, a retailer is introducing a new product range for its camping department. It has asked for a table and set of four chairs to that can be stored in a box the size of a microwave. Learners visit the retailer to investigate the existing range of products. They then present their ideas to the retailer.

Module 2: Focus area guidance

Exposure to professional practice

- respond to and create engineering design briefs
- manage projects (including identifying objectives, setting targets and timescales, managing resources and carrying out risk assessment)
- understand and apply professional standards such as ethical conduct, safe work practices and fundamental principles of intellectual property rights and protection
- investigate roles and responsibilities of engineers.

Ideation, research, discovery, and integrated learning

- design thinking and engineering design processes.

Production and sharing replicating professional paradigm

- communicate with purpose
- assess and develop engineered solutions
- collaborate
- use a design journal
- produce engineering reports.

Module 2: Recommended resources

- 10 Useful Approaches for Formative Assessment (image)
- ATLASSIAN Team Playbook (website - free workshop resources eg agile teams, elevator pitch, disruptive brainstorming, customer journey map, decision making framework, empathy mapping, inclusive meetings, learning circle, project poster, roles and responsibilities, retrospective)
  - Design Brief – (YouTube 3:33min)

- *Working in …* series (Clips from Australia's Science Channel – StarPortal)
  - Robotics and Engineering — Engineer
  - Robotics and Engineering – Project Engineer
  - Robotics and Engineering – Systems Engineer
  - Robotics and Engineering – Development Engineer
  - Robotics and Engineering – Civil Engineer
  - Robotics and Engineering – Robotic Engineer
  - Robotics and Engineering – Biotechnician and Chemical Engineer
- Indigenous Engineers Group (website)
- Stories of Indigenous Engineering (website – Engineers Without Boarders Australia)
- Engineering Design Project Guide (website)
- Design Problem Statements – What They Are and How to Frame Them (website)
- Ideas for Engineering Science Fair Projects (online article)
- Engineering Solutions to Freshwater Problems (website)
- Scale drawing Khan Academy (website)
- Interpreting a scale drawing Khan Academy (website)
- 7 Everyday Items Transformed into Life Changing Innovations (website)
- Pathways for a career in Space (website Australian Space Discovery Centre)
- Biomimicry (website Biomimicry Institute)
- Youth Challenge Design Brief (PDF)
- Code of Ethics and Guidelines on Professional Conduct (website Engineers Australia)
- Stage 1 Competency Standard for Professional Engineer (website Engineers Australia)
- Competitions supported and run by industry, non-profit organisations, governments and universities e.g. National STEM Competitions (website) Science and Engineering Investigation Awards (website)

Module 3: Negotiated projects(s)

The following learning outcomes are a focus of this module:

2. use design thinking to generate creative ideas in response to an engineering design challenge
3. apply an engineering design process in the development of prototypes
4. use project management strategies when working independently and collaboratively with others
5. apply a process to test, review and refine engineered solutions against success criteria
6. communicate engineering design decisions and solutions
8. explain how engineering solutions are utilised and their impact on society.

Module 3: Teaching strategies

Having completed the previous two modules, learners will now propose a final engineering design project. They will conduct their own research, design and construct a prototype and then perform an evaluation of their final product.

Providers should develop protocols with learners to guide sharing, collaboration, construction and co-agency.

Learning is learner directed and the teacher is a guide and facilitator. Direct instruction may be needed to develop technical skills, reduce project fatigue or to bridge a knowledge gap. This may include optional workshops, curated resources, pre-recorded tutorials, class discussions or guided experiments.

Ongoing feedback and reflection on learning will be crucial to guide learners. Teachers support learners to self-regulate, build resilience to overcome challenges and help progression. Use effective questioning to probe learners' thinking. Provide prompts to generate explanation, exploration and justification of choices. Develop connections between prior learning and new knowledge, challenge misconceptions and provide stimulus for further investigation.

Work requirements for this module include:

- Negotiated engineering design project

  Documentation, in a production diary, of the process learners have followed is essential. Presentation of the production diary as a design folio, must include:

  - Problem identification and analysis
  - Project plan
  - Iterative testing plans and implementation
  - Where the engineering solution could be used in society, its impacts, and how those impacts are managed.
  - This is to be presented in an appropriate format that includes:
    - evidence of design development sketching
    - annotated photos of production process
    - documentation of testing processes.

Module 3: Examples of learning activities

The why for learners

These activities describe ways to engage and support learners to set meaningful goals and make connections.

Engagement through authentic design briefs and challenges

Learners may identify and negotiate their own projects or develop ideas based on a choice of problem statements or design briefs.

Example Problems and Solutions (providing guidance around size and scale of problems and solutions) are available in the Engineering Design Microsoft Teams channel.

The what and how for learners

These learning activities describe how to help learners grasp big ideas and key understandings and organise new information. They also describe opportunities to create, transfer and deepen knowledge and understanding.

Design thinking and engineering design processes

Learners extend and apply knowledge and understanding within an engineering design project of interest. With guidance and oversight, learners may collaborate with:

- others in the class
- community projects
- industry professionals
- not for profit organisations.

Unpacking ethical, cultural, economic and environmental issues

Issue	Examples of opportunities for developing an understanding of the issue
Ethical	• The implications of unregulated labour markets and fair-trade suppliers. • The effect of engineering on people's quality of life and the impact of manufacturing processes.
Cultural	• Investigate how engineering contributes to cultural development and a technological future. • How cultural awareness of their audience may impact communication.
Economic	• Making informed decisions about the choice, implementation, and use of materials in engineered products. For example, consideration of cost and the efficient management of money and resources.
Environmental	• How changes in working practices, due to developments in engineered products, impact the environment. For example, globalization of manufacturing, reduction in carbon emissions due to improved production methods. • Explore the effect on natural resources in the creation of engineered products used. For example, the environmental impact of digital devices and their use, deployment and eventual recycling and disposal.

Adapted from Cambridge Nationals Level 1/2 Engineering Design Specification

Project and problem-based learning

- Collaborative Projects - Use online platforms to enable all group members (and teacher) have access to all research, planning, inputs. This is to minimise the impact of individual absences on the project's progress.

Communication and presentation skills

- Watch TED's We can help you master public speaking \ Chris Anderson (YouTube 4:29) and facilitate a class discussion.
- In a lesson, hold an elevator pitch workshop. Provide to learners a client brief/scenario and, in small groups, workshop a project idea. At the end of the lesson, groups pitch a project idea in the time it takes to ride an elevator.

Module 3: Focus area guidance

Exposure to professional practice

- develop an engineering design brief
- manage projects
- consider the needs of the present with the needs of future generations.

Ideation, research, discovery, and integrated learning

- design thinking and engineering design processes.

Production and sharing replicating professional paradigm

- communicate with purpose
- appraise, design and create engineered solutions
- collaborate
- produce an engineering design report.

Examples of learning activities

- Students identify and investigate design needs. They research and assess existing products to gain an understanding of how others have:
  - resolved similar problems
  - identified needs and opportunities

  Learners then prepare a design brief that establishes the requirements of a product that they design and make.
- Document a daily work log/time sheet including record of production with photographs of each stage of the production.
- Test and evaluate your finished product by responding to evaluation questions.

Module 3: Recommended resources

- Victorian Department of Education and Training – Literacy Teaching Toolkit – Extended writing piece: A design brief (website)
- Clean Energy Council – Technologies (website)
- Engineering a Sustainable World – Educator Toolkit (PDF)
- What is PBL? (website)
- Direct instruction is still necessary in a PBL classroom (website)
- What growth, innovation and collaborative mindsets look like for students and teachers (website)
- Guide for giving a group presentation (website)
- Communicating Your Project Results with Professional Posters (website)
- The change-maker's guide to pitching your project idea (Online article)
- Teacher guidance during science investigations and engineering design (PDF poster)

- STEM Lessons From Space: Engineering (website NASA)
- STELR Modules (website ready-to-use STEM resource)

Supporting learner responses

The work requirements outlined in the course document describe the fundamental assessment evidence. Inclusion of other tasks may support and enhance learning. Learning activities aim to support and enrich understanding and achievement of the learning outcomes. Possible strategies to support learner responses to work requirements are provided.

Module 1: Research task - existing, new, and emerging technologies

Context

Investigation of the impacts of existing, new, and emerging technologies, for example, the development of the mobile phone.

Produce a report – written, oral or multimodal.

Relevant learning outcomes

3. use project management strategies when working independently and collaboratively with others
4. communicate engineering design decisions and solutions
5. describe the impact of existing, new, and emerging technologies on people and engineering practice

Scaffolding

- provide a selection of technologies for learners to choose from
- provide some websites as jump off points
- provide graphic organisers and model how to use them (eg a flow chart)
- explicitly teach how to use the internet for research including referencing. A teacher librarian may be able to support this by running a session on researching and academic integrity.

Module 1: Engineering design challenge

Context

The Engineering Design Challenge supports learners to develop an understanding of effective teams and how individuals contribute to team success. They will also develop skills in project management within specific constraints such as resource and time.

Learners will document their experiences using a production diary. They will capture their design process including ideation, sketching and annotated photos.

Learners will present a response detailing their design process journey and produce an individual reflection on teamwork and project management.

Relevant learning outcomes

1. use design thinking to generate creative ideas in response to an engineering design challenge

2. apply an engineering design process in the development of prototypes
3. use project management strategies when working independently and collaboratively with others
4. apply an engineering design process to test, review and refine engineered solutions against success criteria
5. communicate engineering design decisions and solutions
6. describe the impact of existing, new, and emerging technologies on people and engineering practice.

Scaffolding

- develop design briefs and challenges that are guided by learner interest within the engineering context(s) chosen by the provider
- breakdown challenge into smaller parts
- provide a template for learners to document their design process
- provide templates and exemplars for project management
- explicitly teach the language of cognition and metacognition
- provide opportunities for learners to engage in feedback with their peers.

Module 2: Roles and responsibilities of engineers

Context

Identify the key characteristics of engineers, describe how these characteristics apply to the engineer's role in a particular engineering context (eg civil engineering, software engineering).

Produce a poster or infographic.

Relevant learning outcomes

3. use project management strategies when working independently and collaboratively with others
5. communicate engineering design decisions and solutions
7. describe the roles and responsibilities of engineers.

Scaffolding

- engage speakers to talk about engineering careers
- provide a list of useful websites
- provide material for exploration such as the Careers in STEM magazine
- provide a poster template
- provide hints and tips for creating an info graphic in Word or PowerPoint

Module 2: Learner-selected engineering design project

Context

Learners keep a journal to document the engineering design process as they develop their solution. Elements include:

- a description of the science, technology, and mathematics used to explain the key function of the engineering solution. Using scientific symbols, diagrams, and formula where appropriate.
- a plan to collect data to assess the solution
- data collected and represented to enable interpretation
- reasoned conclusions made from the testing process. Scientific, technological, and mathematical theory and the data collected should be evident.
- identification of relevant professional standards and the role of enterprise

This process will form an inquiry cycle where the application of science, technology and mathematics used informs choices. This includes data collection, and refinements made through an iterative process. The completed diary entries reflect this process and document when the learner's engineering systems do and do not behave as expected.

Relevant learning outcomes

1. use design thinking to generate creative ideas in response to an engineering design challenge
2. apply an engineering design process in the development of prototypes
3. use project management strategies when working independently and collaboratively with others
4. apply an engineering design process to test, review and refine engineered solutions against success criteria
5. communicate engineering design decisions and solutions
7. describe the roles and responsibilities of engineers

Scaffolding

- activate prior knowledge (questioning, K-W-L chart, etc)
- structure lessons to ensure learners clearly understand expectations and can confidently complete the activities required to work toward completing their project
- provide timely feedback and promote reflection and self-assessment
- enable opportunities for peer-to-peer feedback and time for learners to reflect and act upon feedback
- support effective group work with project management tools
- embed assessment throughout the project (strategies could include exit tickets, 30 second video snap shots submitted via a LMS (Learning Management System) each lesson, message board discussions, strategic questioning, one-minute papers)

Module 3: Negotiated engineering design project

Context

Design and production of an engineered solution to a specified project brief as provided by the teacher.

The process that learners have followed must be documented in a production diary. The production diary must be presented as a design folio, including:

- Problem identification and analysis
  - clear statement identifying the problem

  - in depth analysis of the problem including:
  - identification of stake holders
  - identification of existing solutions
- Project plan – including:
  - projected timeline
  - initial designs and thoughts on a new solution
  - prototype and appropriate documentation
  - analysis of chosen design
  - identification of flaws in design
  - suggested improvements given ideal circumstances.
- Iterative testing plans and implementation
  - documenting each step of each cycle of the Engineering Inquiry Cycle.

This is to be presented in an appropriate format including evidence of design development sketching and annotated photos of production process and documentation of testing processes.

Relevant learning outcomes

1. use design thinking to generate creative ideas in response to an engineering design challenge
2. apply an engineering design process in the development of prototypes
3. use project management strategies when working independently and collaboratively with others
4. apply an engineering design process to test, review and refine engineered solutions against success criteria
5. communicate engineering design decisions and solutions
8. explain how engineering solutions are utilised and their impact on society

Scaffolding

Selection of appropriate scaffolding will depend on the selected projects and the needs of the learners.

- Ensure negotiated projects connect to learner interest
- Make graphic organisers/mind maps available
- Use exemplars and rubric to model expectations
- Create opportunities for learner conversation/discussion
- Provide ongoing feedback throughout the project

Additional support resources[2]

- Course Document

[2] All resources cited were accessed and checked for accuracy and appropriateness of content in November 2021.

- Sample Scope and Sequence
- Community of Practice Information

CONTACT	years9-12learning@education.tas.gov.au
VERSION	1.0 – February 2022
REVIEW BY DATE	January 2023
THIS DOCUMENT REPLACED	Not applicable