Sustainable Farms - Session 4

What do engineers need to consider when designing large farming machines?

Context:
Learners explore the advantages and disadvantages of using large farm machinery to help with various processes in arable farming. They link some of these advantages and disadvantages to the ongoing theme of sustainability, looking for where greenhouse gas emissions might increase and where they might be reduced. They then focus on one problem - moving large farm machinery around country lanes - and adapt the simple mechanism in a pair of scissors to visualise new ideas to reduce and increase the size of machine attachments for tractors.

Engineering focus:
Learners will be working as an engineer by imagining and planning solutions to problems.

Learning time:
1.5 hours

Suggested age group:
11-14 years old

Curriculum for Excellence links:

Third Level:

I can apply my knowledge and understanding of engineering disciplines and can develop/build solutions to given tasks. TCH 3-12a
I understand how scientific and technological developments have contributed to changes in everyday products. TCH 3-05a
I can create solutions in 3D and 2D and can justify the construction/graphic methods and the design features. TCH 3-09a
I can explore the properties and performance of materials before justifying the most appropriate material for a task. TCH 3-10a
I can apply a range of graphic techniques and standards when producing images using sketching, drawing and software. TCH 3-11a
Scientific analytical thinking skills (see Sciences Benchmarks for further details)
While working through a design process in response to a design brief, I can develop and communicate imaginative design solutions. EXA 3-06a

Fourth Level:

I can solve problems through the application of engineering principles and can discuss the impact engineering has on the world around me. TCH 4-12a
I can analyse products taking into consideration sustainability, scientific and technological developments. TCH 4-05a
I can apply design thinking skills when designing and manufacturing models/products which satisfy the user or client. TCH 4-09a
I consider the material performance as well as sustainability of materials and apply these to real world tasks. TCH 4-10a
I can extend my use of manual and digital graphic techniques to realise ideas, concepts and products and recognise the importance of real world standards. TCH 4-11a
Scientific analytical thinking skills (see Sciences Benchmarks for further details)
By working through a design process in response to a design brief, I can develop and communicate imaginative and original design solutions. EXA 4-06a

Keywords

soil compaction
mechanism
machine
machinery
tractor
efficient
emissions
climate
lever
pivot
visualise
adapt

Resources:

- Sustainable farms Session 4 PPT
- Sustainable farms Session 4 -Problem on a page
- Paper and pens
- Modelling resources: Cardboard, split pins, rubber bands, drawing pins, lolly sticks, string, scissor, craft knives and cutting boards
- Optional: Access to tinker CAD

Suggested Activities

What are the advantages and disadvantages of using large farm machinery?

Share the video of Claas farm machinery in action so learners observe a range of contemporary large agricultural machines in use (Slide 2).

1

Ask learners to collaborate in pairs to think about the possible advantages and disadvantages of using large farm machinery - particularly in relation to the ideas of sustainability covered in the previous session. Provide pairs with large paper and markers/post-its to gather and record their ideas.

Allow time for pairs to share their advantages and disadvantages with the group. Compare the learners ideas with some of the advantages and disadvantages listed in Slide 3.

How do engineers adapt machinery to make particular jobs more efficient?

Help learners to understand the concept of adapting by sharing different ways in which the tractor has been adapted to solve different problems in farming (Slide 4) - Encourage learners to talk about what problems they think the different adaptations have helped to solve (Compact battery-powered, Track tractors, Orchard Tractors, Remote controlled tractors).

2

Provide learners with the opportunity to identify the problem of moving large farm machinery around country lanes (slide 5). Learners think of questions to ask to find problems with using large attachments on the farm. They are looking to identify issues with moving large machines around country lanes under bridges etc.

Now they have identified a problem - now it is time to get creative and think of ways to solve the problem. Advantage of large farm machinery: they spend less time driving up and down the field so less fuel is burnt, it is efficient and time saving, the tractor drives over less of the field so there is less compaction of soil. But farms are in the countryside where roads are typically narrow lanes so how can we have a large attachment and get around the farm easily?

3

Focus on a simple mechanism- scissors

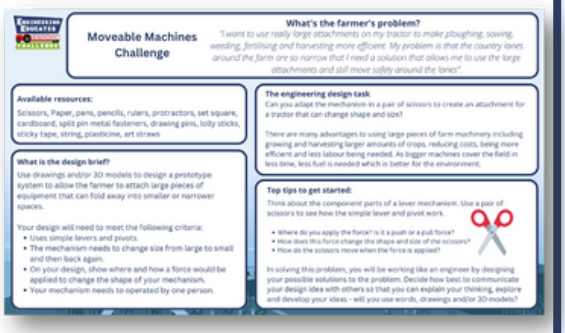
Learners work in teams of 3 or 4 and are challenged to look carefully at the simple mechanism in a pair of scissors. It is a simple lever with a pivot.

- Where do you apply the force?
- How does this affect the scissors? Size? Shape? Movement?

4

Moveable Machines Challenge

As a team the learners imagine and plan how they would adapt this simple scissor mechanism to create an attachment for a tractor that can change size with ease - from super large on the fields for more efficient processes to compact for moving around country lanes and travelling under bridges. Provide teams with the **Problem on a page: Moveable Machines** to set the challenge and provide support (slide 6).



Make resources available for teams to use but allow them to make their own decisions about their design and how they will share their ideas. Slide 7 provides some inspiration on how learners could visualise their design ideas.

5

Share your design ideas

Learners are given a few minutes to present their idea for adapting the scissor mechanism to solve the problem to the rest of the groups. They share their visualisations and answer questions.

The audience are provided with an evaluation tool to make judgements about the success of their peers' suggestion - identifying how the success criteria has been met, strengths of the design idea and suggestions about areas that could be improved (slide 8).

Take some time to reflect on the stages of the Engineering Design Cycle that learners have be working on through this challenge (slide 9).

Take it further

Learners explore contemporary agricultural machines that have been adapted to make different types of farm more efficient, safe and sustainable. The video on slide 10 will support with this showing a range of innovative machines in action on farms.

Moveable Machines Challenge

What's the farmer's problem?

"I want to use really large attachments on my tractor to make ploughing, sowing, weeding, fertilising and harvesting more efficient. My problem is that the country lanes around the farm are so narrow that I need a solution that allows me to use the large attachments and still move safely around the lanes".

Available resources:

Scissors, Paper, pens, pencils, rulers, protractors, set square, cardboard, split pin metal fasteners, drawing pins, lolly sticks, sticky tape, string, plasticine, art straws

What is the design brief?

Use drawings and/or 3D models to design a prototype system to allow the farmer to attach large pieces of equipment that can fold away into smaller or narrower spaces.

Your design will need to meet the following criteria:

- Uses simple levers and pivots.
- The mechanism needs to change size from large to small and then back again.
- On your design, show where and how a force would be applied to change the shape of your mechanism.
- Your mechanism needs to operated by one person.

The engineering design task

Can you adapt the mechanism in a pair of scissors to create an attachment for a tractor that can change shape and size?

There are many advantages to using large pieces of farm machinery including growing and harvesting larger amounts of crops, reducing costs, being more efficient and less labour being needed. As bigger machines cover the field in less time, less fuel is needed which is better for the environment.

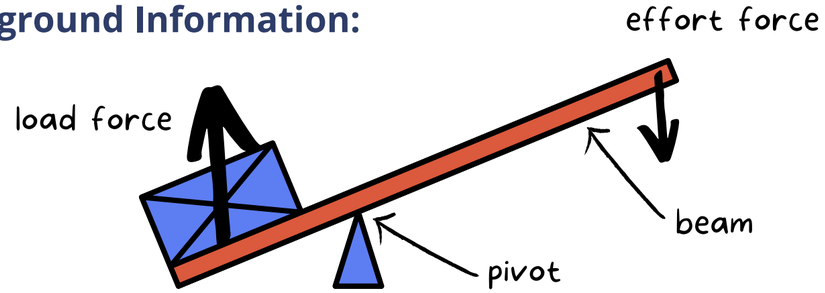
Top tips to get started:

Think about the component parts of a lever mechanism. Use a pair of scissors to see how the simple lever and pivot work.

- Where do you apply the force? Is it a push or a pull force?
- How does this force change the shape and size of the scissors?
- How do the scissors move when the force is applied?

In solving this problem, you will be working like an engineer by designing your possible solutions to the problem. Decide how best to communicate your design idea with others so that you can explain your thinking, explore and develop your ideas - will you use words, drawings and/or 3D models?

Background Information:



A simple lever mechanism is used in a number of simple machines and toys. Levers consist of a beam or rod pivoted at a fixed pivot. When a load or effort force is applied to the beam or rod it causes the lever to turn about the pivot.

Many common tools include levers. A lever increase the input effort force to produce a larger output force, it is a mechanical advantage device.

Can you identify the pivots on these simple tools?

Levers can be combined in more complex mechanism such as a scissor lift. A scissor lift is a lifting mechanism that has a series of supporting beams under a platform that are hinged with pivot points to produce an assembly that looks like several sets of scissor blade. When the working mechanism pushes the beams together the structure extends, raising the platform vertically.

Glossary:

Mechanism – a system of parts working together in a machine.
Lever – a simple machine with a rigid bar resting on a pivot. They are used to move a load at one side by using effort force applied to the other.
Pivot- a central point around which a mechanism turns.
Visualise- to share ideas by drawing, sketching and talking
Tractor- a vehicle with large rear wheels used mainly on farms for hauling large equipment or farming processes.
Attachment- an extra part or extension
Ploughing- to turn over the soil on a field before planting seeds.
Fertilising- to make soil more fertile by adding nutrients to it.
Sowing- planting seeds by scattering them on the soil.
Harvesting- to gather crops from the fields.

More information and inspiration!

Example Youtube videos to inspire you..

- To learn more about levers and how they work.
- Look at this lift used in a warehouse to move boxes.

Want to take it further?

Why not use CAD software to visualise and communicate your designs in 3D. Tinkercad is free to use and can be accessed HERE.

Watch how Tinkercad can help you HERE.

How well did you do?

Use the problem-solving score card to evaluate how well you performed on this design task.

Success Criteria	Score /5
Your mechanism simple levers and pivots.	
Your mechanism can be reduced in size then returned to its original size.	
You have correctly identified where the force should be applied to operate.	
Can be operated by one person.	

Image credit: Smail