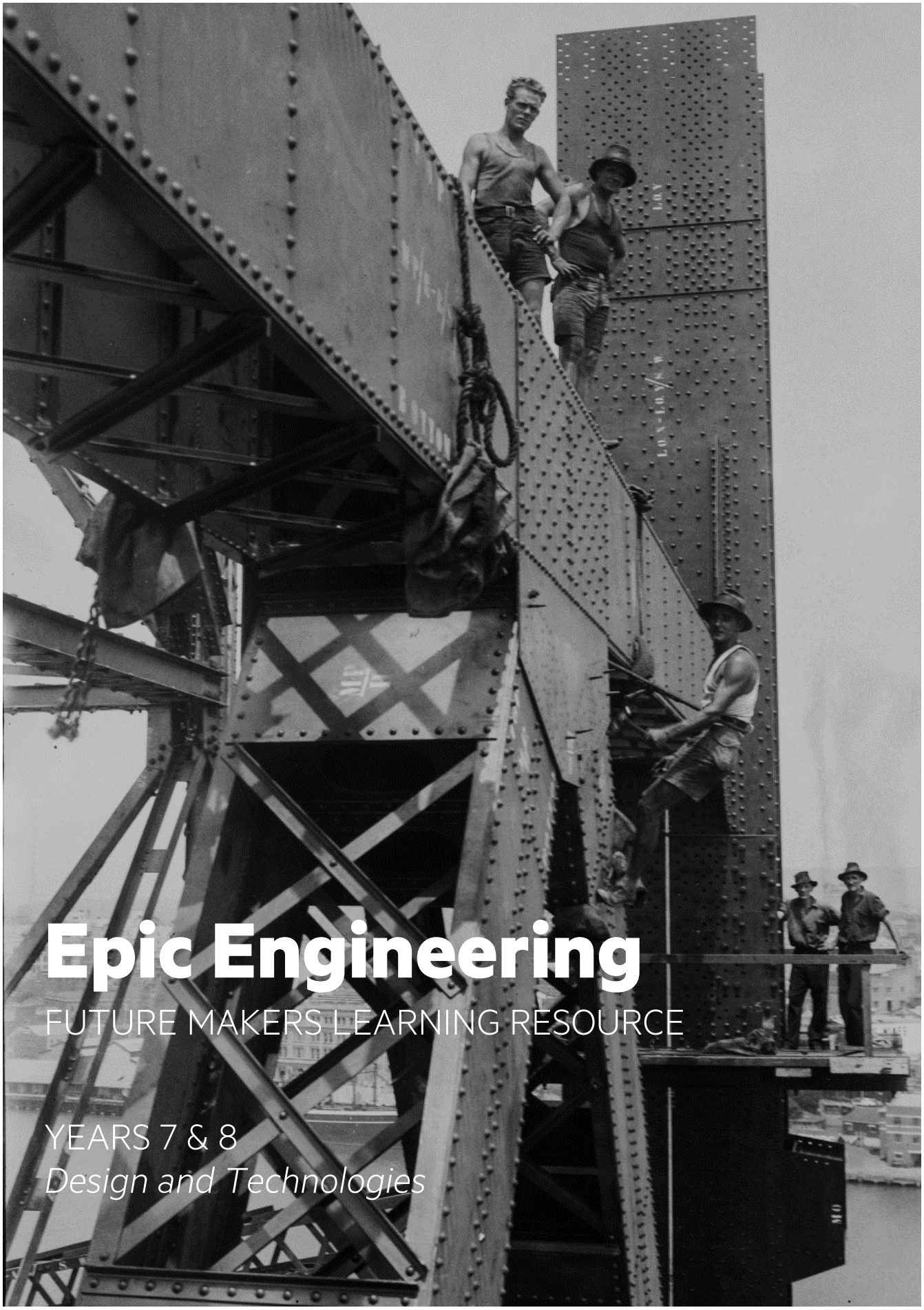


Epic Engineering

FUTURE MAKERS LEARNING RESOURCE

YEARS 7 & 8

Design and Technologies

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM | Queensland Government

Queensland Museum Learning Resources

This Queensland Museum Learning Resource includes practical, high-quality, and engaging activities for teachers to use in the classroom, connected to World Science Festival Brisbane's groundbreaking multi-media show, *Epic Engineering*. It includes clear curriculum links to Design & Technologies: Engineering principles and systems, and is based on the 5E instructional model.

As the state's foremost collecting institution, Queensland Museum celebrates the stories of Queensland from prehistoric giants to modern achievements and scientific discovery spanning millennia. The collection continues to grow through new acquisitions of objects and specimens that are relevant to Queensland. These elements of Queensland 's heritage form the basis for research projects, exhibitions, education programs and events. We use them to better understand key global issues – from climate change to nature conservation, and from cultural understanding to community histories.

World Science Festival Queensland

Each year World Science Festival Queensland paints the town red and takes science out of the laboratory and into the streets, parks, museums, galleries and performing arts venues of Brisbane and regional Queensland. Queensland Museum holds exclusive licence to host the festival in the Asia Pacific – the only global extension of this initiative, attracting over 1.5 million attendances since launching in 2016.

World Science Festival Brisbane reinforces Queensland Museum's position as a leader in Science, Technology, Engineering and Mathematics (STEM) education and engagement. The festival provides Queensland Museum an opportunity to engage audiences outside the traditional education sphere and promote a whole of life "entanglement" with STEM – delivering on our mission of creating authentic and compelling experiences and stories that inspire, enrich and empower. The festival is delivered to regional Queensland throughout the calendar year under the banner of World Science Festival Queensland.

Future Makers

This resource was developed by Future Makers, an innovative partnership between Queensland Museum and Shell's QGC business, who joined forces to increase awareness and understanding of the value of STEM in Queensland schools and communities.

This partnership aims to engage and inspire people with the wonder of science and increase the participation and performance of students in STEM-related subjects and careers – creating a highly capable workforce for the future.

As part of this mission, each year Future Makers brings World Science Festival Queensland to Gladstone and Chinchilla, providing more opportunities to inspire regional students to embrace STEM.

QUEENSLAND MUSEUM Queensland Government

 Cover Image: Story Bridge during construction c.1937. Courtesy Queensland Museum Collection

Contents

Unit Overview

Epic Engineering uncovers the technological challenges, creative problem-solving and collaborative efforts that drive extraordinary projects, revealing the bold ideas and teamwork behind achieving the seemingly impossible.

This unit engages students in an exploration of Epic Engineering through examining Queensland's engineering marvels and the impacts they have on our lives. Students explore the forces that act on structures and how simple machines make life easier. This forms the basis of understanding prior to engaging with the World Science Festival show *Epic Engineering* which presents the future of groundbreaking innovation, featuring inspiring projects that made the impossible possible! After viewing the show, students design and create their own Epic Engineering project, with the chance to build and test their own structures.

From space exploration to deep oceans, the subatomic to monumental mega-structures, delve into the engineering feats that are shaping tomorrow's world.

Australian Curriculum Alignment

Years 7 and 8 – Design and Technologies

Strand	Sub-strand	Content descriptor	AC code	Lesson/s
Knowledge and understanding	Technologies and Society	Analyse how people in design and technologies occupations consider ethical and sustainability factors to design and produce products, services and environments	AC9TDE8K01	1, 2, 3, 5, 6, 7
		Analyse the impact of innovation and the development of technologies on designed solutions for global preferred futures	AC9TDE8K02	1, 2, 3, 5, 6
	Technologies Context: Engineering principles and systems	Analyse how force, motion and energy are used to manipulate and control engineered systems	AC9TDE8K03	4, 5, 6
	Technologies Context: Materials and technologies specialisations	Analyse how characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions	AC9TDE8K06	6, 8, 9
Processes and production skills	Investigating and defining	Analyse needs or opportunities for designing, and investigate and select materials, components, tools, equipment and processes to create designed solutions	AC9TDE8P01	8
	Generating and designing	Generate, test, iterate and communicate design ideas, processes and solutions using technical terms and graphical representation techniques, including using digital tools	AC9TDE8P02	8, 9
	Producing and implementing	Select, justify and use suitable materials, components, tools, equipment, skills and processes to safely make designed solutions	AC9TDE8P03	8, 9
	Evaluating	Develop design criteria collaboratively including sustainability to evaluate design ideas, processes and solutions	AC9TDE8P04	8, 9
	Collaborating and managing	Develop project plans to individually and collaboratively manage time, cost and production of designed solutions	AC9TDE8P05	8

General Capabilities: Critical and Creative Thinking, Ethical Understanding, Literacy

Cross-curriculum Priorities: Sustainability

ENGAGE

Lesson 1: Engineering Your World

Have you ever wondered why buildings don't fall in the wind? Or how bridges can hold the weight of huge, fast-moving trains? Epic engineering is all around us! Engineering makes our lives easier and safer, and helps us to gain a deeper understanding of the world we live in.

This activity gives students the opportunity to explore their local surroundings to discover that engineering impacts almost every aspect of their lives.

Able Point Marina © Queensland Museum, Gary Cranitch

Lesson Steps

1. As a class, brainstorm the question: **What is engineering?** (Students may respond with: Design, innovation, solving problems, improving efficiency, making life easier, solving mathematical or scientific questions, architecture or infrastructure systems)

   Explain to students that engineering is defined as the, "Application of science to the optimum (best) conversion (change) of natural resources to the uses of humankind" (Britannica). Discuss with students that engineered design is all around us, in our buildings, computer systems, transport and even our food production.

2. In small groups, students walk around their school grounds and develop a list of all the feats of engineering that they see.

3. This task could be extended as a homework task where students explore their wider community area to discover more variety of engineering feats.

Lesson 2: The Impact of Engineering: Community of Inquiry

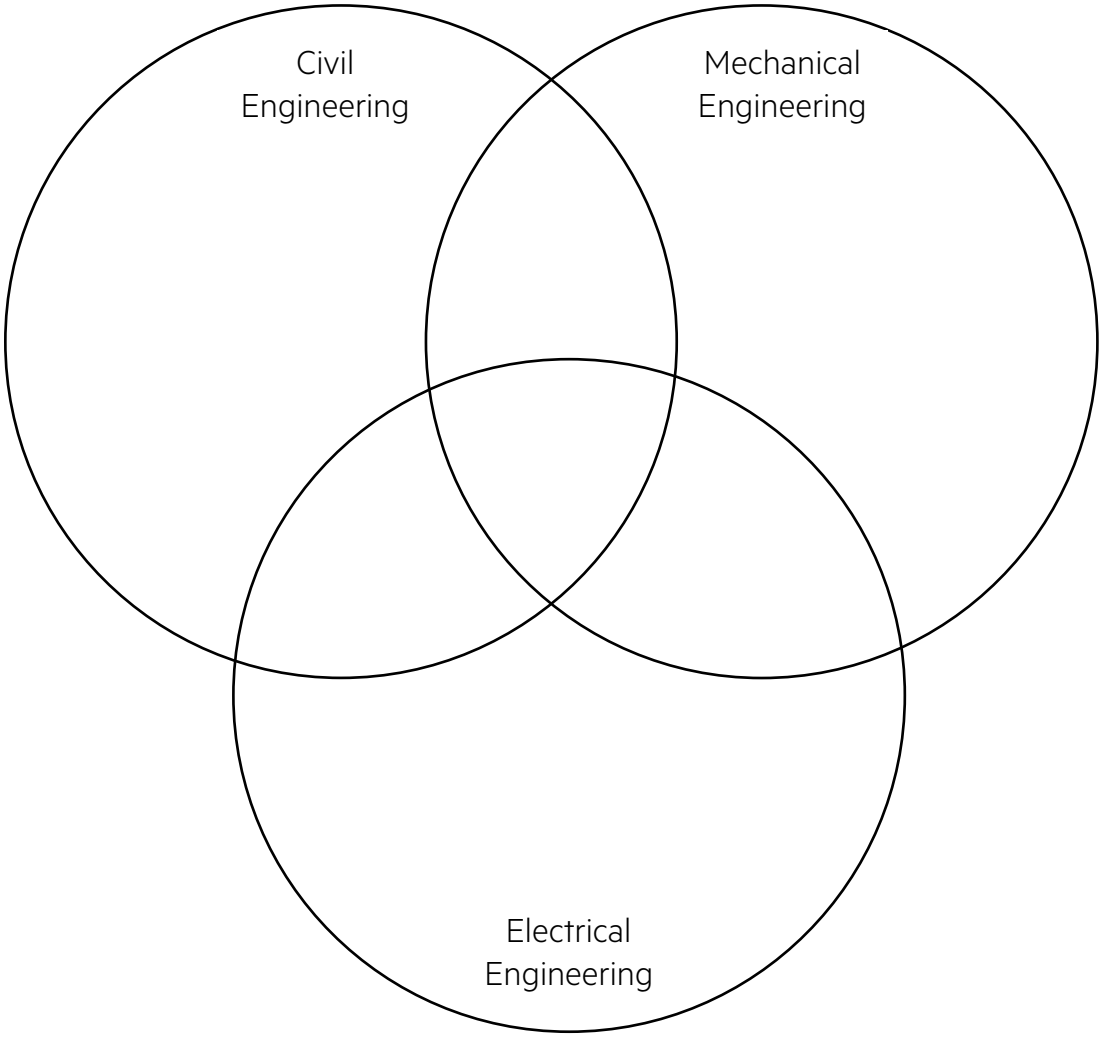
In this activity, students participate in a community of inquiry to consider the impact of engineering in our lives. The community of inquiry is a structured, dialogic process that requires participants to ask open inquiry questions, listen and think, share ideas and consider alternative viewpoints. Problematic issues and concepts are discussed collaboratively within a supportive learning environment where all views are considered and respected. Reflecting on thinking is integral to the process.

The following engagement protocols are used during the community of inquiry process, and these should be displayed for all students to see:

- Listen attentively
- Build on and connect ideas
- Respect self, others and place
- Disagree reasonably and respectfully
- There may be many responses considered to be correct

Detailed step-by-step instructions for this activity can be seen below. It is recommended that you use these instructions to guide your students through the activity as a class.

1. On return from Lesson 1, as a class group, sort the listed engineering feats into the main three types of engineering: **Civil, Mechanical, Electrical**, you may like to include an '**Other'** category as there are many other types of engineering! Use the Venn diagram below to identify any overlap of engineering types.



2. Ask students to discuss the following questions in small groups:
   What impact does engineering have on our daily lives?

   Encourage students to think about how it makes life easier, safer, or more convenient.

3. Ask students to report their group discussion back to the class.

4. Pose the next questions:
   What problems can be solved by engineering?
   Are any problems created because of feats of engineering?

   Encourage students to think critically about the ways that engineering is used in society.

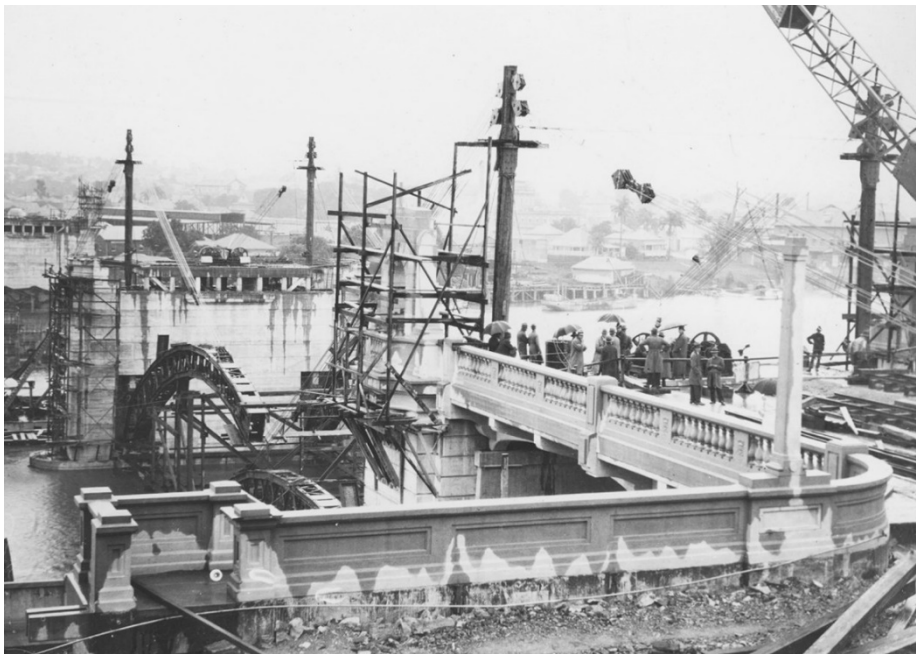
5. Ask students to share their responses to this question in a class discussion which can be recorded on the board or digitally for future reference.

Lesson 3: Epic Engineering in Queensland

Queensland has a long history of epic engineers. Engineering goes back to pre-European history when Aboriginal communities in Queensland used their engineering skills to design and build weirs and fish traps along Queensland's rivers and coastal regions, and manipulated natural materials into new and innovate designs to make their lives better. With the arrival of Europeans, structural engineering feats took a form which continues to be built on by today's epic engineers.

In this activity, students explore some of the most transformative projects that have shaped the way Queenslanders live their lives.

Stone wall fish traps stretch across tidal flats, Gulf of Carpentaria. Image: ABC, Sean Ulm



Construction of the Grey St/ William Jolly Bridge, Brisbane c1930. Courtesy Queensland Museum Network Collection

Lesson Steps

1. Discuss with students Queensland's long history of epic engineering, and that they will now have the opportunity to do a deep dive into one or more of these amazing feats.
2. Students peruse the *Epic Engineering in Queensland* resource and choose one structure they would like to research further and report back about.
3. Students use the supplied links and resources as well as their own thoughts and investigations to complete the attached worksheet.

Resource: Epic Engineering in Queensland

Story Bridge

- Queensland Museum Blog: https://blog.qm.qld.gov.au/2020/07/06/80-years-strong-a-story-bridge-anniversary/
- Engineering Heritage Australia: https://www.engineersaustralia.org.au/sites/default/files/resource-files/2021-11/QLD-Story-Bridge-Flyer.pdf
- Queensland Government Heritage Register: https://apps.des.qld.gov.au/heritage-register/detail/?id=600240
- Queensland State Archives: https://www.youtube.com/watch?v=iFTZ-1NLTBE

Image: Wikipedia

The Clem7 tunnel

- Queensland Museum Talks Science: https://qmtalksscience.wordpress.com/2012/07/26/brisbane-and-its-tunnels-science-in-action/
- Australian Tunnelling Society: https://www.ats.org.au/portfolio-items/north-south-bypass-tunnel-clem7/
- The Clem7: https://www.youtube.com/watch?v=uyJUAnpAJII

Image: ABC News

Kuranda Range Railway

- State Library Queensland Blog: https://www.slq.qld.gov.au/blog/building-kuranda-railway-history-pictures
- Queensland Government Heritage Register: https://apps.des.qld.gov.au/heritage-register/detail/?id=600755

Image: QM

Somerset Dam

- Engineering Heritage Australia: https://heritage.engineersaustralia.org.au/wiki/Place:Somerset_Dam
- Engineers Australia: https://www.engineersaustralia.org.au/sites/default/files/resource-files/2017-01/Somerset%20Dam.Panel_.Jun%202013.pdf
- SEQ Water: https://youtu.be/wdgV-lTkCNo

Image: SEQ Water

Coopers Gap Wind Farm

- Tilt Renewables https://www.tiltrenewables.com/assets-and-projects/Coopers-Gap-Wind-Farm/#project-details

Image: Tilt Renewables

Kareeya and Koombooloomba Hydroelectricity power station

- CleanCo Qld https://cleancoqueensland.com.au/portfolio/owned-and-operated/kareeyaandkoombooloombahydropowerstations/

Image: CleanCo Qld

Walter Taylor Bridge

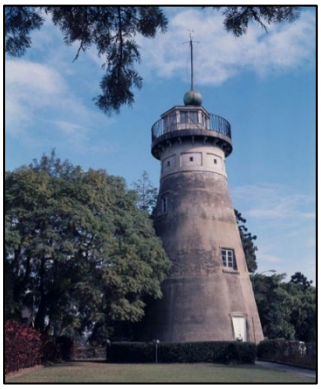
- Queensland Government Heritage Register: https://apps.des.qld.gov.au/heritage-register/detail/?id=600181

Image: Over the Walter Taylor Bridge

Windmill Tower

- Queensland Museum Blog: https://blog.qm.qld.gov.au/2021/05/18/tower-mill-an-archaeological-investigation-of-queenslands-oldest-surviving-building/
- State Library of Queensland: https://www.slq.qld.gov.au/mappingfuturebrisbane/old-windmill-tower
- Queensland Government Heritage Register: https://apps.des.qld.gov.au/heritage-register/detail/?id=600173

Image: QM



Stone Walled Fish Traps

- Moreton Bay Regional Council: https://www.youtube.com/watch?v=UO6zONqUpUs
- Queensland Museum Exhibit (See CABAH Podcast): https://www.museum.qld.gov.au/kurilpa/whats-on/ngurruwarra-derndernyin#about
- Australian Research Council: https://www.arc.gov.au/news-publications/media/making-difference-publication/studying-aboriginal-stone-walled-fish-traps-gulf-carpentaria

Image: Australian Research Council

Resource: Epic Engineering in Queensland

What is the structure and where is it located?

Who built it and when?

What community problem does this structure address?

Which innovative technology was used?

Why is it important to Queensland?

EXPLORE

Lesson 4: Five Fundamental Forces

Why are some buildings made of wood while others are glass and steel? How does a machine stay together and not fly apart while it is being used? When civil and mechanical engineers are designing, they need to consider the external forces and internal stressors that will be applied to the materials they chose. These forces determine the load that is placed on a structure or machine and whether it will be able to do what it was designed for.

In this activity, students are introduced to the five fundamental forces that act on structures which forms the groundwork for future understanding of design decisions.

Construction of the Alexandra Bridge, Rockhampton, Henry Goode. Courtesy Queensland Museum Network Collection

Lesson Steps

1. Introduce students to the five fundamental forces that act on structures – tension, compression, shear, bending and torsion – by watching the video *Fairly Fundamental Facts About Forces And Structures* from TeachEngineering https://www.youtube.com/watch?v=O5DtcJNhOqg and answering the question below in a table in their notebooks:

   What are the five fundamental loads that act on structures? Give an example from the video to illustrate each.

Fundamental Force	Example
1	
2	
3	
4	
5	

2. Use marshmallows and rope candy to demonstrate the effects of the five forces on objects. Students twist, bend, stretch and compress the lollies until they break. Students consider: How much force do you need to use for the material to break? Where does force need to be applied to reach breaking point? Students record their results in the resource provided, *Can you Break it?*

3. Students investigate an engineering wonder from around the world using *TedEd* videos and learn how international teams of engineers overcome environmental and structural challenges using innovation. Use the resource *Epic Engineering Around the World* to take notes on these engineering marvels.
    - Golden Gate Bridge https://www.youtube.com/watch?v=EPd2w5d_qAk
    - Panama Canal https://www.youtube.com/watch?v=uE_UuHRtXCY
    - Channel Tunnel https://www.youtube.com/watch?v=qNS2jj2w-GI
    - Burj Khalifa https://www.youtube.com/watch?v=el1K-xILtwo

Images: Golden Gate Bridge: Darnell Technical Services, Panama Canal: CNN, Channel Tunnel: EuroTunnel, Burj Khalifa:Wikipedia (CC Donaldytong)

3. Students can extend their learning by reporting back to the class about one of the explored engineering marvels. This could be a presentation, poster, PowerPoint, digital design, display or discussion.

Resource: Can you Break it?

What material are you investigating?

Which force are you applying?

Using the scale 0-10, how much force did you apply before it broke/collapsed? (Point of failure)

0	1	2	3	4	5	6	7	8	9	10

How did the material change with the application of force? Consider before, during and after.

Resource: Epic Engineering Around the World

Where is the structure and when was it built?

What community issue is it addressing?

Why is it an Epic Engineering project?

Examine the structure and its environment. Sketch the structure or a section of it in the environment and annotate your sketch by identifying the external and internal forces that would impact it.

For each force, investigate and explain how engineers overcame problems using innovative materials or practices.

Lesson 5: Simple Machines

Complexity builds on simplicity. Engineers are continually adjusting the designs of others to improve them and make things bigger (or smaller!) and better. The groundwork for engineering began millennia ago with the invention of simple machines – the lever, plane, wheel, pulley, screw and wedge. These simple machines make life easier, and they can be combined to produce the complexity of modern engineering marvels.

In this activity, students are introduced to simple machines through the Queensland Museum's collection and participate in hands-on mini experiments to investigate how simple machines work and how they impact our lives today.

A fishing reel made by a worker at the Ipswich Railway Workshops. It is a reproduction of an Alvey fishing reel, which was originally designed by Charles Alvey during his time employed as a coachbuilder at the Ipswich Railway Workshops. Image: Queensland Museum, Jeff Wright.

Lesson Steps

1. Introduce students to simple machines using the resource, *Six Simple Machines*. Students analyse each of the objects and answer the questions.
2. In small groups, students undertake *Round Robin: Simple Machines* consisting of six activities to explore simple machines and how they work. Students spend five to ten minutes at each activity station to explore and discuss how simple machines make our lives easier.
3. Students can then choose one simple machine to focus on and develop an experiement using the resource *Simple Machines Experiment Worksheet*.

Materials needed:

- Pencils
- Rulers
- Paper
- Card
- Weights (e.g Full water bottle)
- Empty paper towel rolls
- Tape
- Marbles (Or small balls)
- Rope
- Tubing
- Cups
- Dowl (Or blunt skewers/straws)

4. If you are interested in exploring these concepts further, visit SparkLab (Above) at Queensland Museum Kurilpa. SparkLab has hands-on, interactive exhibits that explore pulleys, levers, inclined planes and self-supporting arches, and many more. See page 47 for more information.

Resource: Six Simple Machines

Examine the items from the Queensland Museum's collection to learn about simple machines.

Simple Machine: The Screw

Screw excavated from Burke and Wills plant camp in May 2009 © Queensland Museum, Jeff Wright

What is this?

How might it have been used?

How would it make life easier?

Simple Machine: Wheel and Axle

Single cylinder motorcycle parts made by Sussex-born David Spencer (1870-1958) at his garage in Haig Road, Torwood in about 1905-1911. © Queensland Museum, Peter Waddington

What is this?

How might it have been used?

How would it make life easier?

Simple Machine: Wedge

Axe-complete, steel blade
© Queensland Museum, Peter Waddington

What is this?

How might it have been used?

How would it make life easier?

Simple Machine: Pulley

Three spoke pulley wheel found on the wreck of H.M.S. Pandora.
© Queensland Museum, Gary Cranitch

What is this?

How might it have been used?

How would it make life easier?

Simple Machine: Lever

Scales for weighing gold
© Queensland Museum, Jeff Wright

What is this?

How might it have been used?

How would it make life easier?

Simple Machine: Inclined Plane

Old stock loading ramp with Mount Barney in the background
© Queensland Museum, Gary Cranitch

What is this?

How might it have been used?

How would it make life easier?

Resource: Round Robin: Simple Machines

Activity 1: The lever

How can we move something heavy from one point to another? Experiment with levers to find out!

Materials:

- Pencil
- Ruler
- Card
- Weight

Place the ruler over the pencil with the weight on one end. Try to lift something (A pencil case or water bottle) using only one finger. Experiment with moving the position of the pencil (fulcrum) to change the load. Can you use the lever to move the position of the object from one point to another? What did you find out? Discuss with your group some examples of levers in your life and how they make life easier.

Activity 2: The inclined plane

Can you create a marble game using only cardboard and tape? Add the inclined plane to find out how!

Materials:

- Backing board
- Paper towel rolls (Or rolled card)
- Tape
- Marbles

Use paper towel rolls (or tape paper or card into tubes) and tape to create a basic marble run. Tape the rolls onto the backing board and experiment with the angles of the inclined planes to make the marble run faster or slower. Have a race with another team! What did you find out? Discuss with your group some examples of inclines in your life and how they make life easier.

Activity 3: The wedge

What's the easiest way to put a hole in paper? Experiment with a simple wedge to find out!

Materials:

- Paper
- Medium weight card
- Heavy card
- Sharpened pencil
- Tape

Tape a piece of paper tightly across the gap between two desks or chairs. Experiment with putting holes in the paper using the blunt end and the sharp end of the pencil. Which is easiest? Increase the weight of the paper and repeat the experiment. What did you find out? Discuss with your group some examples of wedges in your life and how they make life easier.

Activity 4: The pulley

How do we change the direction of a force? Experiment with a simple pulley to find out!

Materials:

- Rope or cord
- Container
- Weight

Create a basic pulley by using rope and a container over a railing at your school. Attach one end of the rope to your container and place the other end over the railing. Experiment with lifting different loads by changing the weight of the object being lifted and the number of people pulling on the rope. What did you find out? Discuss with your group some examples of pulleys in your life and how they make life easier.

Activity 5: The screw

Can you make water move uphill? Experiment with the Archimedes screw, to find out!

Materials:

- Pencil or dowl stick
- Tubing (or silicone straw)
- Tape
- Cup of water
- Empty cup

Wrap a length of tubing around the pencil or dowl and tape in place at both ends. Place one end of the tubing in a glass of water and turn the pencil while keeping it on a slight slant. Place the empty container under the end of the pencil to catch the water as it moves up the Archimedes Screw. What did you find out? Discuss with your group some examples of simple screw machines in your life and how they make life easier.

Activity 6: The wheel and axle

How can we move things across distances easily? Experiment with simple wheels and axles to find out!

- Heavy card
- Dowl
- Tape or BluTack
- Weight

Cut out circles of card and pierce a hole in the middle of each to put the dowl through, fix with the BluTack. Build a basic flatbed car using two wheels and axles and try to transport different weights across a one-meter distance. Experiment with changing the size of the wheels and the weights on the flat bed. What did you find out? Discuss with your group some examples of wheel and axles in your life and how they make life easier.

Resource: Simple Machines Experiment Worksheet

In this resource, you will design, test and record an experiment based around a simple machine.

- Choose one simple machine to investigate.
- Design an experiment to demonstrate how this simple machine can be used to make life easier.

Experiment Title

Aim

To investigate...

Hypothesis

Using your chosen variable, predict how change will affect outcomes.

Variables

Include an independent variable, a dependent variable, and at least one control variable.

Independent variable (Variable that is purposely changed)	**Dependent variable** (Variable that is measured)	**Control variables** (Variables that are kept the same for a fair experiment)

Results

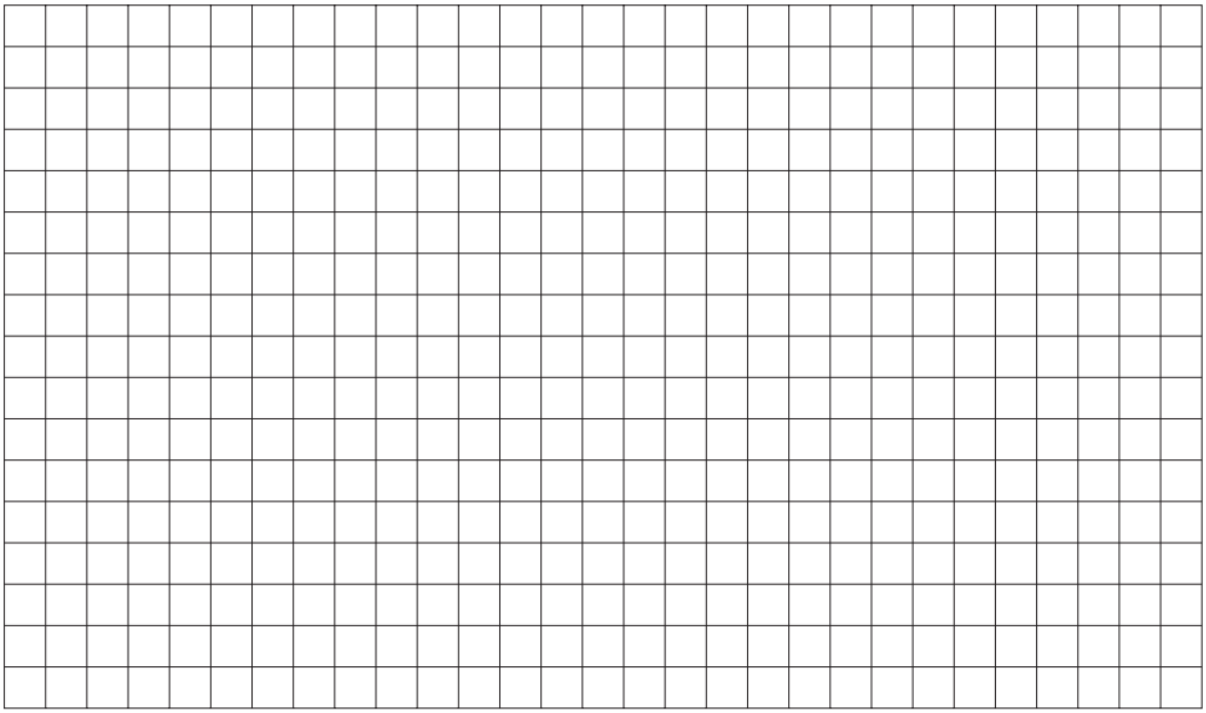
Observations – Draw a scientific diagram of your results in the space below.

Remember to label your scientific diagrams.

Results Table – Record your results.

Variable Name	Measurement 1	Measurement 2	Measurement 3

Graph – Graph your results.



Summary – Summarise your results.

Discussion – Analysis of results.

Explain what happened and why.

Do the results support the hypothesis? Why / why not?

Did you encounter any problems? How could the experiment be improved in the future?

Conclusion – Summarise the experiment and results.

EXPLAIN

Lesson 6: World Science Festival *Epic Engineering* Show

Epic Engineering presents groundbreaking innovation in a multi-media show featuring inspiring projects that made the impossible possible! From space exploration to deep oceans, the subatomic to monumental mega-structures, delve into the engineering feats that are shaping tomorrow's world.

Epic Engineering uncovers the technological challenges, creative problem-solving and collaborative efforts that drive these extraordinary projects, revealing the bold ideas and teamwork behind achieving the seemingly impossible.

Hosted by Angharad "Rad" Yeo (ABC's Good Game Spawn Point) as part of World Science Festival Brisbane, students will uncover the engineering marvels that have amazed the world and demonstrated the incredible possibilities of engineering.

Snowy Hydro 2.0 Image: WSFB.

Students will explore the following engineering feats during the *Epic Engineering* show.

The Great Pyramid of Giza
Begin the journey with one of the oldest and most iconic engineering marvels. Students will learn how ancient Egyptians built this massive structure over 4500 years ago, laying the foundation for civil engineering through meticulous planning, teamwork and ingenuity.

The Deepsea Challenger Submersible
Fast-forward to the modern era of exploration, as we dive into the ocean's deepest point. This segment will highlight how technology has evolved to overcome the extreme pressures of the deep sea and how human curiosity continues to push boundaries.

The International Space Station
Travel from the depths of the ocean to space. The ISS represents the pinnacle of modern space engineering and international collaboration, where astronauts conduct scientific research in microgravity, far above Earth. Engineering helps us reach beyond our planet.

Snowy 2.0
Looking to the future of renewable energy with Snowy 2.0, an impressive hydroelectric project. This part of the show will demonstrate how today's engineers are addressing global challenges like energy sustainability, utilizing innovative underground tunnelling systems.

Resource: *Epic Engineering* Show

During (or after) the World Science Festival *Epic Engineering* show, complete the table with information about the Epic Engineering projects.

Project Name:	**Project Name:**
Challenges to overcome:	Challenges to overcome:
Innovative solutions used:	Innovative solutions used:
Project Name:	**Project Name:**
Challenges to overcome:	Challenges to overcome:
Innovative solutions used:	Innovative solutions used:
My favourite engineering feat is…	
It is epic because…	

ELABORATE

Lesson 7: Epic Engineering Careers

Engineering is a career that combines creativity, innovation, science, design, and technology. There are many branches of engineering and engineers are involved across all industries that use machines, structures or systems. In this lesson, students hear from Queensland engineers about their career paths and the role they play in their industries.

Lesson steps

1. Watch one or more of the following STEM careers videos. They are part of the World Science Festival's *Cool Jobs* series found at: https://www.worldsciencefestival.com.au/cool-jobs.
2. Students answer the stimulus questions in the student resource *Cool Jobs* as they watch.
3. As a class, discuss which engineering jobs would be most exciting, challenging and interesting to your students and why.

Celeste de Mezieres - Biomedical electronic engineer

https://www.youtube.com/watch?v=F657g2oDgRo

Thomas Ireland and Kristin Stewart - Rocket engineering

https://www.youtube.com/watch?v=MGpaHm3fo1M

Estafania Arteaga - Environmental engineering and sustainability

https://www.youtube.com/watch?v=Y6zr82j-Bvg

Resource: Cool Jobs

Biomedical electronic engineering

What are some of the tasks that Celeste undertakes in her role as an electronic biomedical engineer?
Why is biomedical engineering so important in flight?
What are five things you have learnt about this Cool Job?

Rocket engineering

How is software engineering used in rocketry?
What does a day in the life of a rocket engineer look like?
What are five things you have learnt about this Cool Job?

Environmental engineering and sustainability

How can an environmental engineer impact on climate change?
How does Estafania's job help communities?
What are five things you have learnt about this Cool Job?

Lesson 8: Epic Engineering Design Challenge

Epic engineering is all about extremes – can you go higher, deeper, wider or faster than those before you? Humans love to push the boundaries of possibility, and much of what we use in daily life today would have seemed like science fiction to engineers of the past. In this design challenge, students are epic engineers, designing a structure that addresses a local, national or global issue. Students are encouraged to think epically using the design-thinking framework – what is the biggest, strongest and most resilient design that they can come up with? How will it help humanity? And can they test it against the extreme elements of earth and beyond?

Students will work in groups of 3-5 to investigate, design, create, test and refine a structure that makes a lasting positive change to a local, national or global issue. Students can investigate any issue that can be improved with engineering. Some examples could include:

- Investigate the health and survival of our oceans and it's ecosystems by designing a deep-water research station.
- Improve the ability of farmers in remote areas to access irrigation water by designing a series of gravity fed pipelines across the state.
- Provide scientists with real-time data on the state of climate change through the design of a series of worldwide connected lower atmosphere monitoring systems.
- Improve the outcomes for bushfire survival in Queensland through the design of a fireproof farmhouse.
- Improve the outcomes for people living on remote islands in the Pacific Ocean who will be impacted by sea level rise by designing a flood mitigation system.

Their design will need to meet the specific challenges of their chosen issue, consider a contribution to science or design, meet the needs of humanity and the environment, and be EPIC! This activity links to the following Evaluate section, where students subject their designs to testing and evaluation.

Lesson steps:

1. Group students into groups of three to five.
2. Students use the below design thinking framework elements Investigate, Design, Create to complete the first part of the design challenge: (See student resource *Epic Engineering Design Challenge*).
3. INVESTIGATE:
    a. Choose a local, national or global issue and write a clear problem statement.
    b. Brainstorm solutions as a group using a How/Wow/Now matrix
4. DESIGN: Create an initial sketch or digital design of the prototype and justify design choices.
5. CREATE: Consider materials and create a physical scaled model of the prototype structure, including a foundation to consider the environment it will be built in. This model will be subjected to testing in the following lesson.

Resource: Epic Engineering Design Challenge

LNG (liquified natural gas) plant on Curtis Island. Image courtesy of Shell's QGC business

Humanity is pushing the boundaries of our world – we are exploring areas of earth and space that have previously been beyond our reach while learning more about the impact we have on the earth. You and your team of engineers have been tasked with an epic engineering design challenge that will test the limits of your creativity and scientific innovation.

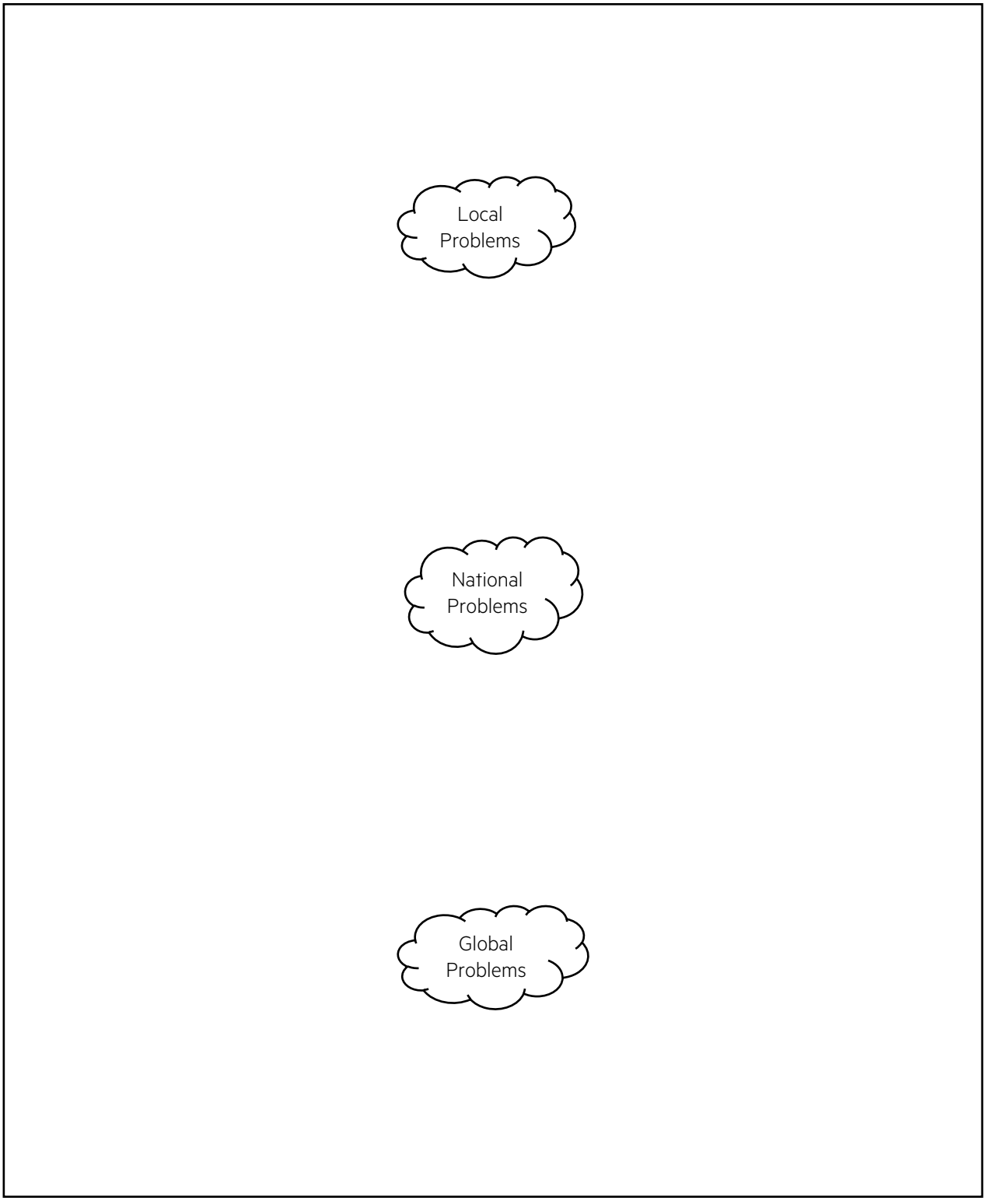
YOUR CHALLENGE is to use the design process below to design an epic structure that makes a lasting positive change to a local, national or global issue. You can investigate **any** issue that can be improved by epic engineering.

INVESTIGATE

Step 1: Identify the Problem

As a group, create a mind-map of potential issues for your local community, your country or beyond.

Note: To complete this task, you may wish to discuss ideas within your group, speak to your family or local community members, or research problems through the internet.



As a group, choose a problem you will tackle and write a problem statement.

A problem statement is a short, clear explanation of an issue or challenge that sums up what you want to change. It helps you, team members, and other stakeholders to focus on the problem, why it's important, and who it impacts.

Your problem statement must be in complete sentences and answer three questions:

- What is the problem or need?
- Who has the problem or need?
- Why is it important to solve?

Clearly outline your problem statement in the space below:

Now that you have defined the problem you wish to solve, it is time to begin brainstorming some solutions!

Step 2: Brainstorm Solutions:

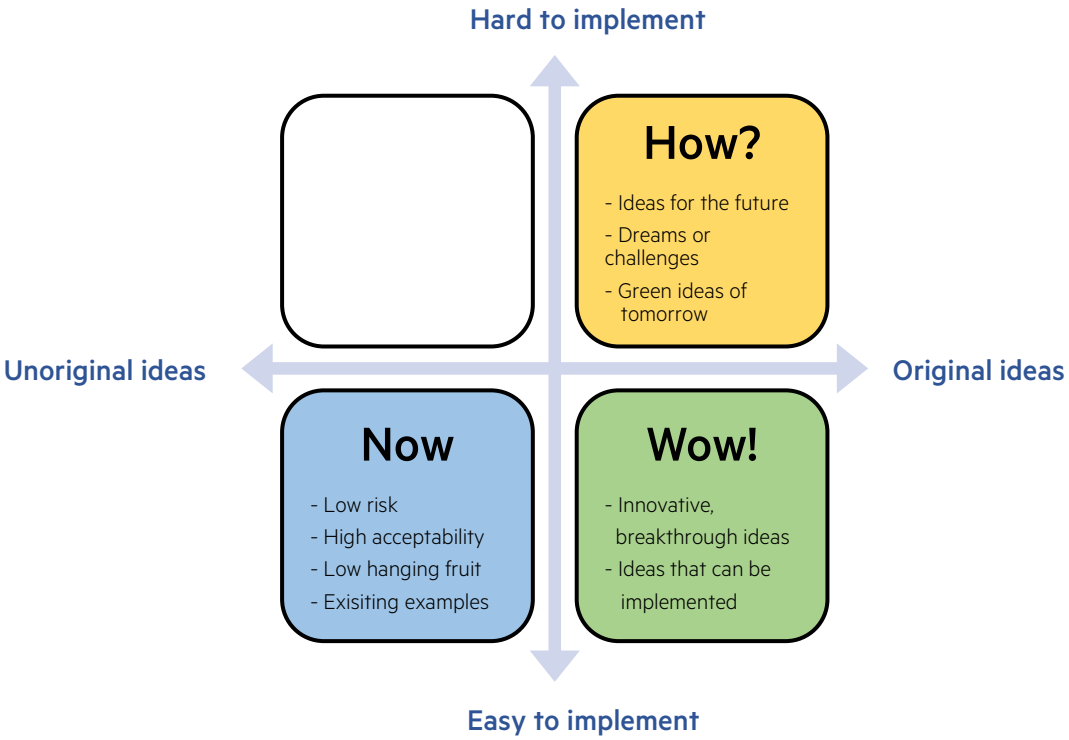
Epic engineering is all about extremes – can you go higher, deeper, wider, or faster than those before you? Humans love to push the boundaries of possibility, and much of what we use in daily life today would have seemed like science fiction to engineers of the past. You must now begin to think like epic engineers, designing a structure that addresses a local, national or global issue. Your group needs to think epically – what is the biggest, strongest, and most resilient design that you can come up with?

Individually, brainstorm three solutions to your chosen problem. Your brainstorming may include lists of materials, basic sketches and explanations on how it would work. Remember, this is an EPIC project – you need to think about how your design can be awe inspiring, mega, or require clever engineering while remaining sustainable in both materials and design.

Epic Engineering Solution 1
Epic Engineering Solution 2
Epic Engineering Solution 3

Once each member of your group has individually brainstormed three ideas for epic engineering solutions, it is now time to decide which idea you will work on for your final EPIC Engineering prototype.

Use a HOW, NOW, WOW Matrix as a framework to rate ideas as unoriginal or innovative, and easy or difficult to implement.



1. Create a 2-by-2 matrix, as above. You can do this in a digital or physical space. If you are using a physical space, you might like to use a whiteboard, large piece of paper or wall with sticky notes. To use a digital HOW, NOW, WOW Matrix on a Miro board, visit: https://miro.com/templates/how-now-wow-matrix/
2. Write each idea on a sticky note.
3. Place each idea in the How/Now/Wow spaces:
    a. Top right: Yellow Ideas – **HOW?** These are futuristic concepts and visions that would be gamechangers if they could work. But how to manage that isn't known yet. These could be revisited in the future.
    b. Bottom left: Blue ideas – **NOW**: Ideas that are easy to execute or have already been done. Not exciting, but effective in the real world.
    c. Bottom right: Green ideas – **WOW!** Big, innovative concepts, real breakthroughs and possible to realise!
    d. In the top left blank space place any ideas you think will be impossible to implement.

Note: Your teacher will be looking for those **WOW** ideas!

Once you have chosen your idea, record it here and have your teacher check it.

DESIGN

Step 3: Design a prototype

Create an initial sketch of your prototype structure or use a digital design program to develop your design.

When designing, consider the following:

- Label materials, components and any key technologies in a key or on the side of your design.
- Include measurements, technical terms, and annotations where necessary.
- Ensure you include a foundation or environmental context to illustrate the environment it will be built in.
- Include any major forces your design needs to account for ie pressure, weight, wind etc.
- Ensure you address sustainability in your design – of materials or in the design itself.
- Complete the table to justify your design elements.

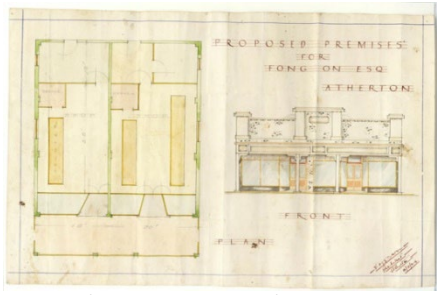
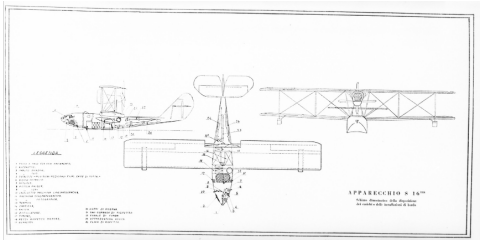
Creating a virtual design

If you wish to create a virtual design, here are some online tools you may wish to use:

Technology	Website
Augmented Reality and Virtual Reality	Cospaces: https://edu.cospaces.io/ Spatial: Spatial.io
Sandbox game	Minecraft Education: https://education.minecraft.net/en-us/quick-start
3D Printing	Tinkercad - https://www.tinkercad.com/

Sketching your design

These are two examples of how to sketch your design:

Arial Views:  *Drawing of a proposed residence for Mr. Fong On, Atherton © Courtesy Queensland Museum Collection*	If you are designing a space or a building, it may be a necessary to include an aerial view with labels of the various rooms, spaces, and objects. This is an architectural building plan in Queensland Museum's collection for the proposed retail and grocery shop to be built by George Fong On in Main Street, Atherton. It includes an aerial view and front view. Fong On was a notable Chinese powerbroker who lived in the township of Atherton in the early 1900's.
Orthogonal Drawing (Top View, Front View, Side View):  *Three-view line drawing of Savoia S.16 flying boat. © Courtesy Queensland Museum Thomas Macleod Qld Aviation Collection*	This is an example of an orthogonal drawing (top, front, and side). The SIAI S.16 was an Italian passenger flying boat, later serving as a military reconnaissance-bomber, claimed to be the most successful flying-boat of the 1920s. Francesco de Pinedo's SIAI S.16 landed on the Brisbane River in Australia in 1925 during his Rome-Australia-Tokyo-Rome flight. We can also see that is has been labelled using a key.

NAME OF STRUCTURE: _____

Design Sketch:	
Design Element (Eg Shape, material, section, simple machine innovation)	Why did you choose this in your design? Which force is it addressing (internal/external)?

CREATE

Step 4: Creating a Prototype Model

As a group you will now create a model to present your EPIC Engineering Solution.

Complete the table to consider the materials you will need to gather to build your design.

Note: Make sure the materials are gathered equally among all team members.

Material	Amount/size	What part of the structure will it be used for?	Who will obtain the material?

Now it's time to get building!

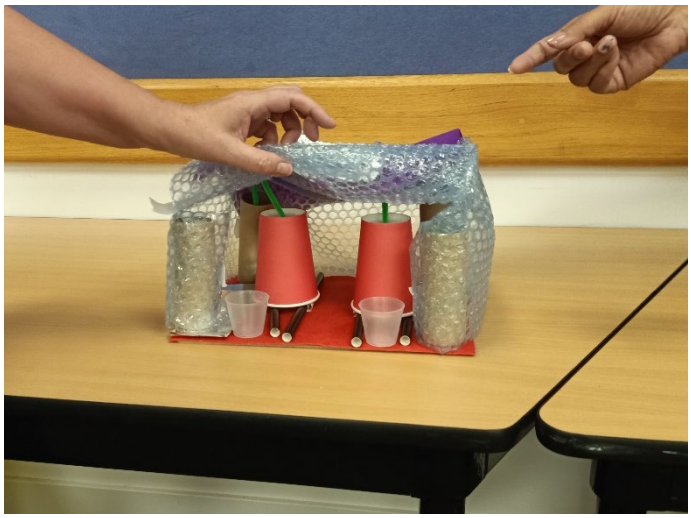
Remember to include a foundation to indicate the kind of environment your structure will be built in.

EVALUATE

Lesson 9: Testing and Evaluation

Testing designs is a vital step in the Design Process which leads to refinement of ideas. Prototypes need to be vigorously subjected to real life conditions to see if they can withstand internal and external stressors and pressures. Engineers test and refine their designs to ensure they are safe and can fulfill the needs of the project.

In this activity, students will develop testing, measurement and success criteria and subject their prototypes to testing, they will then redesign their prototype if necessary and evaluate the success of their design.



Images: Recycled material structures. Future Makers, Queensland Museum.

Lesson Steps:

1. Students develop their testing criteria. They will need to consider environmental factors as well as how the structure is going to be used. They need to determine their variables – independent, dependant and control (E.g. temperature, wind, acidity, pressure, movement), their success criteria (E.g. breakage, freezing, melting) and their how they will take measurements (E.g. temperature, wind pressure, height of a fall).
2. Students make predictions about what will happen, test their prototypes, modify as necessary, and retest.
3. Students evaluate their final design.

Resource: Epic Engineering Design Challenge

TEST

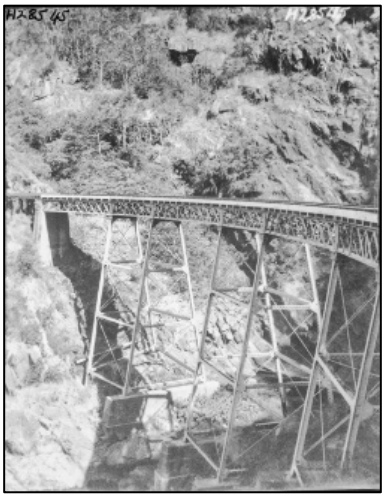
Step 5: Test your design

To test your Epic Engineering structure, you first need to develop a design test.

You will need to consider:

- Testing criteria – What conditions would impact on the structure in real life? How can you simulate these in the classroom? Choose one to investigate.
- Investigation question – This can be related to the survival of the structure or the ability of it to do its job.
- What are your independent (Cause), dependent (Effect) and control (Same) variables? E.g. Temperature, wind, acidic, pressure, movement, materials.
- What is your **Point of Failure?** E.g. At what point… does it leak? Does it fall over? Does it break? Can it survive a fall? Does something inside it melt or freeze?
- To learn more about Failure Points, you can view *Crash Course Kids: Fixing Failure Points* https://www.youtube.com/watch?v=0OtbV8-Mdr4
- How are you going to measure and record your testing?

Example: Bridge on the Kuranda Railway



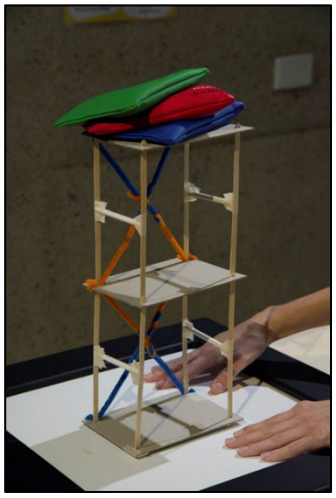
Conditions: Rock falls, mudslides, heavy rain, wind, train weight.

Simulated Conditions: Rolling balls, hair dryer, unstable surface with movement, heavy weights.

Condition to test: Strength of the bridge

Investigation Question: How much weight can our bridge withstand before collapse?

Variables:



Independent –Applying stress to the bridge using a series of increasing weights evenly placed across the top of the bridge.

Dependent – The changes to the bridge structure leading to collapse – bending, twisting or minor breakage.

Control – Bridge structure remains the same with no movement.

Point of Failure: Collapse of the bridge.

Epic Engineering Design Evaluation

Testing criteria

Real-world condition	Simulated condition

Investigation question

Our group will be testing...

Variables

Independent (Change one thing)	Dependent (Measure what happens)	Control (Keep the same)

(Choose one variable to test)

Point of failure

Our design fails when...

Prediction

We predict that...

Record your results

Dependent Variable	Test 1	Test 2	Test 3
	Result	Result	Result

Use this space to visually graph or record your results

REFINE

Step 6: Evaluate test results and retest

At what point did your design fail the testing? What changes could you make to your design? Make these changes and re-test if you have time. Include these results in your evaluation.

Queensland Museum unit extensions

Queensland Museum exhibitions

Queensland Museum welcomes the public to a variety of temporary and permanent exhibitions at their four public sites in Brisbane, Ipswich, Toowoomba, and Townsville. These exhibitions showcase stories connected to Queensland's biodiversity and landscapes, geological past, historical events, products and inventions, and cultural diversity. Most of these exhibitions are free, and for those that are not, teachers can request a teacher preview booking to organise free entry to prepare for your students' learning experience.

Teacher preview booking form: https://www.museum.qld.gov.au/kurilpa/plan-your-visit/visit-as-a-school/teacher-preview-booking-form

The following permanent exhibitions are most suitable to visit to compliment this unit plan.

Queensland Museum Kurilpa (Brisbane) – Maker Space in SparkLab

Imagine and design solutions to challenges at the Maker Space. Make your creation from a range of materials provided, test out your design and share your thinking with others to build on ideas. Maker Space activities are included as part of your SparkLab ticket.

Find out more at: https://www.museum.qld.gov.au/kurilpa/whats-on/sparklab#makerspace

Queensland Museum Rail Workshops (Ipswich)

Queensland Museum Rail Workshops takes visitors on a journey through the state's history as seen from the birthplace of rail in Queensland, the heritage listed Ipswich Railway Workshops.

The Sunshine Route

Queensland's North Coast Line was one of the greatest Australian engineering achievements of the twentieth century. The Sunshine Route – 100 years of Queensland's North Coast Line exhibition commemorates the 100th anniversary of the line's completion on 8 December 1924.

Find out more at: https://www.museum.qld.gov.au/rail-workshops/whats-on/the-sunshine-route

Queensland Museum school programs

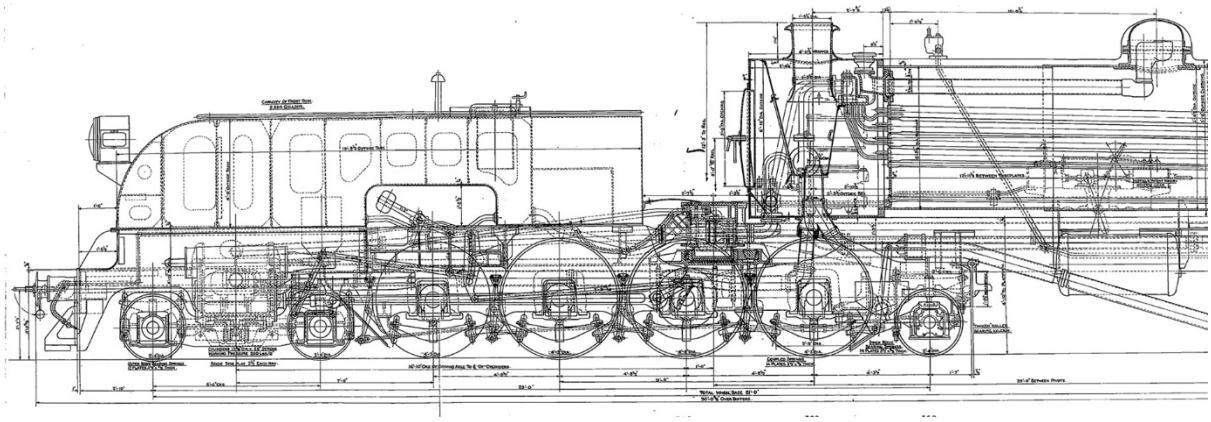
Queensland Museum offers rich and unique experiences for your students that will support and extend their classroom learning. Through specially designed school programs, hands-on STEM exhibits and world-class exhibitions, your students will develop their love of learning and appreciation for Queensland's incredible biodiversity and natural heritage, history and culture when you visit.

The first step in planning a school visit to the museum is to find out what's on. Choose from a range of school programs at your preferred Queensland Museum site:

- Queensland Museum Kurilpa (Brisbane): https://www.museum.qld.gov.au/kurilpa/whats-on?what=schoolprograms
- Queensland Museum Cobb + Co (Toowoomba): https://www.museum.qld.gov.au/cobb-and-co/whats-on?what=schoolprograms
- Queensland Museum Rail Workshops (Ipswich): https://www.museum.qld.gov.au/rail-workshops/whats-on?what=schoolprograms
- Queensland Museum Tropics (Townsville): https://www.museum.qld.gov.au/tropics/whats-on?what=schoolprograms

The following school program is most suitable to visit to compliment this unit plan.

Queensland Museum Rail Workshops (Ipswich) – School Program



Before the introduction of CGI, mechanical drawings, despite their complexity were produced by hand by skilled draftsmen. In this program, students will be introduced to these historical design drawings through the use of original hand drawn locomotive and wagon blueprints from within the museum's collection.

They will learn how to read, interpret, and identify key elements of hand produced design drawings, including scale, measurements, perspectives, and key design features. They will also be introduced to design layering, methodologies and requirements of designing a steam locomotive and carriages. While doing so, students will also gain insight into where current design technologies developed from, and a better appreciation of the craft of skilled tradesmen. For more information and to book your school in, visit: https://www.museum.qld.gov.au/rail-workshops/whats-on/mechanical-drawing

QM Loans Kits

QM Loans is Queensland Museum's object library for Queensland schools. It includes kits with activities and sets of museum objects to support the Australian curriculum.

For those in the Brisbane region, you can become a QM Loans subscriber or submit a booking inquiry at the following link:

https://loans.qm.qld.gov.au/Montage/StaticContent.aspx?staticContent=subscriptions

We have 24 locations across Queensland to collect and return your education loans kits, including Ipswich, Toowoomba, Darling Downs, North Coast, Central Queensland, Townsville and North Queensland.

Contact a local depot at the following link to book and borrow kits in regional Queensland:

https://loans.qm.qld.gov.au/Montage/StaticContent.aspx?staticContent=Locations

Queensland Museum online collections

Search a selection over 800,000 cultural artefacts, historical objects, biological specimens, and geological samples held by Queensland Museum on our online collections database.

Queensland Museum online collections: https://collections.qm.qld.gov.au/explore

Queensland Museum online image library

Queensland Museum's Image Library comprises a collection of digital assets documenting Queensland's natural and cultural heritage. They offer a unique glimpse at Queensland's wildlife, plants, and landscapes, along with a diverse range of collection objects and historical events.

Queensland Museum Image Library: https://imagelibrary.qm.qld.gov.au/

The following images are most suitable to visit to compliment this unit plan.

Construction of the Alexandra Bridge, Rockhampton © Queensland Museum

Transport and Energy:
https://imagelibrary.qm.qld.gov.au/assets/Home/Search?Query=%3Ffp%3DTransport&Type=NavAlbum&TabIndex=1&AlbumName=Transport%20%26%20Energy

Notes

Notes

QGC | QUEENSLAND MUSEUM Queensland Government

FUTURE MAKERS

museum.qld.gov.au/futuremakers

futuremakers@qm.qld.gov.au