



Royal Academy
of Engineering

THIS IS
ENGINEERING

SUSTAINABLE
FUTURES

INNOVATION
CHALLENGE

Deadline: 1 April 2022



INTRODUCTION

SOME OF THE BIGGEST CHALLENGES WE FACE STEM FROM HOW WE INTERACT WITH OUR ENVIRONMENT, AND ENGINEERING IS AT THE HEART OF FINDING SUSTAINABLE SOLUTIONS.

From renewable power and recycling to making our homes more energy efficient, this is a vital field.

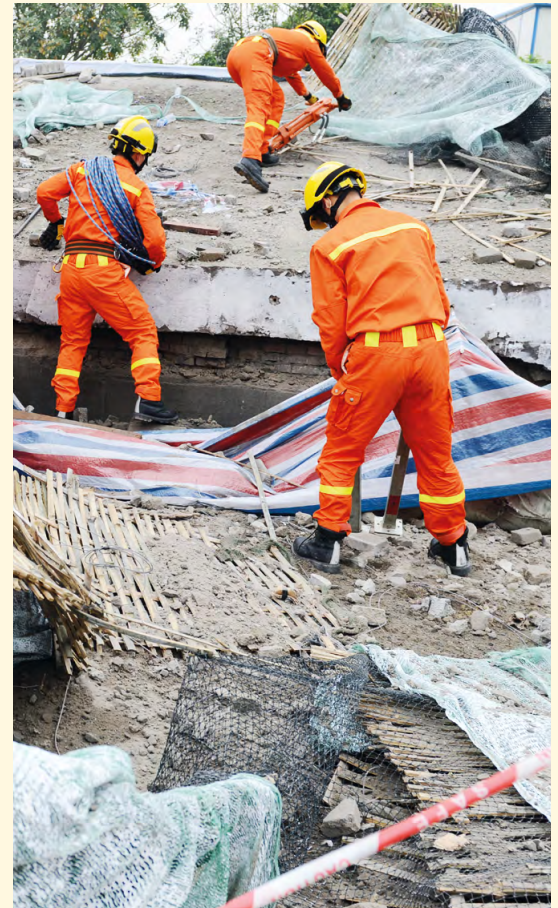
In a changing environment, what makes a hero?

Whatever change you want to make,

choose engineering and be the difference.

Check out the *Help the environment - This is Engineering* video at:

<https://www.thisisengineering.org.uk/what-interests-you/the-environment/>



ENVIRONMENTAL DAMAGE CAUSES NATURAL DISASTERS INCLUDING LANDSLIDES

THE COMPETITION

WE ARE INVITING YOUNG PEOPLE TO BECOME ENGINEERS AND SHARE THEIR IDEAS FOR INNOVATIONS THAT WORK TOWARDS A SUSTAINABLE FUTURE FOR OUR PLANET AND OUR GOAL OF REACHING NET ZERO AS A COUNTRY.

The challenge asks you for creative solutions to tackle some of the biggest problems that are creating carbon emissions and impacting our environment.

All teams who enter have the chance of being invited to events across the country, including an event in London at the Royal Academy of Engineering, where you'll be able to share your ideas with engineers. All finalists will receive £1000, with three finalist teams in for a chance to win an enhanced prize of £2500 for their school.

We want to reward all teams who enter for their commitment to STEM and sustainable development. Every member of each team that enters a complete submission will earn a Royal Academy of Engineering digital STEM badge.

Where do I submit?

Submit your competition entries and claim your digital STEM badge at rae.mindsetsonline.co.uk

All entries must be in by **1 April 2022**.

SUSTAINABLE FUTURES
INNOVATION CHALLENGE BADGE



SUSTAINABLE FUTURES DESIGN CHALLENGE

THE UK HAS SET ITSELF A TARGET TO BE CARBON NEUTRAL, OR REACH 'NET ZERO' BY 2050.

What do we mean by 'net-zero'?

Net zero refers to achieving a balance between the amount of greenhouse gas emissions produced and the amount removed from the atmosphere.

When the amount of carbon emissions produced are cancelled out by the amount removed, the UK will be a net-zero emitter.

The lower the emissions, the easier this becomes.

The UK has reduced its carbon emissions steadily over the last 30 years (although levels have risen globally). In 2018, UK emissions stood at 57% of their 1990 levels.

Despite this, we are still a long way from meeting net-zero targets. To work towards a sustainable future, the UK must work with countries around the world on the frontline of fighting climate change.

What is my carbon footprint?

It is mainly human activities that create carbon emissions: the heating in homes and offices, the electricity we use, the food we eat, the products we buy, our waste and how we travel.

Your carbon footprint is the total amount of greenhouse gas emissions, including carbon dioxide (CO₂), generated by you directly and indirectly. By calculating our carbon footprint, we can learn how we are contributing to the rise in atmospheric CO₂ and how we can reduce this.

Visit the World Wide Fund (WWF) at <https://footprint.wwf.org.uk> and calculate your carbon footprint (you might need some help from a parent, guardian or teacher to answer some of the questions).

Are you surprised by the results? How do you think you could reduce your carbon footprint?



**FOR
YOUR
WORLD**

Growing by the second

Visit <https://www.worldometers.info/world-population/> and explore this tool that shows population growth in real time!

In small groups, discuss the following:

- Which countries have the largest population?
- What is the projected global population for 2060?
- What was the global population in 1990?
- How has the yearly growth rate changed in the last 70 years?
- What other information do you find interesting or surprising on this website?
- Why is this information useful when thinking about sustainable futures and carbon emissions?

Check out theworldcounts.com for more live world data. This could help your project research.

So what's the problem?

In 2021, the world population is approximately 7.8 billion people.

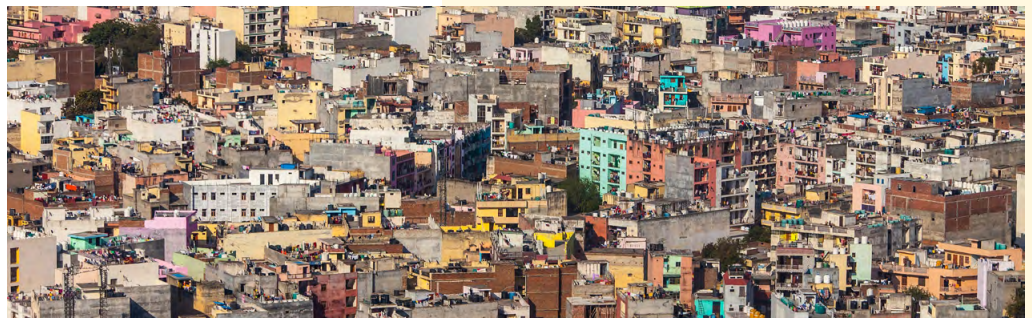
Carbon dioxide levels today are higher than at any point in at least the last 800,000 years.

By 2050, planet earth will support more than 9.5 billion people. According to the UN, by then we will need 60% more food, 40% more fresh water and 50% more energy.

How can we work together to relieve planet Earth from the increasing pressure of human activity?

Engineers are at the heart of finding solutions for sustainable development. This means enabling all people to get their basic needs and enjoy a better quality of life, without putting pressure on our planet and compromising quality of life for future generations.

Engineers find solutions by working in teams to come up with creative ideas that impact the way we live our lives.



THE CHALLENGE

WE THINK THAT EVERYONE CAN THINK AND ACT LIKE AN ENGINEER!

We want to hear about your ideas for creating a more sustainable future.

Enter our *Sustainable futures design challenge* for a chance to share your ideas with real engineers, be invited to Academy events with your team and to win STEM goodies for you and your school.

Choosing one of the themes that you can find on **pages 12 and 13**, we want you to think of an **innovation in technology or society** or an innovative **system or product** that could help address that challenge.

Who can enter?

We are looking for individual students or teams of up to six people.

The competition is open to all young people based in the UK.

There are two categories:

- 9- to 11-year-olds
- 11- to 14-year-olds

What to submit

- Outline the challenge you are tackling – back this up with evidence (see **page 15** to get you started with problem finding).
- Explain what your innovation hopes to achieve and how it works towards a sustainable future (see **page 16** to get you thinking about your solution).
- Draw or design a model of your innovation or build a prototype using recycled materials.

We want to see creativity within your submissions, so will accept videos, vlogs, photographs, poster presentations and everything inbetween if you think it will help explain your solution and bring your idea to life.

Remember!

You must reference any sources that you use in your submission.



CHALLENGE TIMELINE

SUSTAINABLE FUTURES INNOVATION CHALLENGE 2021/2022

28 September

Gitanjali Rao 'How to be an innovator' webinar. Register at <https://stemresources.raeng.org.uk>

November

Teams should be working on finding a solution to the problem they have identified.

November to January

Teams should be working on making and testing their solution.

1 April

Challenge closes. Internal judging begins.

Submit entries on or before this date.

Applications can be submitted to rae.mindsetsonline.co.uk

May

Twenty shortlisted teams take part in a virtual judging process. Alongside this, each team will take part in their own STEM experience and join for a Q and A session with a panel of engineers.

June

Regional winners attend a prize giving celebration event at the Royal Academy of Engineering with a chance to win an enhanced prize of £2500.

SEP
2021

OCT
2021

NOV
2021

DEC
2021

JAN
2022

FEB
2022

MAR
2022

APR
2022

MAY
2022

JUN
2022

1 October


Challenge officially launches.

Throughout October

- Introductory lessons and activities that provide context for the sustainability challenge. These can be found in the 'Sustainable futures innovation challenge booklet' and the 'Sustainable futures student guide'.
- Decide on your teams. Teams can be up to six people. We are also accepting individual entries.
- Choosing one of the 'Big Challenges', investigate a sustainability problem.

January

- Teams should be working on putting their project portfolio together.
- Teams could be working on their video pitch if they decide to include this as part of their submission.



Competitions
You can submit entries here for the Sustainable Futures Innovation Challenge.

[Submit entry](#) [More info](#)

The activities highlighted on the timeline above are just a suggestion to guide students through the challenge.

YOU CAN SUBMIT...

PROJECT PORTFOLIOS

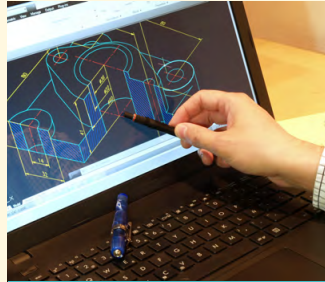
These should tell the story of your innovation journey. Project portfolios can be a Word, PDF or PowerPoint document. Your portfolios can include:



PHOTOGRAPHS



VIDEOS



CAD DRAWINGS



VIDEO PITCH



PROTOTYPES & PHYSICAL MODELS



DRAWINGS & SKETCHES



APP DESIGNS & WIREFRAMES

VIDEO PITCH

You can also submit an optional video pitch along with your project portfolio.

The video (max two minutes in length) should provide an engaging overview of your solution and the problem it solves.

When you submit:

- Decide on a team name
- Save all your files with your team and school name
- Send all your files to your teacher who will submit
- Include your year group on your submissions.

We recommend you spend between 5 and 10 hours on this project.

WHAT ARE WE LOOKING FOR?

OUR JUDGES WILL BE LOOKING OUT FOR THE FOLLOWING:



Addressing the challenge and problem finding

- Have you shown a good understanding of the problem?
- Why is it important?
- What impact is it having on our planet and carbon emissions?
- How can you demonstrate this through your own work?



Quality and creativity of the solution

- Does your solution address the problem you have identified?
- How does it stand out?
- Does it provide something new or improve an existing product or service?



Presenting your idea

- How have you communicated your ideas?
- Does your presentation clearly explain your idea?
- Can you demonstrate your design and engineering journey?



Scaling up your idea

We will also be looking for entries that can be built in a larger scale. Three finalists will be chosen based on not only their idea, but whether we can recreate a life-size model of their project.

**This is not an essential criteria.*

WHAT DO WE MEAN BY...

A product is an object or system for consumer use.

A service is a transaction where no physical goods are transferred from a seller to a buyer. A service is seen as a type of product.

A system is a set of rules, an arrangement of things, or a group of related things that work toward a common goal.

HOW DO I SUBMIT?

Sharing your entry with us is super easy!

Submit your entry, along with all supporting materials to rae.mindsetsonline.co.uk

All entries must be in by **1 April 2022**.

WHAT CAN I WIN?

Win up to £2500 to enhance STEM at your school!

Invitation to regional and national events where you can share your idea with engineers.

All entries will also receive a digital STEM badge.



AWARDS AND EVENTS

Gitanjali Rao webinar

To launch the competition, we are hosting a webinar with Gitanjali Rao on the 28 September. Gitanjali is an author, inventor and STEM innovator who was awarded Top Young Scientist for Tethys, a device she developed that detects lead contaminated in water.

She will be leading an interactive session, introducing innovation and creative real-world problem solving. The session will give you an understanding of the role innovation has in engineering solutions and get you started on your journey through the Sustainable Futures Innovation Challenge.



At your school

Every team that submits an entry to rae.mindsetsonline.co.uk will receive a digital STEM badge.



Shortlisted teams

Shortlisted teams will be invited to a virtual event where they will have the opportunity to:

- Showcase their project portfolios and innovations to a panel of judges
- Participate in their own virtual STEM experience
- Meet engineers and STEM professionals from local industry
- Join in a Q and A panel discussion with STEM professionals

Shortlisted teams will receive individual prizes and schools will receive prizes to enhance STEM within the school.



Final celebration event

From the shortlisted teams, finalists will be selected. They will be invited to the Royal Academy of Engineering for a prize giving celebration event.

Finalists will have the opportunity to present their projects to another panel of judges as well as engineers and others working in STEM.

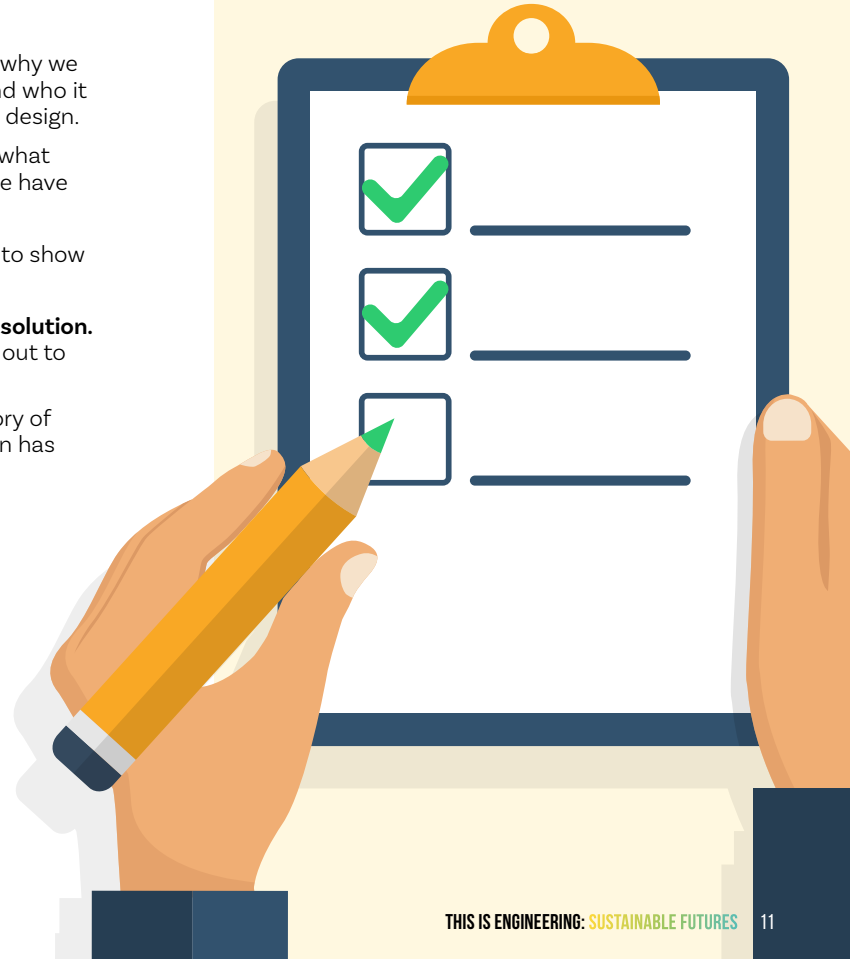
Every team that makes the final will win a team prize as well as £1000 to enhance STEM at their school. Three of the finalist teams will also win £2500 to enhance STEM at their school.

Prizes will be presented to the finalists by a special guest of the Academy.



CHALLENGE CHECKLIST

- We have clearly outlined a problem.** We have explained why we think it is a problem, how it impacts the environment and who it affects. Our problem is narrow enough to be solved by a design.
- We have a clear solution to this problem.** We can show what it does and how it tackles the environmental problem we have identified.
- We have used** sketches/models/prototypes/app design to show how our solution will work.
- We have shown how we have tested and evaluated our solution.** We have shown how we have used what we have found out to adapt our solution or next steps to take.
- We have prepared a project portfolio** which tells the story of our innovation challenge journey, shows how our solution has developed and talks of the challenges we faced.
- We have prepared** a two-minute video pitch (optional)
- We have shown how this solution is affected** by larger environmental, social, or economy systems
- We have referenced** all our research information, claims made and images used.
- All of the files are saved** with our team name, school name and year group.
- Our teacher has uploaded** our project portfolio rae.mindsetonline.co.uk



THE BIG CHALLENGES

WE HAVE CHOSEN FOUR AREAS THAT WE FEEL ARE SOME OF THE BIGGEST CHALLENGES OUR SOCIETY FACES AS WE WORK TOWARDS A MORE SUSTAINABLE FUTURE.

Choose one of these challenges for your sustainable futures design challenge.

1 Travel and transport

This could include looking at fuel we use for cars, buses and aircrafts.

However it is not just about making existing transport more fuel efficient, it is about reimagining the system: redesigning spaces that reduce the number of cars on the road, ideas that reduce the need for air travel or that encourage more people to walk and cycle.



2 Food systems

This could include looking at where our food comes from, what food we eat and how it impacts the planet.

You might want to explore how our food is packaged, and what we do with packaging and food waste.

What about eating out at restaurants, cafes and your school canteen?



THE BIG CHALLENGES

3 Our homes and habitats

This could include the energy we use at home or at school.

You might want to look at how we heat and insulate our homes.

Over one billion people live without access to reliable, modern energy for their homes, schools and businesses so you might want to look at 'off-grid' energy solutions.



4 Our lifestyles and what we consume

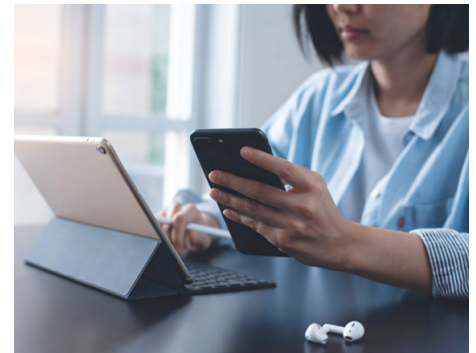
This could include our shopping habits.

Where do our clothes and electronics come from?

How are they made?







What do we do with them once we no longer want them?

What about our hobbies and the impact that they might have on the environment?



ENGINEERING HABITS OF MIND

I AM GOOD AT...

 Problem-finding	 Creative problem-solving	 Systems thinking	 Visualising	 Adapting	 Improving
Thinking about the world around me and how it could be better	Coming up with lots of new and good ideas	Spotting patterns and working out what comes next	Thinking out loud when I am being imaginative	Deciding how something could be done differently	Making what I have done better
Finding out why something does not work	Working successfully in a group	Using ideas from one subject in another	Making a plan before I start work	Explaining how well I am doing to my teachers or friends.	Experimenting with things just to see what happens
Finding mistakes in mine and other people's work	Taking on board other people's ideas and using them	Putting things together to make something new	Practising something in my head before doing it for real	Evaluating how good something is	Working hard and practising to get better, even when it's tricky
Checking and checking again until I am happy	Making detailed mind maps	Spotting similarities and differences between things	Explaining my ideas to other people so they understand	Behaving appropriately in different settings	Working out what I need to do to improve
Asking lots of questions to make sure I understand	Thinking first before doing something	Working out the possible consequences of something before they happen	Making models to show my ideas	Sticking up for what I think when talking with other people	Sticking at doing something until it's the best it can be
<p>The quiz and student statements are based on EHoM research supported by the Royal Academy of Engineering and published in Hanson, J., Hardman, S., Luke, S., Maunders, P. & Lucas, B. (2018) Engineering the future: training today's teachers to develop tomorrow's engineers. London: Royal Academy of Engineering.</p>					

USING YOUR 'ENGINEERING HABITS'

THE 'ENGINEERING HABITS' DESCRIBE THE WAYS IN WHICH ENGINEERS THINK AND ACT — AND WE WANT YOU TO THINK AND ACT LIKE AN ENGINEER!

Take the ['engineering habits' quiz](#) to find your engineering habits and find out more about what each of the different engineering habits mean.



Problem finding

Once you have decided on a general area you want to investigate, you will need to decide on a problem

you are going to solve linked to that theme. Choose something that you feel passionate about and start researching the problem in more detail, and how this problem impacts the world around you.

*Remember, you can't solve everything!
Keep your problem clear and focused.*

You will need to show us that your problem is a 'real problem'. To do this, you will need to back this up with evidence that you uncover through your research.



Documentaries



Sustainable Futures Student Guide



Your lessons



Interviewing

RESEARCHING THE PROBLEM YOU WANT TO TACKLE



News articles



Magazines

Remember!

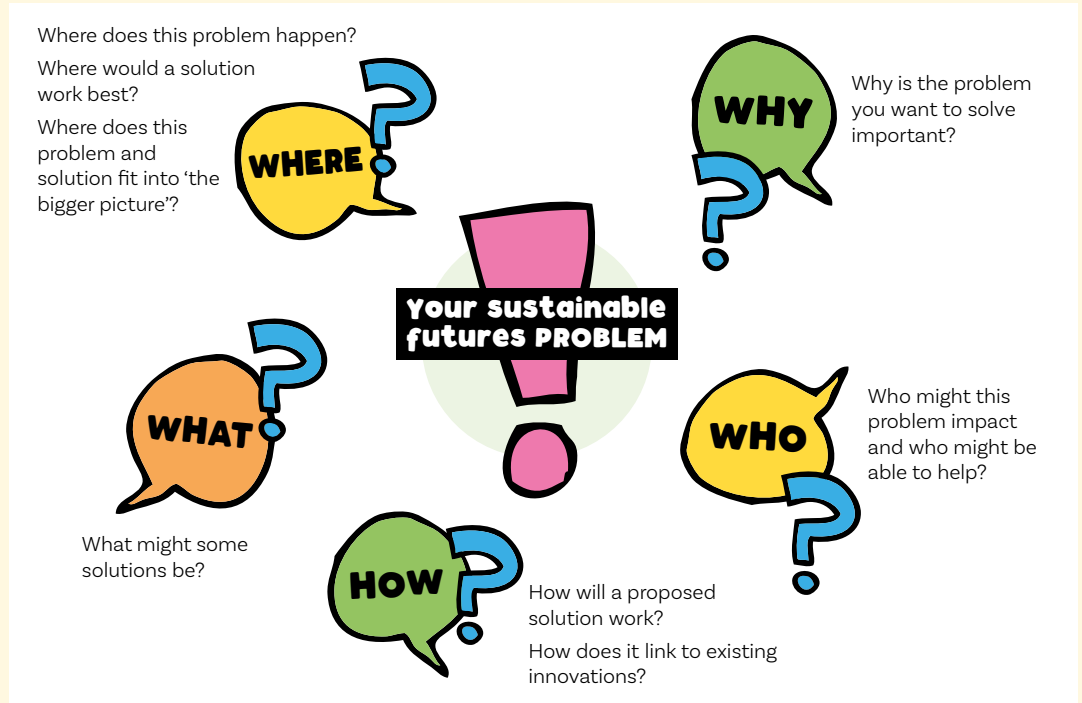
You must reference any sources that you use in your submission.

CREATIVE PROBLEM SOLVING AND SYSTEMS THINKING



ONCE YOU HAVE IDENTIFIED YOUR PROBLEM, YOU MIGHT FIND THAT ANSWERING THESE QUESTIONS IS HELPFUL IN GENERATING IDEAS FOR POSSIBLE SOLUTIONS TO THAT PROBLEM.

Doing lots of research and asking questions about your problem is important to coming up with an impactful solution.



VISUALISING, ADAPTING AND IMPROVING



NOW IT'S TIME FOR YOU TO START WORKING ON YOUR SOLUTION.

This will be an *iterative* process. This means that you will revisit and reflect on your solution and refine your design ideas to ensure that the solution is tackling the problem you identified, always looking to improve what you are doing.

You might find that you will be looking at and analysing existing ideas. You might want to adapt existing products or ideas, or think about how they could be done differently.

Throughout this whole process you will need to be thinking about how you communicate your ideas, whether it's brainstorming or making a plan with your team before you start work.

You will also need to think about how you demonstrate to others what your final ideas are. This could be through models, drawings, diagrams, or verbal explanations.



IDEAS AND INSPIRATION

Explore some of the groundbreaking engineering innovations tackling some of the biggest sustainability and environmental problems we are facing for ideas and inspiration for your own innovations and competition entry.

Find more stories around engineers working in the circular economy at [Engineering X](#).

Engineering X
Founded by the Royal Academy of Engineering and Lloyd's Register Foundation

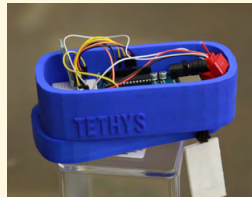
WATER SAFETY

The problem: The Flint, Michigan water crisis, when water in the city was contaminated with lead. Home test strips were available, but results were inconclusive and unreliable.

The solution: Tethys. This is a small, mobile device that tests for lead in drinking water. Tethys was designed and developed by Gitanjali Rao when she was 11 years old.

How it works: Carbon atoms link together in a beehive shape and connect to create a tube – a nanotube. The carbon nanotubes respond to changes in the electron flow. If there is lead in the water, the lead sticks to the carbon ions, creating resistance. Tethys measures that resistance, and sends the data to a smartphone app to give the status of lead in water.

Scientist and inventor Gitanjali Rao is inspiring other young people around the world to find their passions and to become innovators for positive change.



Gitanjali Rao, Scientist and inventor

TOILETS & SANITATION

The problem: Two billion people around the world do not have access to safe sanitation, and 60% of the world's waste is disposed of unsafely.

The solution: Loowatt is a company that has designed a toilet that does not use any water to flush. It is part of a system that allows the waste to be converted into energy. It was invented in 2008 by engineer Virginia Gardiner.

How it works: The toilet bowl has a liner that wraps the waste and pulls it into a barrel below with each flush. The waste, smells and germs are sealed away, and a clean bowl is left after each flush. Loowatt has also invented a machine that separates the waste from the liner. The waste can be converted into fertilizer or biofuel. The liner can be composted or recycled. They use a 'circular' system and aim for zero waste from the process. Their toilets are being used in homes around the world, but also at festivals and large events.

Visit www.loowatt.com to find out more.



Virginia Gardiner, Inventor, engineer and CEO of Loowatt

MUSEUM OF ENGINEERING INNOVATION



Royal Academy
of Engineering

Scan the QR code to visit the Museum of Engineering Innovation for more stories of engineers that are making a difference to our every day lives.

#BeTheDifference



THIS IS
ENGINEERING
MUSEUM OF ENGINEERING INNOVATION

BRICKS

The problem: Traditional clay bricks use a large amount of energy when firing. They cannot always be recycled and their insulation properties could be improved.

The solution: K-Briqs. These are bricks made from more than 90% recycled materials, using construction and demolition waste.

How it works: It looks and behaves like a clay brick and weighs the same but offers better insulation properties. The bricks don't need to be fired, so produce just 10% of the carbon emissions that standard bricks create. At the end of their life, bricks can be ground back down to create new K-Briqs.

K-Briqs will be used to create [2021's Serpentine Pavilion](#).

Read more about K-Briqs by visiting the [Museum of Engineering Innovation](#).



A member of the architecture team, Counterspace, who are using K-Briqs to design the Serpentine Pavilion.

MUSIC & LEARNING

The problem: Low-cost and low-weight instruments to replace heavy and expensive metal counterparts so that playing instruments becomes more inclusive.

The solution: The pBone plastic trombone. This is a trombone made from recycled ABS plastic. It is particularly popular with younger players who have difficulties with the weight and balance of a metal trombone.

How it works: The pBone weighs less than a kilogram and costs a tenth of its metal cousin. It draws on methods used to manufacture fibreglass fishing rods and 3D printed design. A quarter of a million brightly coloured trombones made of recyclable plastic can now be found worldwide.

Read more about the pBone by visiting the [Museum of Engineering Innovation](#).





Royal Academy of Engineering

The Royal Academy of Engineering is harnessing the power of engineering to build a sustainable society and an inclusive economy that works for everyone.

In collaboration with our Fellows and partners, we're growing talent and developing skills for the future, driving innovation and building global partnerships, and influencing policy and engaging the public.

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

What we do

Talent & diversity

We're growing talent by training, supporting, mentoring and funding the most talented and creative researchers, innovators and leaders from across the engineering profession.

We're developing skills for the future by identifying the challenges of an ever-changing world and developing the skills and approaches we need to build a resilient and diverse engineering profession.

Innovation

We're driving innovation by investing in some of the country's most creative and exciting engineering ideas and businesses.

We're building global partnerships that bring the world's best engineers from industry, entrepreneurship and academia together to collaborate on creative innovations that address the greatest global challenges of our age.

Policy & engagement

We're influencing policy through the National Engineering Policy Centre – providing independent expert support to policymakers on issues of importance.

We're engaging the public by opening their eyes to the wonders of engineering and inspiring young people to become the next generation of engineers.

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