Royal Academy of Engineering

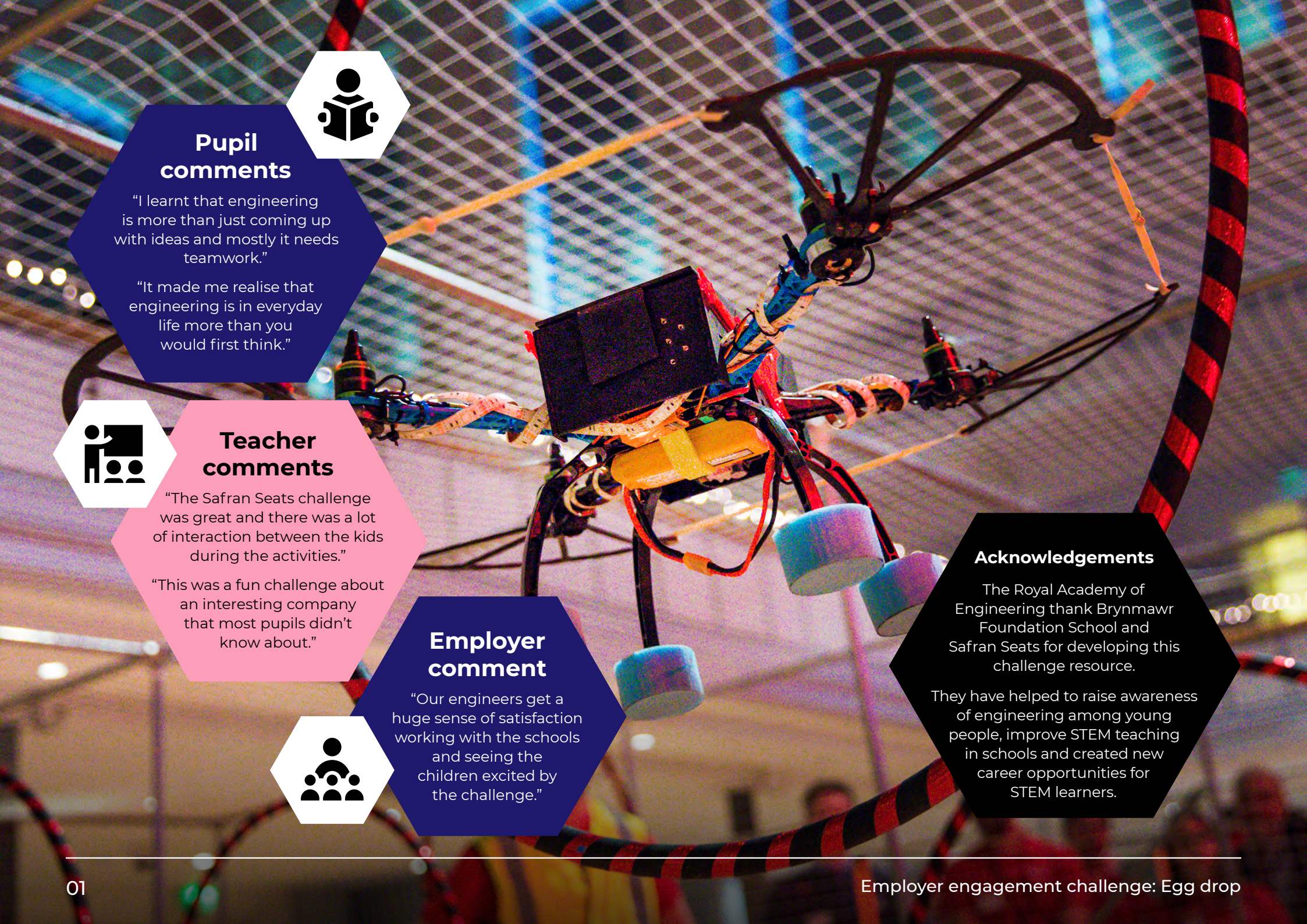
Employer Engagement Challenge

Egg drop

Can you design and build a landing system to safely drop air passengers?

Ariennir gan Lywodraeth Cymru
Funded by Welsh Government

THIS IS ENGINEERING



Pupil comments

"I learnt that engineering is more than just coming up with ideas and mostly it needs teamwork."

"It made me realise that engineering is in everyday life more than you would first think."

Teacher comments

"The Safran Seats challenge was great and there was a lot of interaction between the kids during the activities."

"This was a fun challenge about an interesting company that most pupils didn't know about."

Employer comment

"Our engineers get a huge sense of satisfaction working with the schools and seeing the children excited by the challenge."

Acknowledgements

The Royal Academy of Engineering thank Brynmawr Foundation School and Safran Seats for developing this challenge resource.

They have helped to raise awareness of engineering among young people, improve STEM teaching in schools and created new career opportunities for STEM learners.

Safran Seats

Safran Seats designs and manufactures aircraft seats to enhance the comfort and safety of air travel. Based in Cwmbran, Wales, it produces seats for various airlines, including Air New Zealand and Japan Airlines.

The company develops new technologies that help reduce the environmental impact of aircraft seats. These include lightweight materials, energy-efficient components and sustainable manufacturing processes.

The challenge

This challenge aims to inspire young learners to explore the concepts of physics, aerodynamics and safety. It is designed to be fun and engaging while providing students with a valuable learning experience.

Working in teams, students are encouraged to apply their engineering and collaborative skills to design and construct a landing device capable of protecting an egg from damage when dropped from a significant height. They will have the opportunity to apply their knowledge of material properties and construction techniques to create a successful egg drop device, learning about the forces of impact and acceleration when analysing the results.

During the challenge, teams will explore various materials to select the most suitable ones for the task and develop their communication skills while applying engineering and problem-solving throughout the process. When things go wrong, they will learn from the iterative design and manufacturing process, gaining insights from their mistakes along the way.

This challenge is designed to support practitioners to follow Curriculum for Wales' careers and work-related experience guidance. It is supported by a set of videos that give an inside look at how engineers at Safran Seats work, and introduces first-hand how the challenge is delivered in school.

The challenge is recommended for secondary school pupils and can be adjusted to match different age groups and abilities.

Here are some of the learning opportunities that the challenge provides:

- **Collaborative teamwork**
- **Creativity, design and build**
- **Material selection and testing**
- **Problem finding and solving**
- **Ethical and security considerations**

Challenge overview

Setting the class challenge

Safran Seats would like you to revolutionise its drone passenger service – a future where flying taxis transport customers to their destinations safely and securely.

Can you design and build a system that does this without risk or injury?

Welcome to the egg drop challenge. Your task is to design and build a landing device for a test passenger (the egg), which can safely cushion the landing from a height. Your landing device must be constructed from recycled and reusable materials.

You will be part of a team designing, testing and improving your landing devices. Get ready to collaborate, communicate and complete this challenge. The most successful landing device will be the one that keeps the egg safe from impact at the greatest possible height. The world record is 213 metres. Explore, experiment and enjoy this egg-citing challenge.

By participating in this challenge, young learners develop the skills and practices that engineers use every day in their professional lives.

Asking questions, imagining and planning ideas, creating and refining outcomes, while continuously reflecting on how things could be improved, are all 'Engineering Habits of Mind' as demonstrated in 'the Progressing to be an Engineer' cycle.

The Progressing to be an Engineer cycle

Learning opportunities	Core skills
■ Collaborative teamwork ■ Creativity, design and build ■ Material testing and selection ■ Problem finding and solving ■ Ethical and security considerations	**Literacy:** Reading and technical vocabulary. Selective research. Writing and reporting. Presenting and communication. **Numeracy:** Data collection and analysis. Pattern spotting. Measurements and calculation. **Scientific:** Problem-solving and experimenting. Visual and special awareness. **Technical:** Systems thinking and problem-solving. Communication and teamwork.

Engineering design process		Activity	Success will look like
0–1 hour	Research the challenge	**Watch the challenge videos** – engineers films **Time to research** – principles of physics and landing devices **Time to present** – findings from research	Understand the aims and requirements of the challenge, as well as how engineering concepts relate to it. Gather relevant information and have a clear and comprehensive understanding of the challenge.
1–2 hours	Ask	**Time to problem solve** – bouncing ball experiment **Time to question** – systems thinking	Identify problems and ask questions to understand how to resolve them. Explain how systems work while identifying ways they can be improved.
2–4 hours	Imagine Plan	**Time to imagine** – design and develop egg drop landing devices **Time to plan** – identify and plan each stage of manufacture	Draw and label multiple design ideas, effectively communicating fitness for purpose and why certain ideas are better than others Use simple annotated sketches to turn ideas into words and drawings. Plan a design that aims to solve a problem or task for a specific user, by transforming one idea into a better one.
4–6 hours	Create	**Time to create** – construct and test the landing device	Use knowledge of how systems and components work and interact to create a product that achieves a specific purpose. Evaluate the product's fitness for purpose and look to find ways to improve this based on observation and improvement.
6–7 hours	Improve	**Time to reflect** – on experiences in relation to each stage of the challenge	Test the outcome for quality using a logical approach gathering evidence to make an informed decision. Evaluate how the product is working, identifying areas for improvement and describe possible changes that can enhance the design.
7–8 hours	Present the challenge	**Time to present** – highlight the success of passenger deployment and landing	Communicate ideas effectively and with confidence, making complex concepts understandable to the audience. Engaging interactions and making a lasting impression.

Research the challenge

Ask

Imagine

Plan

Create

Improve

Present the challenge

Time to start

Begin by showing the class the set of three engineer videos that showcase the diverse range of engineering roles within the company. Each video is approximately three minutes long.

Go to **raeng.org.uk/wvep** or scan the QR code to watch the videos.

Ben: Mechanical design engineer

Bhacyashri: Mechanical service engineer

Thomas: Electrical design engineer

The aim of this first activity is to explore scientific and engineering concepts relating to energy, forces and landing devices.

Students work in teams to research and investigate one of the four given topics and then present their findings to the class.

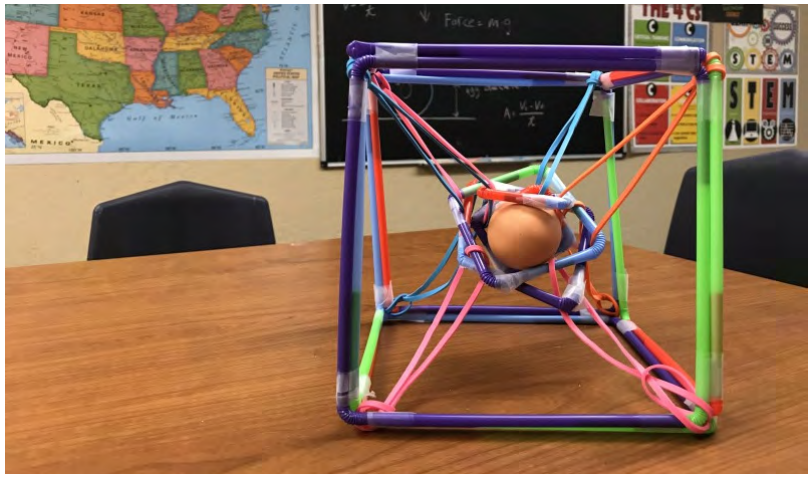
Time to research

Start by introducing the four topics to be researched.

Briefly explain the importance of each topic in the context of the challenge and how engineering and physics apply to real-world applications.

1. **Kinetic and gravitational potential energy**.
2. The force of **gravity** and properties of matter – **mass and weight**.
3. Kinematics – **acceleration and velocity** and fluid mechanics – **drag and resistance**.
4. Different types of **landing crafts and devices** to secure passengers and absorb impact.

Provide a list of pre-approved websites related to the topics to save time and ensure they access reliable and relevant information.



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Time to research – *continued*

Instruct teams to work together to conduct in-depth research on their respective topics, while making notes and sketches of key concepts, examples and applications.

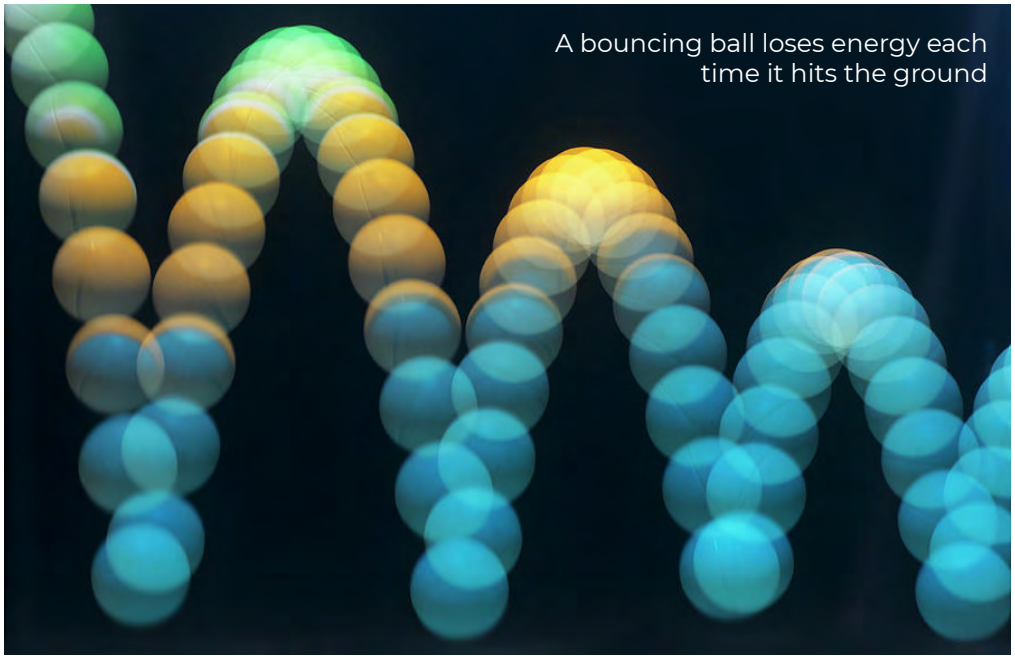
Ask them to explore how each topic is inter-related to the success of designing and making landing devices capable of safely and securely landing passengers.

Time to present

Give each group an opportunity to present their findings to the class and emphasise the importance of each team member's involvement in some aspect of the presentation.

They can use posters, drawings or verbal explanations to share the information they have found. Encourage the other students in the class to ask questions and engage in discussions after each presentation.

By researching and analysing the relationship between energy, forces and landing devices, the students will uncover valuable insights that contribute to their creative problem-solving and innovative designs in later activities.



A bouncing ball loses energy each time it hits the ground

An engineer working on seat safety

Time to problem solve

The aim of this activity is to understand the scientific principles when an object with mass impacts a surface.

Dropping someone (or an egg) out of a drone taxi from the sky could be dangerous and may lead to serious injury. Therefore, understanding and establishing safety should always be a top priority.

Further investigation with a 'non-human or non egg' test subject is required before the design and planning stage can begin.

Divide the class into teams of three or four students.

Provide each team with a bouncy ball and a one metre measuring tape or ruler. Choose a suitable location where they can safely drop the ball.

Ask teams to conduct the following experiments and record their observations for each trial.

1. Drop the bouncy ball from one metre and measure the bounce height and the time it takes to reach this height.
2. Repeat the same procedure from both two and three metres.
3. Perform multiple trials for each height to ensure accuracy.
4. Repeat the process with a foam or sponge landing area.

The video function on a mobile phone could come in handy for this activity.

After collecting the data, ask teams to analyse their results and identify any patterns or trends they observe in the bounce heights for different drop heights.

Bring the teams together and discuss their findings as a group. Guide them to draw conclusions about the relationship between the drop height, bounce height and the conversion of gravitational potential energy to kinetic energy.

Materials

- Bouncy ball
- Stopwatch or mobile phone with video function
- Measuring tape or ruler
- Graph paper or Excel spreadsheet

Time to question

Systems thinking is "explaining how things work together and why each part is there".

Discuss the following questions as a group and facilitate the conversations in class.

Systems thinking questions	
1	How can you ensure the safety of passengers and not endanger lives?
2	What considerations should be given to the emotional impact on passengers when designing a drone taxi that drops them rather than providing a traditional landing experience?
3	How will the drone taxi system handle unexpected situations, such as inclement weather during the drop-off process?
4	How can the drone taxi's onboard systems be designed to accommodate passengers with limited mobility during the drop-off process?
5	What are the potential challenges associated with dropping passengers from a moving drone taxi, and how can these be addressed effectively?

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Time to imagine

The aim of this activity is to design landing devices that can protect an egg from breaking when dropped from a designated height.

In teams, students design and sketch ideas for their drone taxi egg drop landing device. They should incorporate features including safety and functionality, which they have researched and investigated in previous activities.

Teams should be as creative as possible, using colour to present the decorative aspects of each design effectively.

Encourage them to think innovatively about ways to make the landing device user-friendly, sustainable and visually appealing.

Further information before designing your landing device

Here are some further requirements to follow:

- The egg passenger must always remain seated during the landing phase
- The seat can be repaired after each landing
- A new seat can be used for each landing

Helpful tip

- Seats absorb impact
- Heavy seats have heavier landings
- Other factors that may affect the result include the size of the seat, the material it is made from and the shape of the seat

A Safran Seat aircraft product

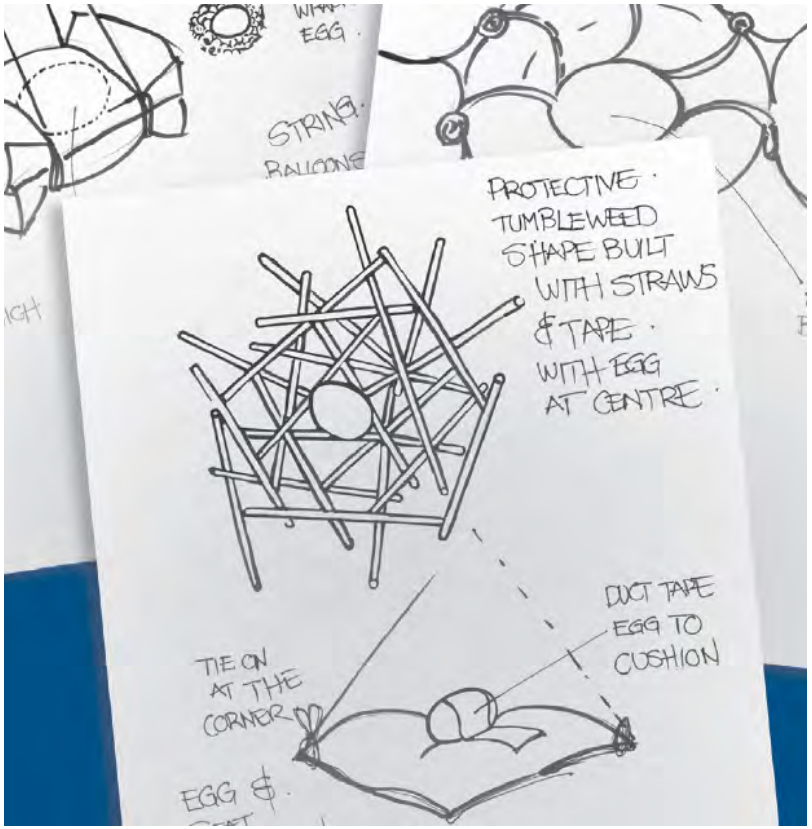
Initial design ideas

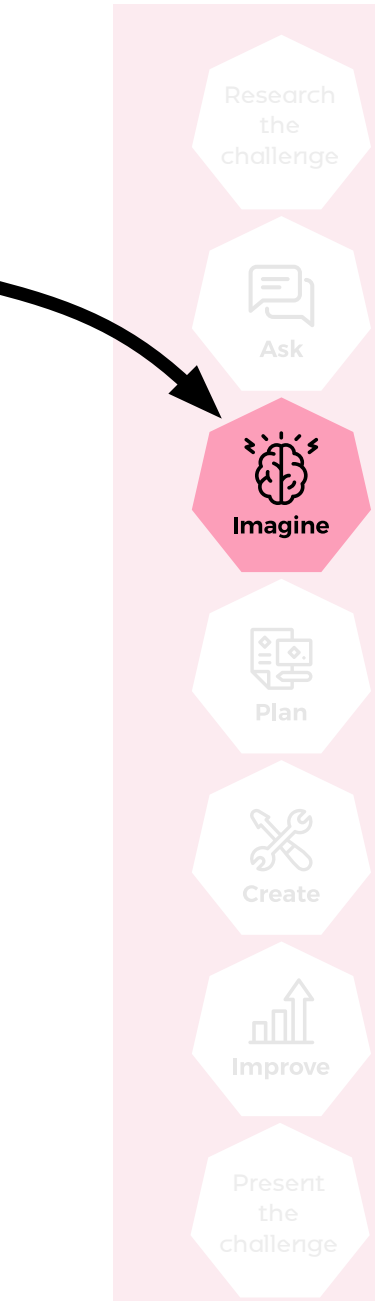
Draw and label several concept ideas of what the landing device will look like and how the landing device will be constructed. Describe its physical structure and functionality.

Consider how to create secure fixings and safety net features, as well as drag force and uplift air flow systems.

Describe how the device will work and include notes, calculations, measurements, plus any relevant research undertaken.

Encourage students to share ideas and collaborate, fostering discussions to refine their designs collectively.





Development of ideas

Ask teams to review all of the initial design ideas and establish a ranking system. Use scores to determine the preferred designs and those that need improvement.

Students should consider safety, use of materials and the overall aesthetics of each landing device design.

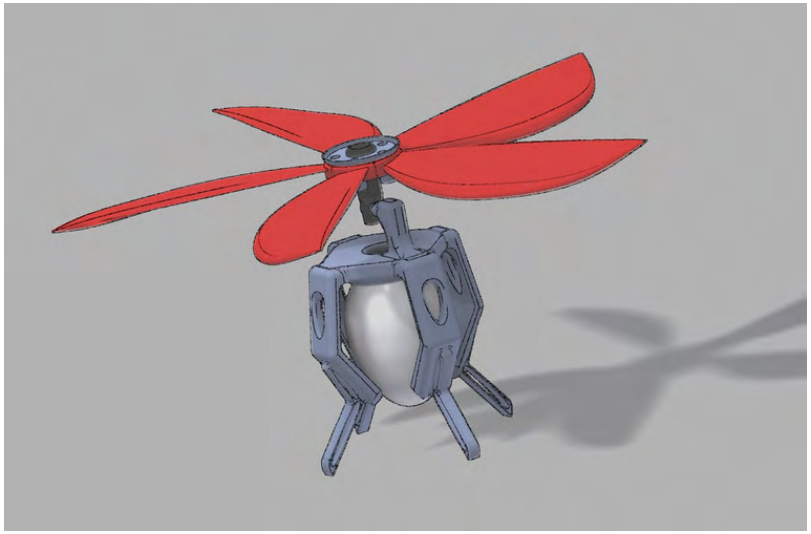
The cumulative scores for each design should play a role in shaping the decision regarding which ideas to develop further.

Final design

Ask teams to produce final designs or CAD drawings using computer aided design software.

These should be three-dimensional or drawn from various angles to illustrate the landing device. They should be fully rendered and include information about how the device will be constructed and what materials will be used.

Students share the final designs within the team and discuss which features should and should not be incorporated when building the landing device.



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Time to plan

The aim of this activity is to outline each stage of manufacturing for the landing device, using recycled and sustainable materials.

Before building begins, ask students to plan each step of manufacturing the egg drop landing device. This will involve cutting, shaping and assembling the materials according to the chosen final design. Establish quality control measures to ensure the design meets the required standards. Check for any weak points or defects in the manufacturing process that could lead to an unsuccessful test run.

Decide on the materials that will be used to construct the egg drop device. Provide teams with a selection of recycled, reused and repurposed materials to choose from. Consider lightweight yet sturdy materials capable of absorbing impact forces.

Materials

- Containers, like cardboard tubes, cups, boxes, etc
- Recycled materials, bottle caps, cardboard tubes, etc
- External protection materials, like balloons, sponges, rubber bands, craft sticks, straws, etc
- Internal padding, packing materials, bubble wrap, tissue paper, etc
- Eggs, tape and scissors

Ask teams to consider the mechanical properties of materials such as strength, weight, flexibility and impact resistance, before selecting which materials to use based on the designs they have drawn.

They should also take into account the outer structure, cushioning, and protection for the egg, external protection systems and any other additional features they wish to include.

Research the challenge

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Time to create

The aim of this activity is to construct and test a landing device that protects an egg from breaking when dropped from a designated height.

In teams, ask students to start building their egg landing device based on their chosen designs, materials and manufacturing preparations. Provide guidance on using tools safely and effective techniques.

Before testing, ask teams to trial the drop without the egg and discuss observations and patterns. Predict the success of the trial and record these predictions.

Head to a designated testing area. Drop each egg landing device from a consistent height. Ensure safety measures are in place. Record whether the egg survives or breaks upon impact. Use slow-motion video if possible to analyse the device's performance.

Inspect the landing device for damage and gather results. Ask teams to analyse the impact forces and acceleration experienced by the egg landing devices during the drop.

Design iteration

Design iteration encourages critical thinking and problem-solving, as well as teamwork and creativity.

Based on the test results and observations, ask teams to discuss factors that contributed to the success or failure of each drop.

If the drop was successful, ask them to increase the drop height. If it failed, guide them to identify areas for improvement in the design and build process. Ask them to implement any necessary changes and fine-tune the egg landing device for better performance. This can involve altering the design, materials or construction techniques.

Instruct each group to test their landing device at least three times.

Teams testing the landing pad for their egg drop

Time to reflect

Success can be based on the skills students develop and the practices they acquire throughout each stage of the challenge.

These include the ability to ask questions, imagine and plan ideas, create and refine outcomes, while continuously reflecting on how things could be improved.

Engineers also demonstrate the following practices as part of their day-to-day activities.

- Problem-finding and creative problem-solving
- Systems thinking and visualising
- Adapting and improving
- Teamwork and collaboration
- Project and time management

At the end of the challenge, gather teams for a post-challenge debrief. Encourage them to reflect on their experiences and assess their personal growth in relation to the skills they have developed and practised throughout the challenge.

Research the challenge

Ask

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Present the challenge

Present the challenge

Time to present

The aim of this final activity is to present outcomes, explain choices throughout the challenge and highlight what went well and what could be improved.

This should be a group task where every member of the team contributes to the presentation in some way.

The presentation can be divided into the following sections.

1. A summary of the final product and its features.
2. What went well during the design and building process.
3. What challenges they faced and how they overcame them.
4. How the outcome could be improved or enhanced.

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Together we're working to tackle the greatest challenges of our age.

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