Cattle Carers - Session 4

How can we use simple machines to improve air quality in the dairy barn?

Context:
Learners will learn about the need for housed animals to have access to a constant supply of fresh air if they are to maintain good health and well-being. Effective ventilation in a barn allows the inward movement of clean air and the expulsion of stale air, odours, bacteria and viruses. 'Natural' ventilation relies on the principle that the wind causes a difference in air pressure inside and outside the building, drawing in fresh air and displacing the stale.

Engineering focus:
Learners will be working as engineers to create a prototype system using pulleys or cams, which will raise a window in the roof of a barn and create an outlet for stale air to be released.

Learning time:
1.5 hours

Suggested age group:
9-11 years old

Keywords
gases
air
stale
ventilation
inlets
ridge
eves
outlets
stack effect
dispersed
machine
cam
pulley
movement
force
prototype

Curriculum links:
Design Technology: *Make, Evaluate and Technical knowledge*

- Selecting from and using a wider range of tools and equipment to perform practical tasks accurately
- Evaluating their ideas and products against their own design criteria and consider the views of others to improve their work
- Understand and using mechanical systems in their products [for example, gears, pulleys, cams, levers and linkages]

Resources (per group):

- Cattle Carers Session 4 PPT
- Problem on a page Mechanisms for living handout
- Shoe box or equivalent
- String/thread
- Pulley
- Cams
- skewers/chopsticks
- thick cardboard
- cotton reels
- Tape/scissors/craft knife/cutting board
- Transparent material such as cellophane or laminate pouch

Step-by-step plan

1

What is ventilation and why is it important?

Show learners examples of ventilation they may have come across in their daily lives (slide 2) and pose the question 'What is going on here?' - Encourage paired discussion about the images, what they have in common and why they are important.

Define the term ventilation (slide 3) and pose the questions:

- Why is **ventilation** important for us?
- Why do you think that **ventilation** is important for cows?

Make time for learners to discuss these key questions and ask them to use the key words displayed to develop their answers which can then be shared with the rest of the class.

Explain to learners:

- A mature dairy cow will typically breathe out 22 litres of water each day as water vapour and produce between 600 to 700 Watts of heat – that's as much as an electric fan heater. This warm, moist air may cause cows heat stress and can also provide ideal conditions for germs to thrive. Poor ventilation makes it more likely that the air carries viruses and bacteria which can lead to pneumonia (infection in the lungs) and mastitis (infection in the udders) in the animals.

So why is ventilation so important in the dairy barn?

2

How is ventilation achieved in farm buildings?

Begin my giving a simple scientific explanation of why air moves around, introducing simple ideas about convection currents (slide 4).

Explain what is meant by **natural ventilation** (slide 5) and that for air to circulate through the barn there needs to be air **inlets** and **outlets**. Discuss the different places these inlets and outlets could be positioned and the advantages and disadvantages of them (slide 5). Ask learners to consider why farmers may want to sometimes close and reopen inlets and outlets. Explain that using natural ventilation reduces carbon emissions because it makes the best use of the surround environment rather than using electricity to power fans and air conditioning systems.

Learners watch sections of a video of a dairy farm in Scotland where the farmer explains how he has introduced ventilation into his barn. Encourage them to think about how his ventilation system works and why he has chosen to introduce it (slide 6).

How can we use simple machines to improve air quality in the dairy shed?

3

Learner collaborate in small groups to develop prototypes to solve the farmers problem of introducing outlets in the roof of the barn that can be open and closed. Provide groups with the Problem on a page: Mechanisms for living handout to support them in their problem solving and creating.

Groups will use a shoe box of equivalent to model the dairy barn and then use the resources provided to use simple machines to create a mechanism that can open and close shutters/windows in the roof the allow warm, stale air to escape. This can easily be achieves with simple cams and/or a pulley system.

Encourage groups to go through a brief planning stage, sharing ideas on a whiteboard before they start to create, tinker and fine tune their prototypes.

How can we improve out prototypes?

4

Learners are encouraged to regularly reflect on what is working well with their prototype and what is not working well. They should be encouraged to try new ideas and adapt their designs, tinkering with the mechanism, trying to make it work more efficiently.
This tinkering stage needs time and learners shouldn't be rushed. Take time to talk to each group about what they are doing and what they might try next to improve their mechanism.

How well does our prototype meet the design criteria?

5

Make time for groups to come together and share their solutions, using their prototype to share ideas. They should present to peers:

- What are the essential parts of the system in their lifting device?
- How well does their device meets the design criteria?
- How might their solution help solve the barn's ventilation problem?

Mechanisms for living Challenge

What's the farmer's problem?

"I need to improve the air quality in my barn as there is nowhere for the stale air to escape in the roof."

Available resources:

- Shoe box (representing the barn)
- Additional cardboard
- Wooden skewers/chopsticks/cocktail sticks/lolly sticks
- plastic tubes/cotton reels
- string/splitpins
- scissors/ tape/ craft knife/ cutting board

What is the design brief?

Create a working prototype of a mechanism that incorporates simple machines such as pulleys, cams and levers to open and close ventilation outlets in the roof of the dairy barn.

The mechanism should:

- be able to be **operated by one person** who is **stood at floor level** in the dairy barn.
- the operator should be able to **apply a force** to the mechanism to both **open and close** outlet vents or windows in the roof of the building.
- The mechanism should use **cams and/or pulleys** to lift and lower the outlet vents or windows.
- the prototype should work in collaboration with **well positioned inlet vents** in the dairy barn design that draws in clean, cooler air.

The engineering design task

Can you create a simple mechanism to allow the farmer to open and close outlets on the roof to improve natural ventilation?

Good ventilation is essential for the health and well being of dairy cows housed in a barn. Keeping clean air circulating helps keep the cows comfortable and helps to prevent the spread of infection. Natural ventilation methods are low cost and more sustainable.

Top tips to get started:

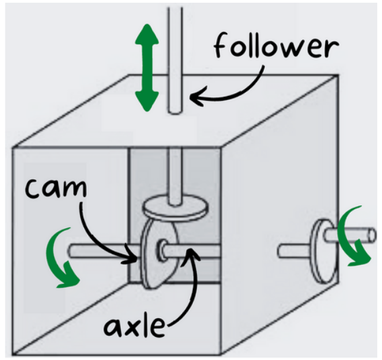
Will your outlet vents be opaque or transparent to also let in light?

Think about the simple machines you have learnt about in science. Which would be most useful for transferring a force from one place to another?

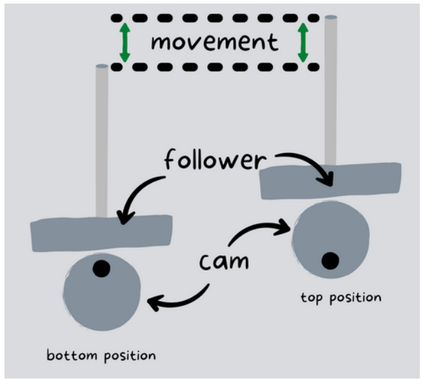
How could turning cams be used to lift and lower an outlet vent? Where would they need to be positioned in the dairy barn? How would the farmer turn the cams?

How could a pulley be used to lift and lower an outlet vent? What sort of structures might need to be added to make this possible?

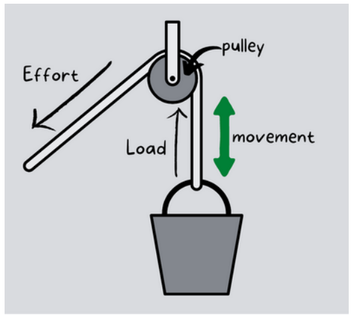
Background Information:



A **cam** mechanism has two main parts: a cam, attached to a **crankshaft** or **axle**, which rotates and a **follower** which touches the cam and follows the shape, moving up and down.Changing the shape of the cam changes the way the follower moves.



A cam changes a **rotating movement** into an **up and down movement**. If an **effort force** is applied to turn the cam, the follower will apply a force to lift and lower the load that rests on the top.



A single **pulley** changes the direction of force, making pulling down easier than lifting up. It doesn't increase the effect of the effort force but it can make it easier to apply a force when it is needed in a difficult to reach a location.

Glossary:

outlet - a vent installed in buildings to allow stale air to leave the building.
inlet - a vent installed in buildings to allow fresh air to be drawn into the building.
cam - a rotating piece in a mechanism that can turn rotating movement into linear movement.
follower - a piece of a mechanism that follows the movement of a cam.
axle - a rod or spindle passing through the centre of a wheel or cam.
pulley - a simple machine made from a wheel with a string or cord passed around the rim. It changes the direction of a force and is used to lift weights.
ventilation - the provision of fresh air into a room or building.
prototype - a first version of a device or mechanism from which other forms are developed.

More information and inspiration!

Take a look at this video from NUSTEM that shows different ways cams are used to make automata.

Want to take it further?

Can you adapt your design to be able to open the vent by different amounts to increase or decrease the flow of air? The farmer should be able to fully open, partially open and close the outlet from the ground.

How well did you do?

Success Criteria	Score /5
Operated by one person	
Outlet vent can be opened and closed from the ground	
The outlet vent can be both opened and closed	
The mechanism uses cams and/or pulleys	
The design includes an inlet vent to draw in fresh air	