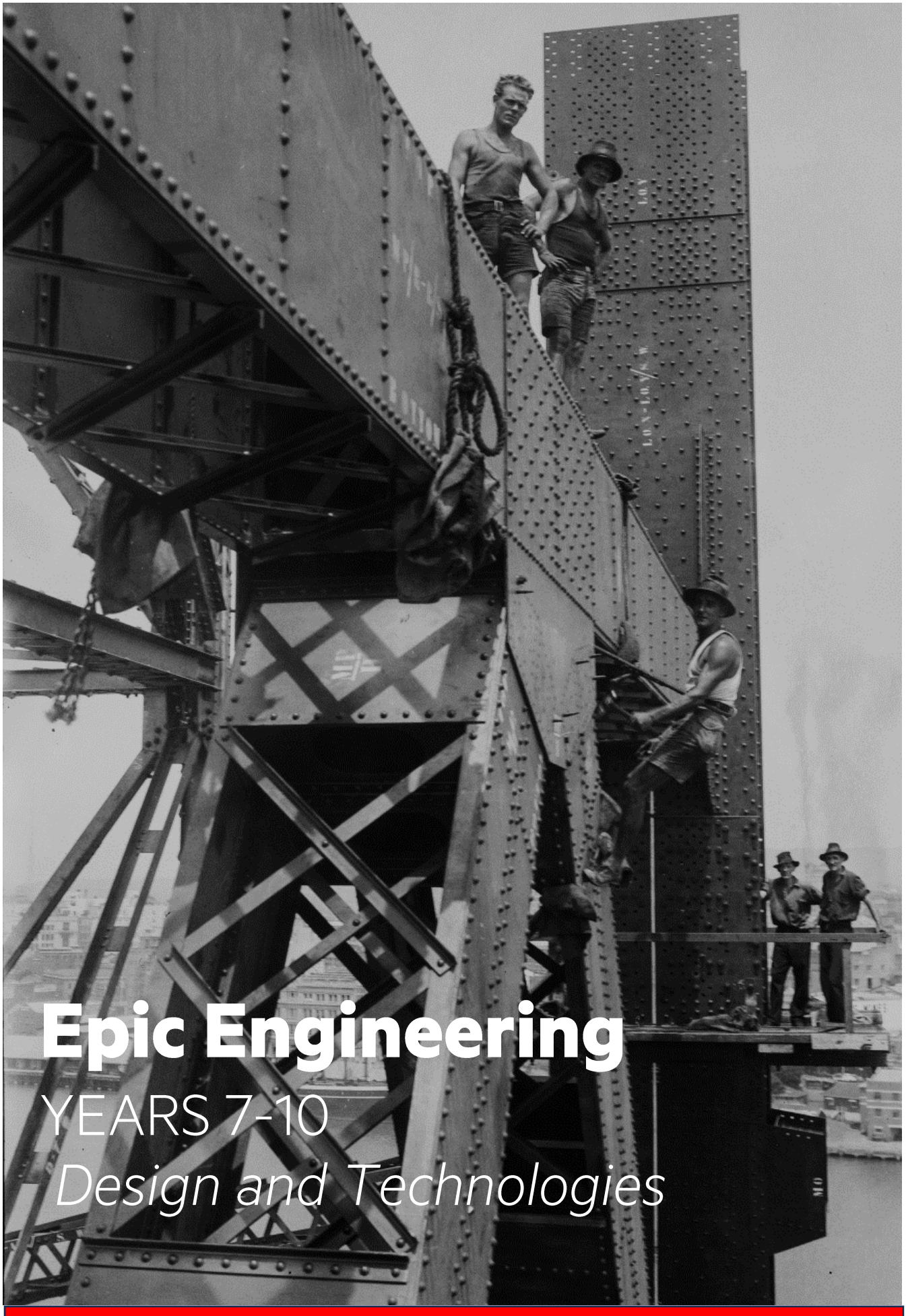


Epic Engineering

YEARS 7-10

Design and Technologies

WORLD SCIENCE FESTIVAL BRISBANE

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 Brisbane 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.

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

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 then 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!

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
		Analyse the impact of innovation and the development of technologies on designed solutions for global preferred futures	AC9TDE8K02	1, 2, 3, 5
	Technologies Context: Engineering principles and systems	Analyse how force, motion and energy are used to manipulate and control engineered systems	AC9TDE8K03	4, 5

Years 9 and 10 – 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, security and sustainability factors to innovate and improve products, services and environments	AC9TDE10K01	1, 2, 3, 5
		Analyse the impact of innovation, enterprise and emerging technologies on designed solutions for global preferred futures	AC9TDE10K02	1, 2, 3, 5
	Technologies Context: Engineering principles and systems	Analyse and make judgements on how the characteristics and properties of materials are combined with force, motion and energy to control engineered systems	AC9TDE10K03	4, 5

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 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

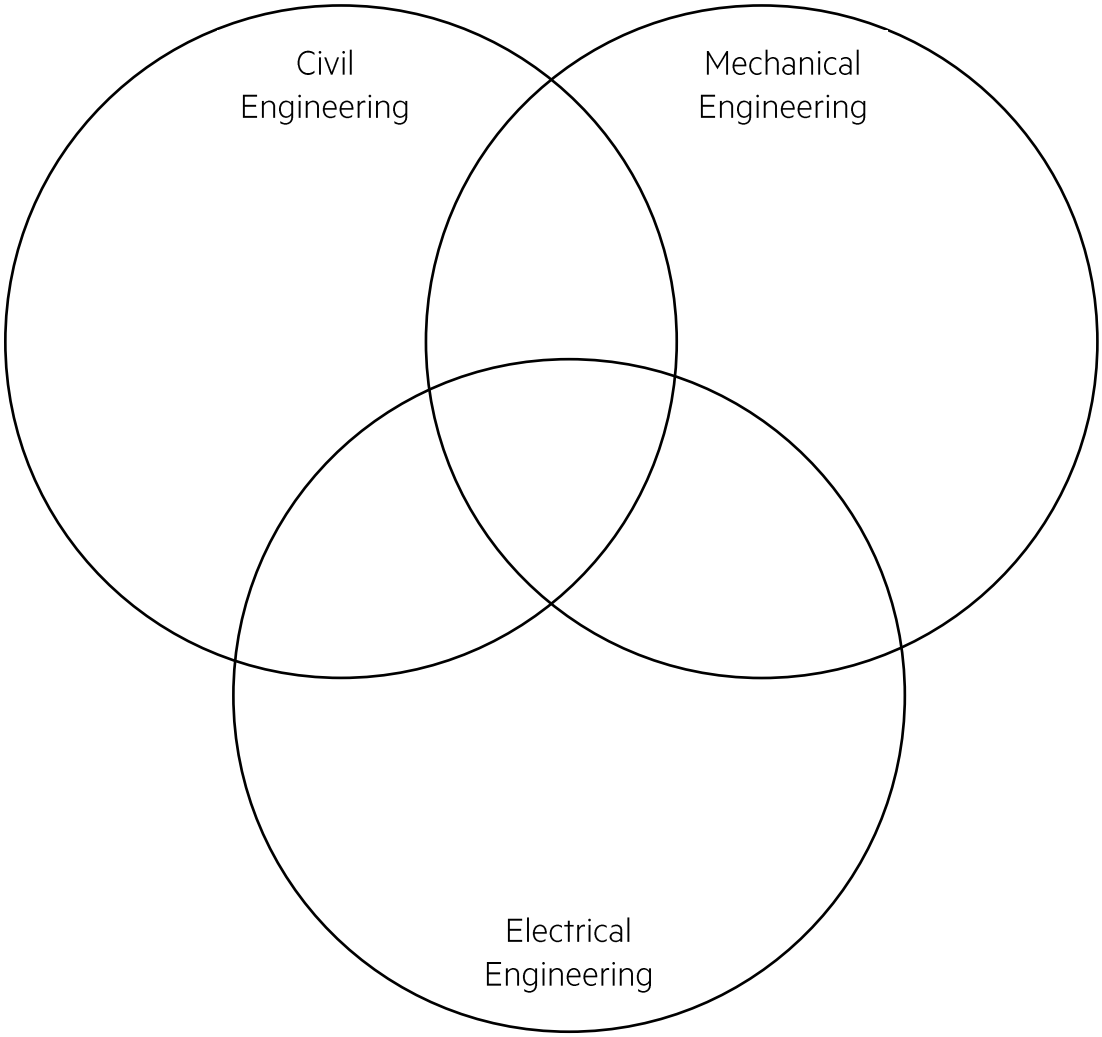
In this activity, students participate in a community of inquiry to consider the impact of engineering in our lives. The community of inquiry is a structured, dialogic process that requires participants to ask open inquiry questions, listen and think, share ideas and consider alternative viewpoints. 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.

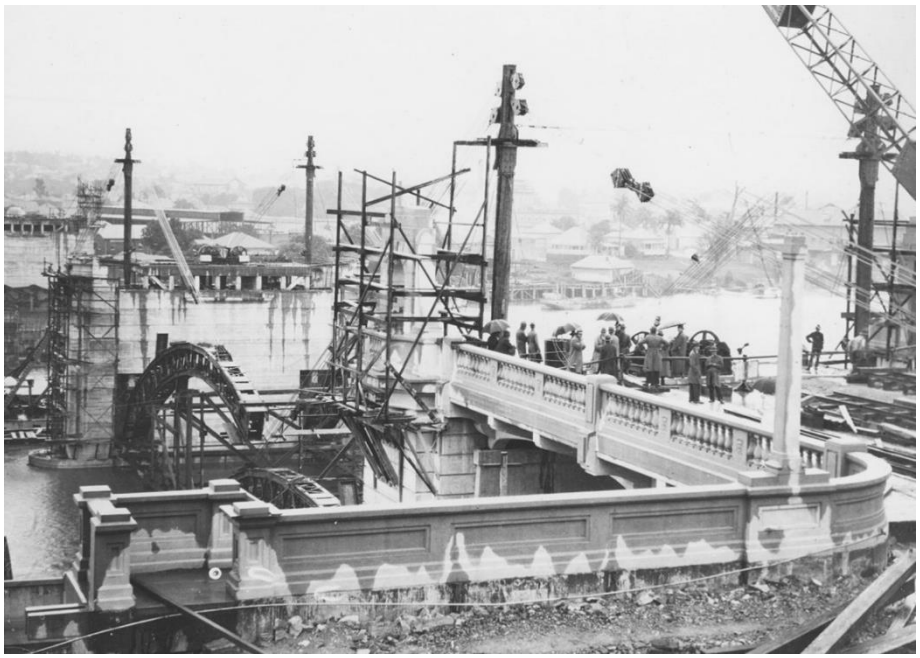
5. Ask students to share their responses to this question in a class discussion which can be recorded on the board or digitally for future reference.

Lesson 3: Queensland's Epic Engineers

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 continue 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 about 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 they would like to research further and report back about.
3. 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: Tile Renewables

Kareeya and Koombooloomba Hydroelectricity power station

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

Image: CleanCo Qld

Walter Taylor Bridge

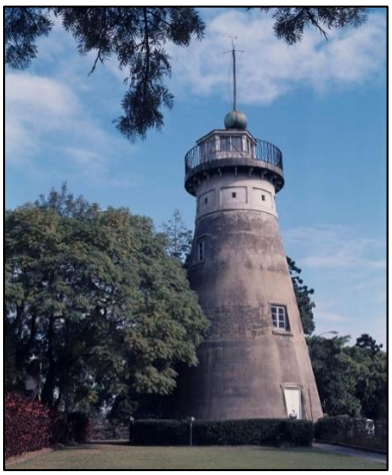
- Queensland Government Heritage Register: https://apps.des.qld.gov.au/heritage-register/detail/?id=600181

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



Resource:

Queensland's Epic Engineers

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 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.

Resources:

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?

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.

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 the problem 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 provided, *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 record their results in the *Simple Machines Experiment Worksheet* resource.

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. Please visit https://www.museum.qld.gov.au/kurilpa/plan-your-visit/visit-as-a-school/school-booking-form to book an experience your class will never forget!

Resources

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?

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.

Simple Machines Experiment Worksheet

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

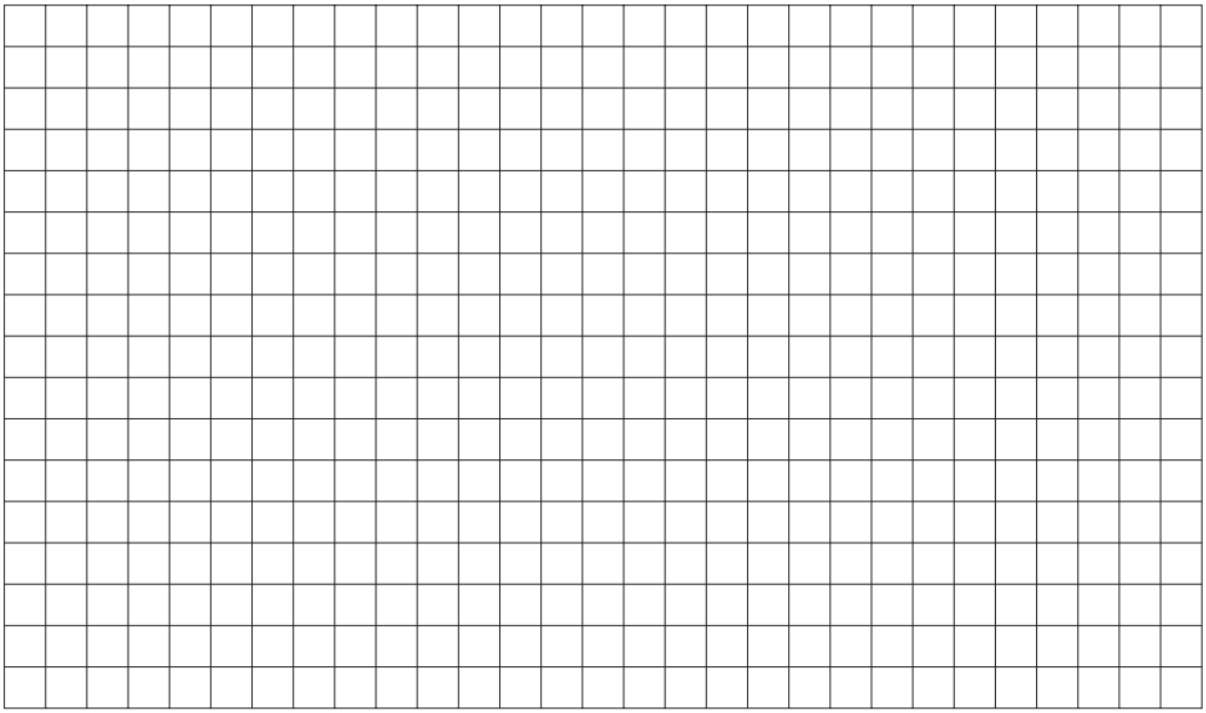
Observations – Draw a scientific diagram of your results in the space below.

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.

Students will explore engineering feats during the *Epic Engineering* show which include:

The Great Pyramid of Giza
Begin the journey with one of the oldest and most iconic engineering marvels. Students will learn about this massive structure, which is over 4500 years old. Civil engineering has been conducted through meticulous planning, teamwork and ingenuity throughout human history.

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.