Famous

Scottish

Landmarks

Building Challenges

Introduction

This set of building challenges based on famous Scottish landmarks, can be completed using recycled materials, and/or craft materials e.g., lollypop sticks, matchsticks, playing cards, pipe cleaners, straws, cardboard etc. or any construction kits e.g. KAPLA, LEGO, K'NEX, makedo (Makedo UK) etc.

The challenges have an engineering focus and sit within the 'Craft, Design, Engineering and Graphics' part of the Technologies Es and Os, specifically the 'Design and construct models/product', 'Exploring uses of materials' and 'Application of Engineering' organisers.

What is engineering?

The definitions of engineering are as follows:

engineering (noun) - the branch of science and technology concerned with the design, building, and use of engines, machines, and structures.

engineering (verb) - design and build.

Engineering is about making things work and making things work better. Almost everything we own, and use has involved engineering!

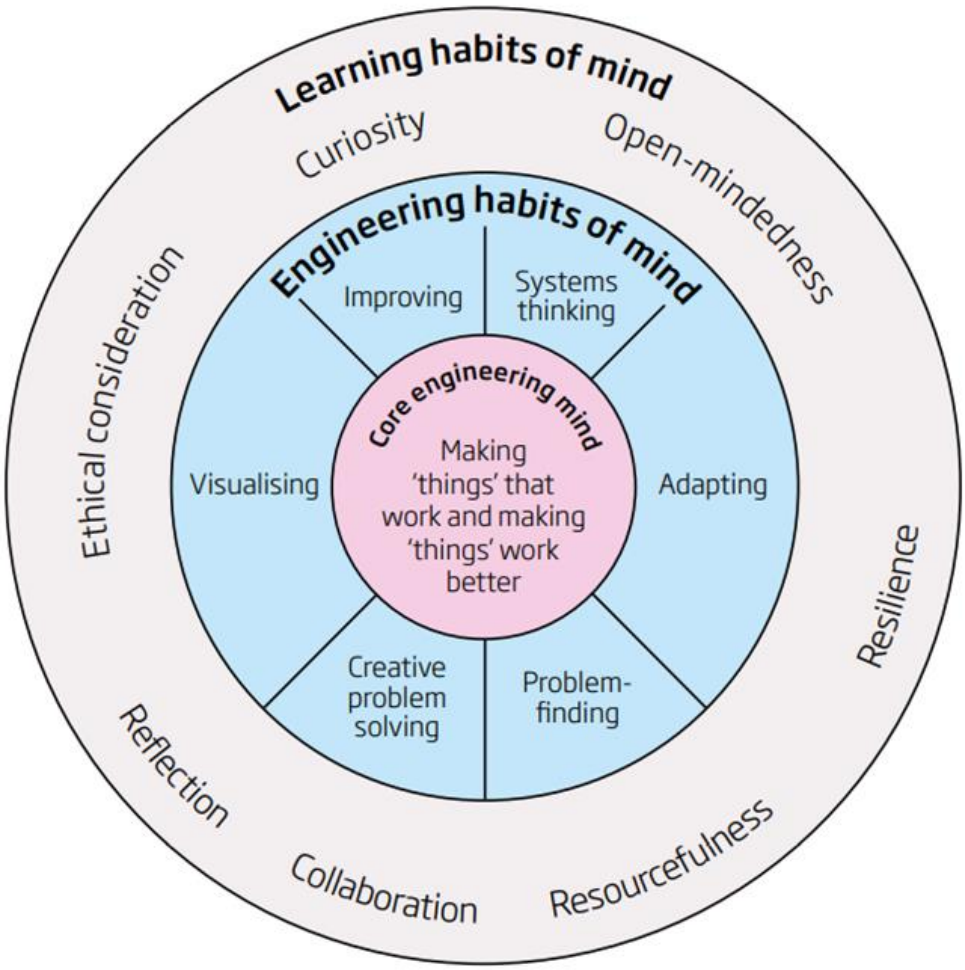
Engineering is part of the Curriculum for Excellence and is part of the Technologies Experiences and Outcomes (Curriculum Organiser: Craft, Design, Engineering and Graphics). However, information for teachers is limited and there is no explicit guidance about the skills or the progression of skills within the 'Engineering' Es and Os, unlike in other areas of STEM e.g., Science Enquiry Skills.

There are many opportunities for incorporating learning activities aligned to different engineering disciplines across the curriculum. For example, civil engineering – which involves infrastructure, the construction of roads, houses, bridges etc, can be included within Social Studies (People, Place and Environment), Technology (Exploring Uses of Materials, Designing and Constructing Models), Science (Forces and Materials), Maths (Measure) and Expressive Arts (creating objects for specific tasks/solutions to a design problem). Given these opportunities involve a wide range of engineering disciplines, the question that arises is how can we teach them all? One solution is to move away from looking at all the different disciplines and focus on the skills that are common to all disciplines of engineering.

The Royal Academy of Engineering have identified common attributes and the skills engineers have regardless of their engineering discipline; they call these the ***Engineering Habits of Mind***. There are six Engineering Habits of Mind, and these have now been broken down into more specific skills which are transferable across all curricular areas.

Engineering Habits of Mind

Developed by The Royal Academy of Engineering to outline the skills and attributes employed by Engineers across disciplines.



Systems Thinking – Smaller parts coming together to make a whole.

Problem Finding – Finding problems, deciding how to fix them and checking existing solutions.

Visualising – Thinking about how the final product will look.

Creative Problem Solving – Working together to create solutions to problems.

Improving – Making things better.

Adapting – Applying things in a new context.

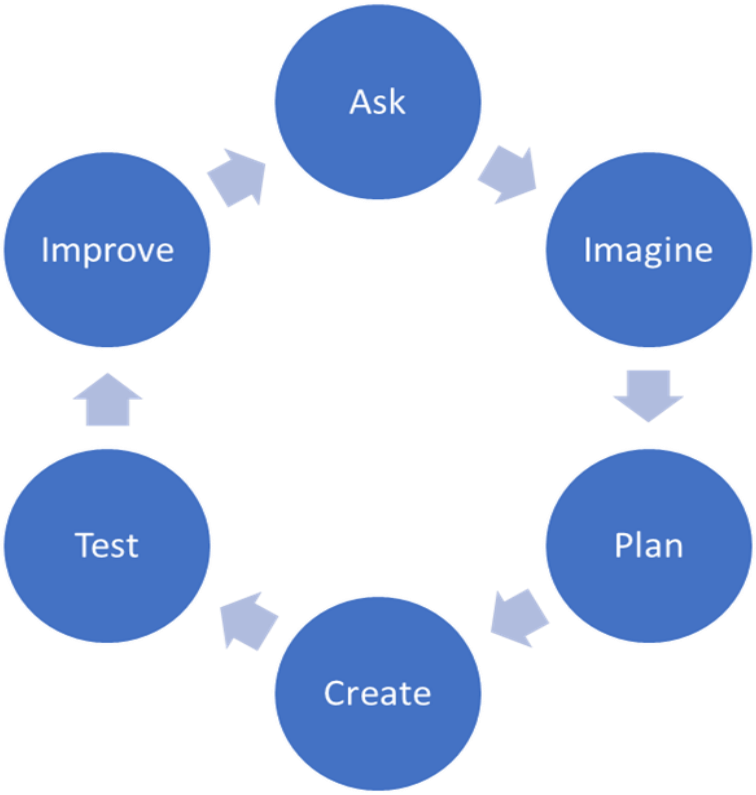
More information can be found here:

Bill Lucas Webinar: Engineering Habits of Mind:
https://www.youtube.com/watch?v=1Ty3MIDPZ3s

These have been broken down:

We can help the children to develop these skills, and to ‘think like an engineer’ by using the Engineering Design Process:

The Engineering Design Process



ASK: Students identify the problem, requirements that must be met, and constraints that must be considered.

IMAGINE: Students brainstorm solutions and research ideas. They also identify what others have done.

PLAN: Students choose two to three of the best ideas from their brainstormed list and sketch possible designs, ultimately choosing a single design to prototype.

CREATE: Students build a working model, or prototype, that aligns with design requirements and that is within design constraints.

TEST: Students evaluate the solution through testing; they collect and analyse data; they summarise strengths and weaknesses of their design that were revealed during testing.

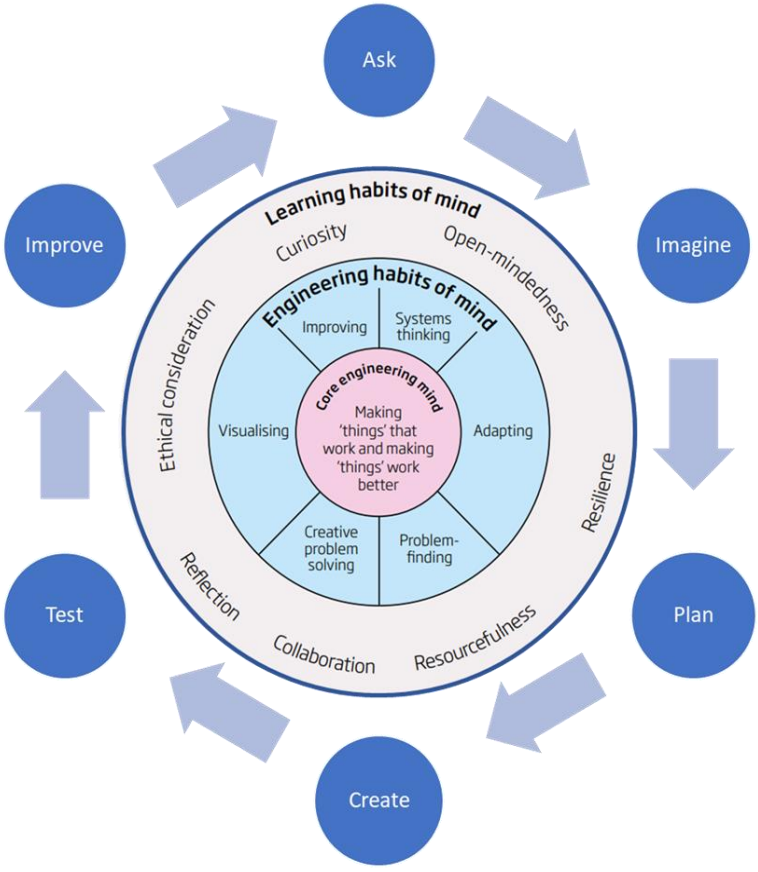
IMPROVE: Based on the results of their tests, students make improvements on their design. They also identify changes they will make and justify their revisions.

THIS PROCESS IS A CYCLE – NOT LINEAR

Younger children might find it easier to work with less steps in the design process:

Taken from the FIRST® LEGO® League programmes (IET)

When the Engineering Habits of Mind are used alongside the design process, they can be used to develop pupils' STEM skills and skills that can be used across the curriculum.



If the children are given time to work through this cycle, they will naturally develop the skills within the Engineering Habits of Mind, leading to the core engineering mindset of 'Making 'things' work and making 'things' work better.'

The majority of the activities in this resource are linked to civil engineering and are designed to be used with the Engineering Design Process. Each activity consists of two build challenges: the first one is based on a Scottish landmark, and the second one is a brief based on the first but asks the children to design and create their own model.

Can you make a model of each these famous Scottish landmarks?

1. **Craigievar Castle**
2. **Forth Bridge**
3. **Blackhouses**
4. **The Kelpies**
5. **SEC Armadillo**
6. **Suggestions for International Building Challenges**

For each of the structures, you might like to find out:

- When it was built
- Where it is located
- Who designed it/who the architect was
- The materials that were used
- The style that was used

Can you then follow the brief and design something new?

1. Craigievar Castle

Find out more about what the castle looks like here:

Scotland | Aberdeenshire Castles | Craigievar Castles

Location: Aberdeenshire

Height: Seven stories high

Interesting fact: Craigievar Castle is very well-known for how well it has been preserved, but its claim to fame lies in its pink colour. It is also said to have been an inspiration for Walt Disney's Cinderella Castle!

Design and build your own castle and include (constraints):

- A working draw bridge
- Square towers

Use the Engineering Design Process (*see page 5*) to research, design, and construct a castle and then test and improve the model.

Suggested topic links:

- Castles
- Local study

Books:

- Harry Potter
- Jack and the Beanstalk
- Iggy Peck, Architect

Curricular Links:

Social Studies:

People, past events and societies

SOC 1-03a, SOC 1-04a, SOC 2-03a, SOC 2-04a

People, place and environment

SOC 0-09a, SOC 1-07a, SOC 2-10a

Technologies:

Craft, Design. Engineering and Graphics

TCH 0-09a, TCH 0-10a, TCH 1-09a, TCH 1-10a, TCH 2-09a, TCH 2-10a

Expressive Arts:

Art and Design

EXA 0-02a, EXA 0-06a, EXA 1-02a, EXA 1-06a,EXA 2-02a, EXA 2-06a

2. Forth Bridge

Find out more about what the bridge looks like here:

[4th March 1890: Forth Bridge in Scotland opened by the future King Edward VII - YouTube]

Location: Firth of Forth, connecting Edinburgh, with Fife

Length: 2,528.7 metres

Interesting fact: the Forth bridge is a Category A listed building and is a UNESCO World heritage site. The bridge took 10 times more metal to build then the Eiffel Tower!

Design and build your own bridge which must (constraints):

- Be at least 30cm wide (span)
- Stand on its own
- Support 2 kg of weight in the middle

A bridge's strength comes from its structure. Research different types/structures of bridges. Which shapes are stronger than others? How important are the materials used in building bridges? How can you use the materials provided to add strength to the bridge and make good use of them?

Use the Engineering Design Process (*see page 5*) to research, design, and construct a bridge and then test and improve the model.

The constraints and/or the materials available to build the bridge can be altered depending on the age/stage of the children.

Can you change the design or build a new bridge that spans at least 50 cm and supports 2 kg of weight?

Suggested topic links:

- Transport
- Famous Engineers and Inventors
- Local study

Books:

- Iggy Peck, Architect
- Three Billy Goats Gruff

Curricular Links:

People, place and environment

SOC 0-09a, SOC 1-07a, SOC 2-09a

Technologies:

Craft, Design. Engineering and Graphics

TCH 0-09a, TCH 0-10a, TCH 1-09a, TCH 1-10a, TCH 2-09a, TCH 2-10a

Expressive Arts:

Art and Design

EXA 0-02a, EXA 0-06a EXA 1-02a, EXA 1-06a,EXA 2-02a, EXA 2-06a

3. Blackhouses

Find out more about what blackhouses look like here:

https://www.youtube.com/watch?v=C2gcdg4zar8&t=68s

Location: Gearrannan Blackhouse Village, Isle of Lewis

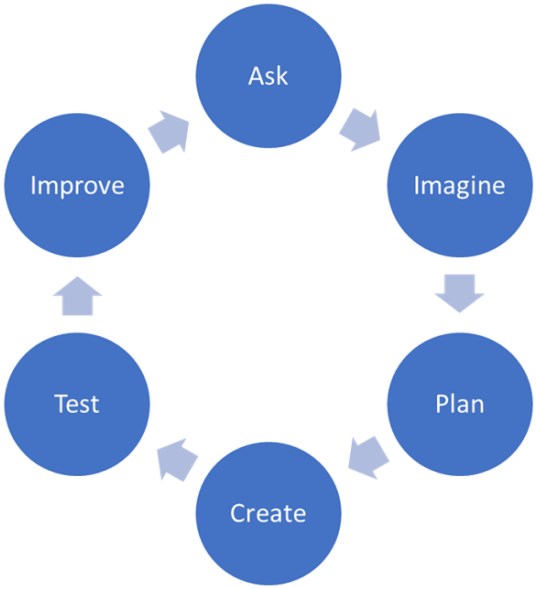
Interesting fact: The Lewis blackhouses were designed to survive the tough weather; they have low rounded roofs to protect the house against strong winds and the roof is anchored down with rope netting and stones! People lived at one end and the animals lived at the other with a partition between them!

Design and build a shelter that would protect you against 'wild weather' which must (constraints):

- Protect against wind, rain, sun and snow (or natural disasters e.g., earthquakes, flooding etc)
- Must be big enough to contain one or more people (standing figures drawn onto pieces of card about 8cm x 4 cm)
- Must fit inside a tray for testing

For testing:

- Spray bottle (to simulate rain)
- Small bottle of water (to use to simulate snow weight by standing it on the model)
- Small fan (to simulate wind; alternatively, you can blow through a straw)
- UV-sensitive beads (to test for protection against the Sun)



Use the Engineering Design Process (see page 5) to research, design, and construct a shelter and then test and improve the model.

The constraints and/or the materials to build the shelter can be altered depending on the age/stage of the children. For younger children, the number of 'wild weathers' could be reduced. For older children, resources available for building might only include limited 'rigid materials '. Natural materials could also be included.

Suggested topic links:

- Natural Disasters
- Weather

Books:

- Kensuke's Kingdom
- Where the Wild Things Are

Curricular Links:

Social Studies:

People, place and environment

SOC 0-12a, SOC 1-09a, SOC 2-07a

Technologies:

Craft, Design. Engineering and Graphics

TCH 0-09a, TCH 0-10a, TCH 1-09a, TCH 1-10a, TCH 2-09a, TCH 2-10a

Expressive Arts:

Art and Design

EXA 0-02a, EXA 0-06a EXA 1-02a, EXA 1-06a, EXA 2-02a, EXA 2-06a

5. The Kelpies

Find out more about what the Kelpies look like here:

The Kelpies, Scotland. Sculpture by Andy Scott @ScotlandAbove - YouTube

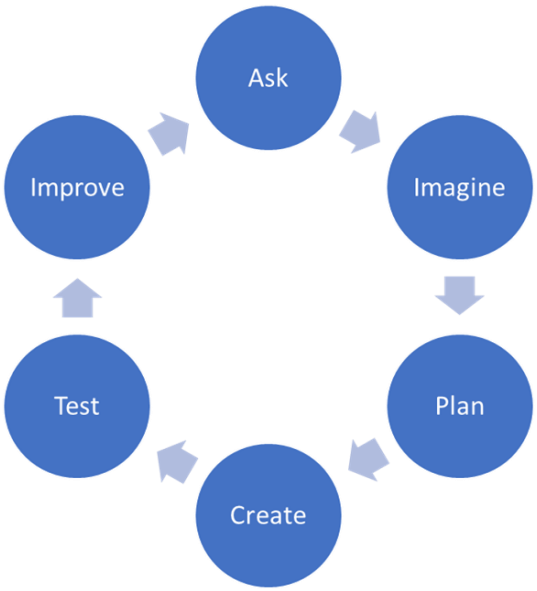
Location: Falkirk

Height: 30 metres

Interesting fact: Kelpies are mythological, shape-shifting water spirits, usually described as powerful and beautiful black horses inhabiting the deep pools of rivers and streams of Scotland.

Design and build a model of an animal native to Scotland (lives in Scotland naturally) which must (constraints):

- Stand on its own
- Be three-dimensional
- At least 30cm tall



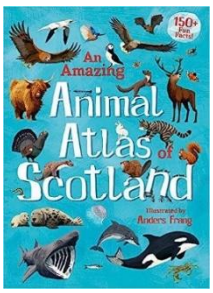
Use the Engineering Design Process (*see page 5*) to research, design, and create a model of an animal native to Scotland and then test and improve the model.

Suggested topic links:

- Biodiversity
- Local Study

Books:

- The Gruffalo
- Percy the Park Keeper stories
- An Amazing Animal Atlas of Scotland (Kelpies World) by Anders Frang (Illustrator)



Curricular Links:

Sciences:

Biodiversity and Interdependence

SCN 0-01a, SCN 1-01a, SCN 2-01a

Technologies:

Craft, Design. Engineering and Graphics

TCH 0-09a, TCH 0-10a, TCH 1-09a, TCH 1-10a, TCH 2-09a, TCH 2-10a

Expressive Arts:

Art and Design

EXA 0-02a, EXA 1-02a, EXA 2-02a

6. SEC Armadillo

Location: Glasgow

Area: 13 000 m²

Interesting fact: the SEC Armadillo takes its name from the animal of the same name because of the similarity of its shape to the armadillo!

Design and build a building which is for people to use (e.g., a theatre, a cinema, a library etc). based on the shape of an animal. The model must (constraints):

- Stand on its own
- Be three-dimensional

Use the Engineering Design Process (*see page 5*) to research, design, and construct a building based on the shape of an animal and then test and improve the model.

Suggested topic links:

- Famous Engineers and Inventors

Books:

- Iggy Peck, Architect

Curricular Links:

Technologies:

Craft, Design. Engineering and Graphics

TCH 0-09a, TCH 0-10a, TCH 1-09a, TCH 1-10a, TCH 2-09a, TCH 2-10a

Expressive Arts:

Art and Design

EXA 0-02a, EXA 1-02a, EXA 2-02a,

7. Suggestions for International Building challenges

The Eiffel Tower

Location: Paris, France

Height: 320 m

Interesting fact: The Eiffel Tower was originally built as the entrance arch for the World's Fair in 1889.

The Taj Mahal

Location: Agra, India

Height: 73 m

Interesting fact: The Taj Mahal is considered to be one of the most beautiful buildings in the world.

The Great Pyramid

Location: Cairo, Egypt

Height: 147 m

Interesting fact: The Great Pyramid Giza is more than 4,000 years old.

The Parthenon

Location: Athens, Greece

Height: 14 m

Interesting fact: The Parthenon is built from limestone and marble.

References and suggested resources

- Engineering Design Process | NASA
- Engineering Habits of Mind – STEM Nation (glowscotland.org.uk)
- Bill Lucas Webinar: Engineering Habits of Mind: https://www.youtube.com/watch?v=1Ty3MIDPZ3s
- thinking-like-an-engineer-full-report.pdf (raeng.org.uk)
- ltbae_report_final_web-min.pdf (raeng.org.uk)
- Makedo UK

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