Pack

Science Hunters: Engineering for Sustainable Societies

Using Minecraft to engage children
with engineering and
the Sustainable Development Goals

Building sustainable communities resource pack

Science HUNTERS

Engineering for Sustainable Societies

UWE Bristol University of the West of England

SCU | science communication unit

Royal Academy of Engineering | Ingenious

Contents

Resources are available from:
https://go.uwe.ac.uk/EngineeringforSustainableSocieties

This project was supported by the Royal Academy of Engineering under the *Ingenious Awards* scheme.

Science Hunters: Engineering for Sustainable Societies

Science Hunters is a programme which **engages and enthuses children about science** using the popular, construction-based computer game **Minecraft**.

It is run by environmental scientists who specialise in communicating science to children and young people, especially those facing barriers to accessing educational opportunities. Previous research has shown the Science Hunters approach to be effective in increasing subject knowledge and understanding, and improving social communications skills; for more information please see the programme website.

Engineering for Sustainable Societies delivers activities and resources to help children from under-represented backgrounds discover the many facets of engineering involved in sustainable development, and provide them with opportunities to apply their newfound knowledge by creating their own model sustainable solutions and communities in Minecraft.

Resources have been made freely available on the project webpage. There you can find 12 Minecraft-based session outlines, each relating to a different element of engineering and the UN's Sustainable Development Goals (SDGs).

These are available individually, and as this 'building sustainable communities' pack aimed at those wishing to use the sessions as a series. A 'resource guide' sits alongside this pack, to provide information on how it might be used.

These 'building sustainable communities' topics are designed to help children learn more about the engineering and the SDGs through Minecraft, by building up elements of a sustainable community of their own design.

Engineering Systems Thinking

Systems thinking is a way of looking at complex systems as a whole.

It helps us to see how different parts of a system connect and work together.

The Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015 as a call to "end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity". Find out more here: https://www.undp.org/sustainable-development-goals.

Systems thinking in engineering and the SDGs

Systems thinking helps us understand how achieving one goal can help achieve others in engineering and science.

For example, creating clean energy solutions (**SDG 7**) can lead to better health (**SDG 3**) and combat climate change (**SDG 13**).

By seeing the connections, we can create technological solutions that address multiple goals at once.

Find out more about some of the ways engineers and engineering can help shape a better, more sustainable future in This is Engineering's short video: https://www.youtube.com/watch?v=tmGsOSGGURY

How does Systems Thinking help in engineering?

Systems thinking in engineering helps:

- solve complex problems by understanding how things are related and how changes affect the whole system
- engineers and scientists make better decisions by looking at the big picture
- teamwork and creative problem-solving in projects like designing robots or building eco-friendly houses
- create solutions that have long-lasting positive effects on technology and the environment.

Skills for Systems Thinking in Engineering

- Seeing whole systems and their parts.
- Understanding how the parts connect together.

Female civil engineer discusses weir plans with colleague. © This is Engineering. Used under CC BY-NC-ND 2.0 via Flickr.

- Understanding how changes in one part of the system can affect the whole system.
- Recognising patterns.
- Bringing all the parts together to make a whole system.

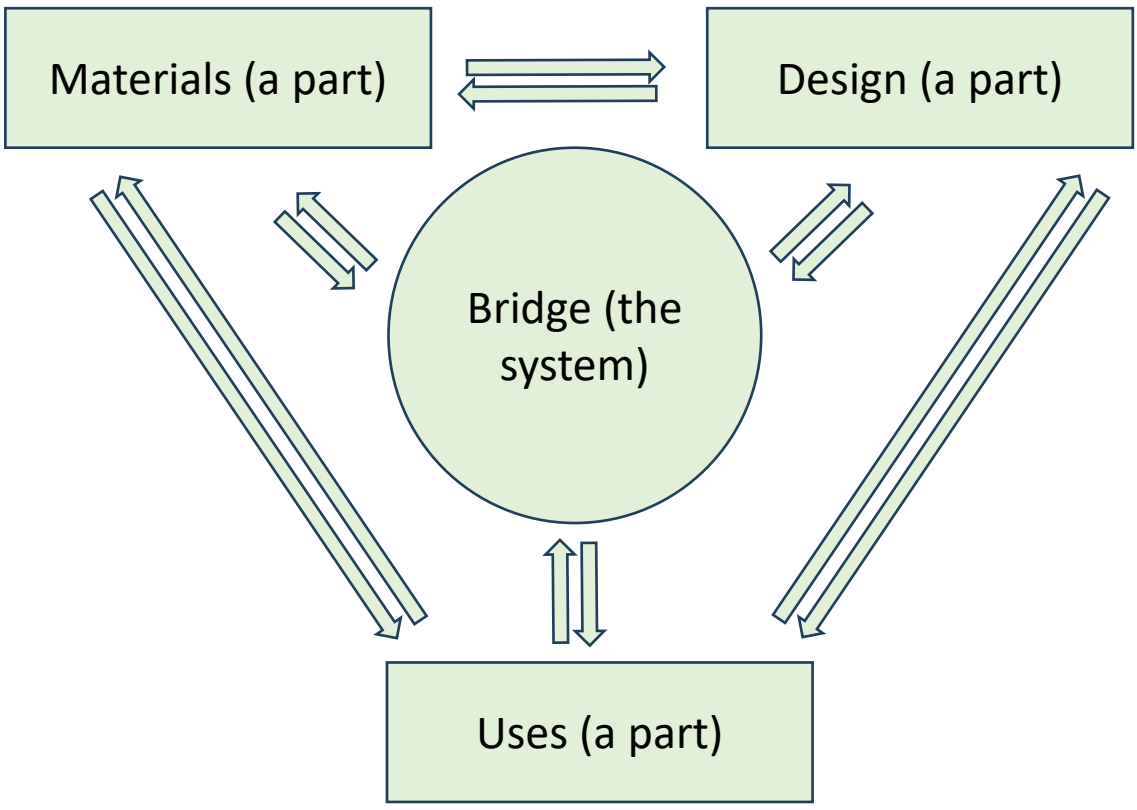
Imagine a bridge.

Engineers think about:

- the materials
- the design
- how it will be used

Image: Keith Proven from Pexels

to make it strong and safe. Each of these separate parts affect each other, and the whole bridge.



What other parts could there be in this system?

Minecraft Challenge

Use systems thinking to design a plan of a sustainable town.

You don't need to build it yet! Use Minecraft to map out where the parts of your town might go, to make a whole town system.

You could use blocks or signs to mark out areas, or any other ideas you come up with – it's your plan. Here are some tips:

- **Think like an engineer**. How do different parts of your city like schools, parks and hospitals connect and work together?

- How can you make your city **environmentally friendly, healthy, and happy for everyone**? For example, you might want to include:
  - Renewable energy sources like wind turbines and solar panels
  - Public transport systems to reduce pollution
  - Community gardens to grow food and bring people together.

If you do not have access to Minecraft you could:
- draw your design
- build your own using simple materials.

For ideas and information about building the parts of your town, please see our other sessions!

Not an official Minecraft resource. This project was supported by the Royal Academy of Engineering under the *Ingenious Awards* scheme. Developed with Adriana D'Souza, Airbus. For educational use only. Contact: sciencehunters@uwe.ac.uk.

Active Design

'Active design' is a planning approach for places. We've used the Active Design guidance from Sport England for this session. You can find out more in their YouTube video: https://www.youtube.com/watch?v=N_GOduDVOzc

Places are planned so that they encourage active, healthy lifestyles. This involves Active Travel, High quality places and spaces, and Creating and maintaining activity.

A key part of this is providing 'Activity for all' so that everyone can access these benefits.

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Active Design and the Sustainable Development Goals

Active Design supports people's physical health and well-being, which is part of:

- SDG 3: **Good health and well-being**
- SDG 11: **Sustainable cities and communities**

Active travel

This means designing places so that:

- People can easily walk or wheel themselves between places that they need every day
- Travel routes connect to each other
- Places have a mix of facilities
- People can do different things in the same place

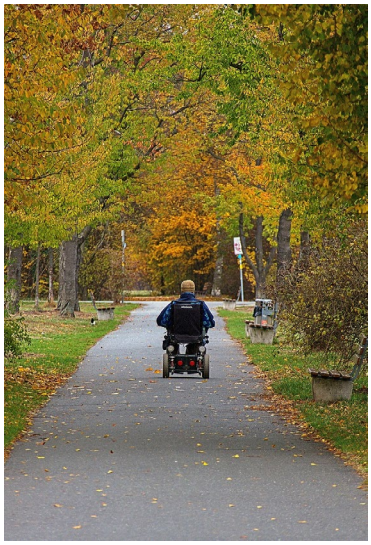

Image: anaterate from Pixabay

This doesn't only mean walking and cycling!
It also includes mobility aids, e.g. scooters and wheelchairs.

High quality places and spaces

Image: mattbuck (category), CC BY-SA 2.0, via Wikimedia Commons

High quality spaces have features such as:

- Connected open spaces
- Allowing people to make active journeys
- Providing places for exercise and leisure
- Buildings that encourage physical activity
- Places that are safe, attractive, easy to use and let people connect to each other.

Creating and maintaining activity

Spaces should encourage physical activity (which includes places to rest!)

Keeping places well-maintained means that they are safe and can be used for longer

Plans should include thinking about how spaces will be used in future too!

New play park at Alconbury Weald by Richard Humphrey, CC BY-SA 2.0, via Wikimedia Commons

Making sure spaces are designed to be flexible means:

- They can be used in more ways
- They are more likely to keep being used
- They can be easily adapted in the future

Minecraft Challenge

Starter: Create a resource that the community can use to stay active. This could be play equipment, an activity area, or something else.

Medium: Connect two open spaces where people can be active, and do different things in. Think about what activities people might need do in their everyday lives.

Advanced: Build a place where people can come together, be active, and move between different spaces (without using cars!). Think about how the place could be adapted to be used in different ways.

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The Circular Economy

In a circular economy things are made to last. They are designed to be repaired, reused and recycled, rather than used and thrown away.

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The circular economy and the SDGs

Key SDGs for the circular economy include:

SDG11 | Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable.

SGD12 | Responsible consumption and production: Ensure sustainable consumption and production patterns.

SDG13 | Climate action: Take urgent action to combat climate change and its impacts.

SDG14 | Life below water: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

SDG15 | Life on land: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

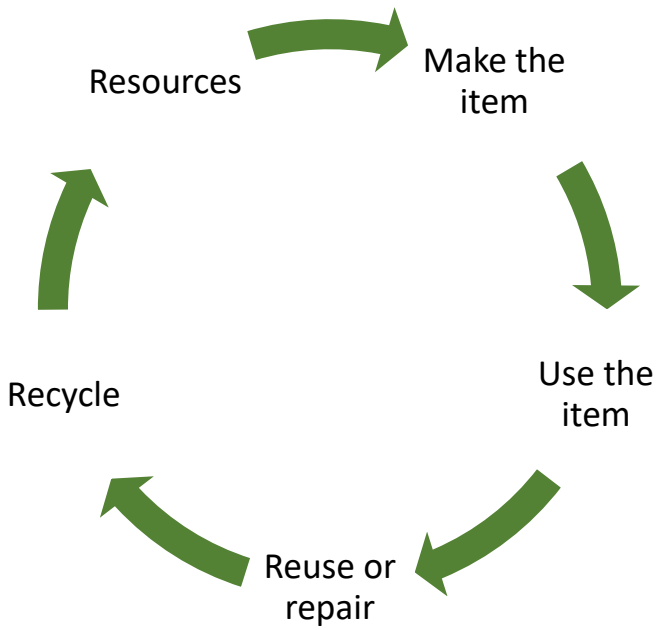
Where are we now?

We currently have a mainly Linear Economy, which means that we:

Take resources → Make something → Use it → Throw it away

This means that we are taking too many resources and producing too much waste.

In a Circular Economy, we would use our resources like this:



However, the Circularity Foundation reported in 2023 that only 7.2% of the global economy is circular, and this has got worse in recent years. https://www.circularity-gap.world/2023

Find out more from National Geographic Kids: https://www.natgeokids.com/uk/discover/science/general-science/all-about-the-circular-economy/

How can a circular economy help?

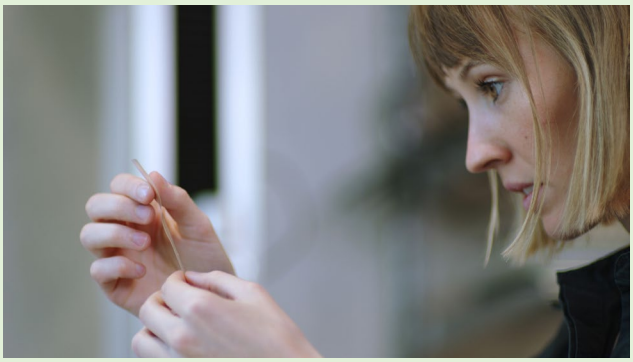
The United Nations say that a circular economy "aims to minimize waste and promote a sustainable use of natural resources, through smarter product design, longer use, recycling and more, as well as regenerate nature."

https://climatepromise.undp.org/news-and-stories/what-is-circular-economy-and-how-it-helps-fight-climate-change

This can help with problems such as:

- Pollution
- Climate change
- Biodiversity loss (declining numbers and reduced variety of species).

For example, real-life engineer Lucy uses fish processing plant waste to make biodegradable plastic. Because she uses fish scales and red algae, not only is she making good use of the waste, she is also helping to protect the oceans. The plastic is made of natural marine materials, so even if it does end up in the sea, it won't harm the wildlife there.
Find out more at:
https://thisisengineering.org.uk/people/lucy-hughes/



Female product designer creates biodegradable plastic alternative.. © This is Engineering. Used under CC BY-NC-ND 2.0 via Flickr.

Other ways we can move to a more circular economy include:

- Making use of community projects like Repair Cafés, where people repair your items for you. As the sign in this photo from a Repair Café in Reading says, “What do you do with a chair when the leg has come loose? With a toaster that no longer works? Or a woollen jumper with moth holes? Toss it? No way! You can repair it at Repair Café!”

Image: Karen Blakeman. Public domain via Flickr.

- Buying items second-hand, or swapping things between people.

- Turning waste into something useful, for example making food waste into compost.

- Designing things so that they can be easily repaired, instead of being thrown away and replaced.

- Renting items rather than buying them, so they can be reused when were finished with them, and designing products so their components can easily be reused and recycled.

Engineering and engineers help us understand how to do this!

Find out more in the Ellen MacArthur Foundation’s video: https://www.youtube.com/watch?v=zCRKvDyyHml

Minecraft Challenge

Design and build a community space or resource that helps towards a circular economy.

This could be something like:

- A place to get things fixed
- Somewhere to make things from second-hand items
- Equipment to help people repair their items
- A space to swap items
- A community orchard where food waste can be composted
- Anything else you think of!

You could use:

- some of the engineering techniques we have covered
- your own ideas

If you do not have access to Minecraft you could:

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Sustainable Housing

Sustainable housing is about designing and building homes that are good for people and the planet. This includes using eco-friendly materials, saving energy, and reducing waste.

It also considers the needs of different people, and ensures that sustainable transport options can be easily reached.

Sustainable homes can be more expensive to build at first, but they save money over time, for example by using less energy.

The Sustainable Development Goals

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Sustainable housing and the SDGs

Sustainable housing directly supports these goals by reducing energy use and making cities greener. This links to SDGs such as:

SDG 11 (Sustainable Cities and Communities) making cities and human settlements inclusive, safe, resilient and sustainable.

SDG 7 (Affordable and Clean Energy) ensuring access to affordable, reliable, sustainable and modern energy for all.

SDG 13 (Climate Action) taking urgent action to combat climate change and its impacts.

Land use

Sustainable housing is not just about what we build, but how we use land. Detached houses take up a lot of space because each home sits on its own plot.

This leads to **urban sprawl**, where cities spread over large areas, increasing the need for roads, transportation, and causing more pollution.

Mid-rise apartment blocks, for example, use land much more efficiently, housing multiple families in space that might only fit one or two detached homes.

By housing more people in a smaller area, mid-rise apartments reduce the need for additional infrastructure, lower energy use per person, and make public transportation more accessible.

Image by Thomas Murray, used with permission.

Building design

Sustainable housing design includes:

- **Energy efficiency** such as having good insulation to keep heat in during winter and out during summer.
- **Renewable energy sources** such as solar panels or wind turbines, instead of relying on fossil fuels.
- **Water conservation** features such as low-flow toilets, rainwater collection systems, and greywater recycling (reusing water from sinks or showers for other purposes).

Building with **sustainable materials** such as recycled wood or bamboo, which grows quickly and doesn't harm the environment as much as cutting down trees or using lots of concrete.

Different homes for different needs to meet the requirements of a range of people and families. Some people will need to avoid steps, for example, and some families will need more bedrooms than others (what other needs can you think of?).

Accessible links to **sustainable transport** such as good paths, cycle storage and shared electric cars.

You might also like to try our sessions on Solar Panels and Water Resources.

Green roofs are with vegetation like grass and shrubs.

Image: Valentina Zotova from Pixabay

They provide **natural insulation**, helping buildings stay warm in winter and cool in summer, reducing energy needs.

They also **absorb rainwater**, reducing runoff and helping prevent flooding in cities, and filter the air by absorbing pollutants and producing oxygen, making the area healthier.

Green roofs also **create habitats** for birds, insects, and other wildlife, supporting biodiversity in urban areas.

Minecraft Challenge

Design a **mid-rise apartment block** in Minecraft that supports sustainable living.

Think about using **eco-friendly materials**, **energy-saving features**, and **community spaces.**

For example, you could add **green roofs** and **community gardens** to enhance biodiversity and provide fresh food, and shared spaces like **gyms** and **libraries** to encourage community interaction. How will all these features be sustainable?

How can you make your building **efficient** and **comfortable** for everyone? Think about different people and their needs. For example, what might a young family need? Or a wheelchair user?

How will you provide access to **sustainable travel options**?

You could use:

- some of the engineering techniques we have covered
- your own ideas

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Natural Flood Management

Flooding

Floods happen when water spills out over the sides of rivers. This can be caused by heavy rain and global warming can increase flooding.

Many people in the UK live near rivers, and flooding can be very damaging to people and their homes. Engineers design ways to help prevent and reduce the risks.

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You can find out more here:
https://www.undp.org/sustainable-development-goals

Flooding and the Sustainable Development Goals

Reducing damage from flooding is part of:

- SDG 6: **Clean water and sanitation**
- SDG 9: **Industry, innovation and infrastructure**
- SDG 11: **Sustainable cities and communities**

Sustainable solutions

It is important to:

- think about everything that could be affected by putting flood protection in place, including local wildlife and surrounding land.
- not make big changes to the shape of the river that might cause it to flow faster than it did before.

Image: Pauline Eccles, CC BY-SA 2.0, via Wikimedia Commons

Concrete is a material often used in flood defences. (You can find out about this in a session from another of our projects, Building to Break Barriers, available here).

What about more **natural solutions**?

Image: Laura Hobbs. Used with permission.

Adding vegetation means that there are more plant roots to take up water (so less goes into the river).

Putting bends back into rivers slows down their flow. This is called **re-meandering**.

Find out more about Natural Flood Management from Stroud District Council: https://vimeo.com/139321429

Sustainable solutions

Natural barriers (or 'leaky dams') made of materials such as mud, trees and leaves can slow down river flow.

Image: Laura Hobbs. Used with permission.

In some places, **wetland environments** have been restored. This can help hold water upstream, and make it flow more slowly downstream, reducing flood risk.

And another way to reduce flooding that's gaining more attention is to introduce…**beavers**!

- Beaver dams hold water and then release it slowly.
- Beaver activity makes rivers bendier.
- Their dams also filter river water, making it cleaner.

Image: Forestry England/Crown copyright. Used with permission.

Beavers have been released and supported at sites in the UK (the one in the picture is at the Wyre Forest in Worcestershire/Shropshire), turning streams into ponds and helping reduce flooding.

You can find out more from the Environment Agency here, including an animation showing the impact of beavers.

Minecraft Challenge

- Build a river and a house or small settlement in Minecraft
- Engineer a natural flood management method (e.g. trees, re-meandering, natural barriers or beavers)
- Think about where this should be placed to help prevent people's homes flooding

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Wildlife crossings

Civil engineering is the **design and construction of infrastructure** that we use every day like roads, bridges, and buildings.

Civil engineers make sure these structures are safe, functional, and durable. You can find out more about this in a session from another of our projects, Building to Break Barriers, available here.

One important area of civil engineering is building bridges, which connect places and people.

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Civil Engineering and the SDGs

Civil engineering directly supports these goals by creating resilient and sustainable infrastructure.

Building bridges supports **SDG 9 (Industry, Innovation, and Infrastructure)** by developing reliable and sustainable infrastructure.

It also supports **SDG 11 (Sustainable Cities and Communities)** by improving urban transportation and connectivity.

By designing resilient structures, civil engineering contributes to **SDG 13 (Climate Action)** by preparing for climate impacts.

Wildlife crossings

Wildlife crossings, also known as green bridges, allow animals to safely move across roads and other barriers.

They **reconnect habitats** that have been split apart, making it safer for both animals and people by reducing accidents.

Habitat fragmentation happens when things like roads and railways cut through animal homes, making them smaller and less healthy.

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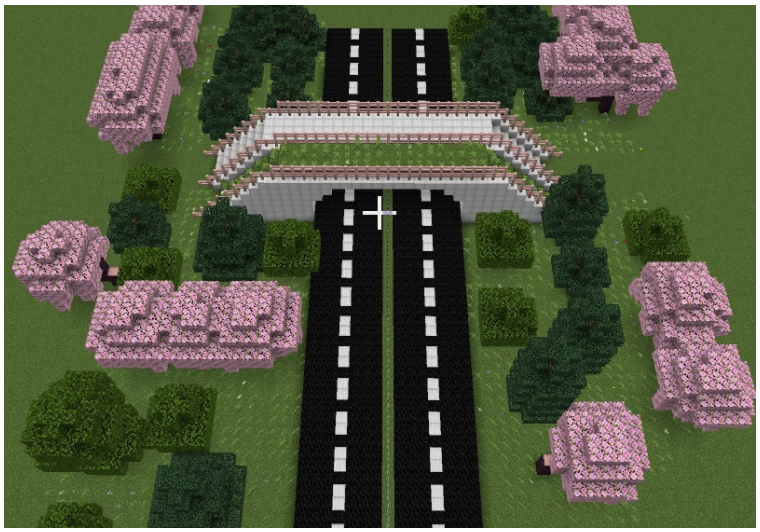

Image: Thomas Murray, used with permission

Roads can:

- Reduce the space and quality of habitats.
- Cause accidents that can kill animals.
- Block animals from reaching food and shelter.
- Split animal groups into smaller, weaker ones.

These problems can make it hard for animals to survive and can even lead to extinction if their numbers get too low.

Green bridges are a way to help solve these issues.

Minecraft Challenge

Use your creativity to design and build a green bridge in Minecraft that connects two areas.

Think like a civil engineer: **how do you make your bridge strong, safe, and useful?**

Consider the **materials** you'll use, the bridge **design**, and how it fits into the **environment**.

Include features like **pedestrian walkways** and **green spaces**.

Make sure your bridge can withstand weather events like rain and wind.

Anything else you think of!

You could use:

- some of the engineering techniques we have covered
- your own ideas

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Leisure: Entertainment

Leisure activities are things that people enjoy doing in their spare time.

Image: GR_Stocks on Unsplash.

This could be things like:

- Watching films or TV
- Visiting places
- Sport or exercise
- …and lots more.
- Playing games
- Listening to music
- Reading for pleasure

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Leisure and the Sustainable Development Goals

Leisure is a key part of SDG 3, **Good Health and Well-being**. This means:

- Making sure people have healthy lives
- Supporting well-being for everyone

Leisure activities such as entertainment are an important part of this!

Broadcasting and film-making

Find out how real-life engineer Jahangir makes sure people can keep watching TV in this video from This is Engineering: https://youtu.be/-6KHT336Nuk

Engineers use their skills to create realistic:

- **robotic** characters
- environments
- movie sets
- **special effects**

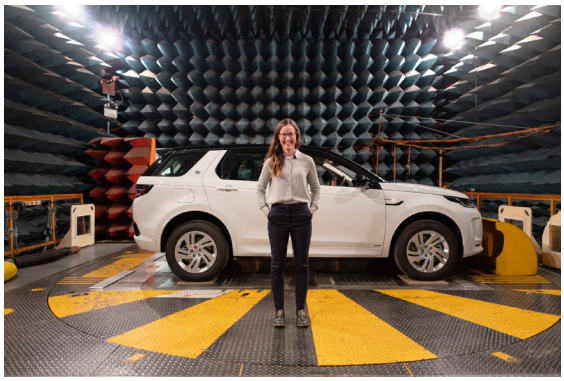
This often involves **mechanical** and **electrical engineering**.

You can find out more about this in a session from another of our projects, Building to Break Barriers. That's available here, and is based on the is based on the Royal Academy of Engineering's '**Engineering in the Movies**' resources and resource guide, where you can find even more information about the roles of engineers in making films.

Light and sound

Engineers use light and sound lots of ways to support entertainment. For example:

- Well-engineered **light and sound effects** help tell a film's story.
- Engineers like Orla make car sound systems a great experience.



Female engineer in anechoic chamber. © This is Engineering. Used under CC BY-NC-ND 2.0 via Flickr.

- Others like Pavlina design lighting for fashion shows, museums and art galleries.

Find out how software engineer David uses code to help people be creative with music and sounds in this video from This is Engineering: https://youtu.be/dr8Dc1lEYsA

Virtual and Augmented Reality

Virtual and augmented reality (VR and AR) give people new experiences, ways to connect with each other and creative methods.

Felicia has worked in video games, and uses VR and AR to create new worlds and connect people.

Female design engineer sketches car designs in 3D VR. © This is Engineering. Used under CC BY-NC-ND 2.0 via Flickr.

Mechanical engineer Daniela runs her own business, using software for 3D design in VR.

Minecraft Challenge

Create a place that a local community could come together for entertainment, such as watching films, playing games together, looking at displays or doing something else they enjoy.

Here are some things to think about in your design:

- What will people do there?
    - What might you need engineers for?

      For example:
      - lighting,
      - sound,
      - equipment,
      - music?

- How much space will it take up?
- Will it be indoors, outdoors, or both?
- How can you make your community leisure space sustainable?

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Leisure: Sport and Exercise

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- …and lots more.
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Leisure and the Sustainable Development Goals

Leisure is a key part of SDG 3, **Good Health and Well-being**. This means:

- Making sure people have healthy lives
- Supporting well-being for everyone

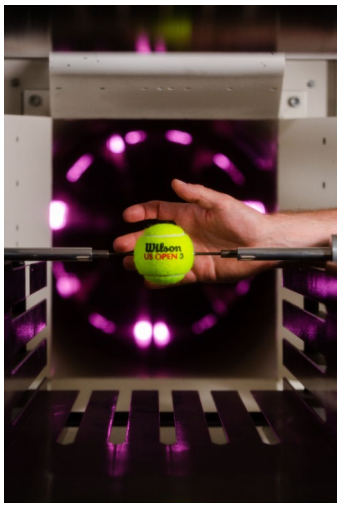
Leisure activities such as sport are an important part of this!

Engineers: Making tennis accessible and sustainable

Sports engineer James works to make tennis more accessible, so that everyone can enjoy it.

This includes:

- Making balls bounce slower to help children learn
- Developing equipment for blind players.



Male sports engineer tests tennis equipment. © This is Engineering. Used under CC BY-NC-ND 2.0 via Flickr.

Sports engineers monitor tennis footage. © This is Engineering. Used under CC BY-NC-ND 2.0 via Flickr.

James also researches how to make tennis more sustainable.

For example:

- Making new tennis court surfaces from old tennis balls.
- Reusing old tennis balls for training police dogs.

Engineers: Making sports cars more sustainable

Mechanical engineer George designs Extreme-E race cars with Sir Lewis Hamilton's electric racing team, making race cars faster, better, and more sustainable.

Male mechanical engineer designs electric vehicles. © This is Engineering. Used under CC BY-NC-ND 2.0 via Flickr.

Specialist automotive technicians like Georgia service sports cars, which helps to keep them running efficiently.

The motorsport industry is taking steps to become more sustainable, such as using **electric cars**, **biofuel** and fuel made from **waste**. What else could they do? How could engineers help?

Community sports and sustainability

Moving, sport and physical exercise help to keep people healthy.

Community sports facilities help in various ways, including:

- Providing opportunities for people to be active
- Making exercise more available for people
- Shared resources are more efficient than everyone having their own equipment (which lots of people aren't able to do)
- People can come to together, make friends and build their communities.

Minecraft Challenge

Create a community sports resource.

Here are some things to think about in your design:

- Will it be:
  - A piece of equipment?
  - A place?
    - Will it be indoors, outdoors, or both?
  - Both?
  - Something else?
- How will people use it?
- How much space will it take up?
- How can you make your community sports resource sustainable?

Our session on **Active Design** might help you make sure your resource is sustainable.

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Solar Panels

A solar panel captures energy from the Sun and converts that energy into electricity. This electricity can then be used to power houses, cars, and more!

Image: NxTide from Pixabay.

Because this energy comes from natural sources, and more can be made quickly, it is called **renewable energy**.

The Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015 as a call to “end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity”.

You can find out more here: https://www.undp.org/sustainable-development-goals

Renewable energy and the Sustainable Development Goals

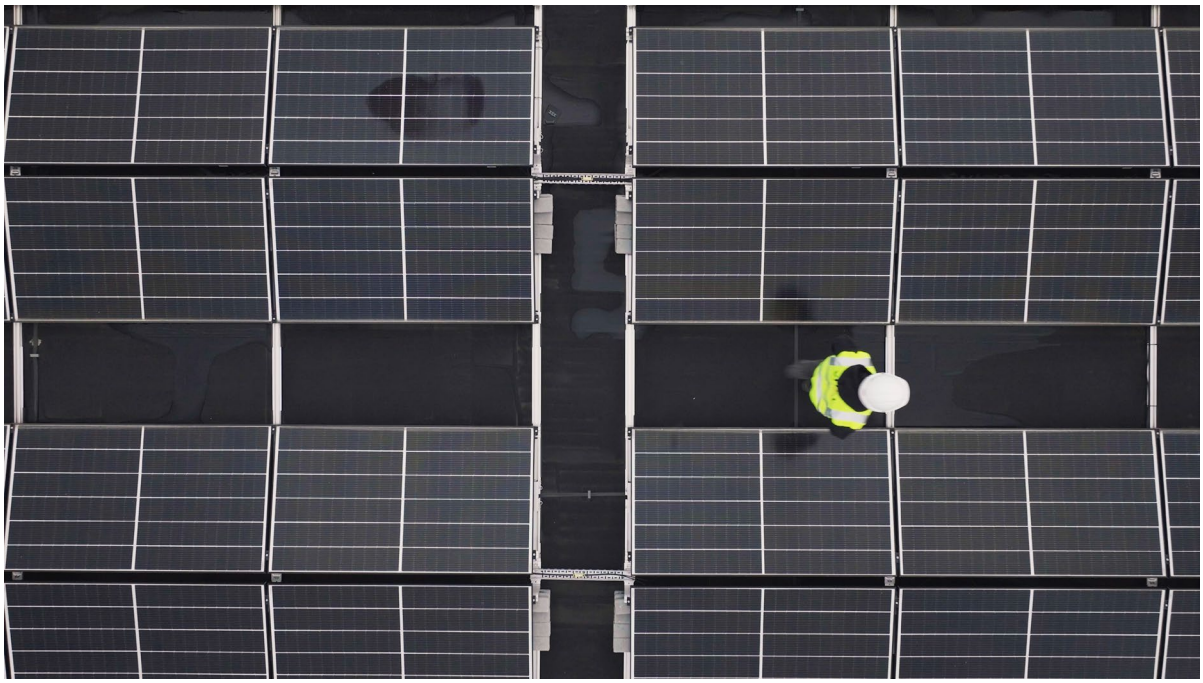
Renewable energy is a key part of **SDG 7**. This is **Affordable and Clean Energy**: Ensure access to affordable, reliable, sustainable and modern energy for all.

It can also be linked to **SGD 12**. This is **Responsible Consumption and Production**: Ensure sustainable consumption and production patterns.

Solar panels are made up of lots of connected solar cells that convert the Sun's energy into electricity.

It is important to use renewable and sustainable energy sources, like the Sun, to make sure we can slow down global warming and look after our planet.

Renewable energy can help reduce energy poverty in rural and remote areas of developing countries, where lack of energy access is often hindering economic development.



Find out more about real-life engineer and 'Net Zero Navigator' Harvey (shown inspecting solar panels in the photo above) from This is Engineering: https://thisisengineering.org.uk/people/harvey-hudson/.

Minecraft Challenge

Create solar powered lights:

- Connect a daylight sensor to a light, such as a redstone lamp.
- You can connect them using redstone dust to act as electrical cabling.
- Pick a location that you think will get you the maximum amount of solar energy.
- Are there any instances where the solar panels don't produce energy?

Create a solar powered train network:

- Use daylight sensors and powered rail to create a network in which trains are powered by solar energy.

Create a battery to store the solar energy:

- As solar panels only produce energy during the daytime, try to develop a battery to store the energy so it can be used at night. You could watch our engineer Daisy's YouTube tutorial for help with this.

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Water Resources

Water is essential for life, agriculture, and industry.

Access to clean water is essential for people's health.

However, clean water and hygiene are not available to billions of people around the world: https://sdgs.un.org/goals/goal6.

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Water and the Sustainable Development Goals

SDG 6 (**Clean water and sanitation)** includes making sure everyone has access to clean water and sanitation (keeping things clean and removing waste).

Reducing pollution and overuse of water resources links to **SDG 14 (Life Below Water)**.

Conserving water and helping communities adapt to water scarcity also relates to **SDG 13 (Climate Action)**.

Water conservation

Water conservation involves using water efficiently to reduce unnecessary water use. Conserving water helps ensure there is enough for future generations and protects natural ecosystems.

Engineers develop technologies and systems to make water use more efficient and sustainable, such as:

Image: Sarah Behenna, used with permission

Drip irrigation: Water is delivered directly to the roots of plants through a network of tubes, reducing water waste and promoting healthy plant growth by providing precise and consistent hydration.

Greywater recycling: Water that has been used in sinks or baths can be used to flush toilets.

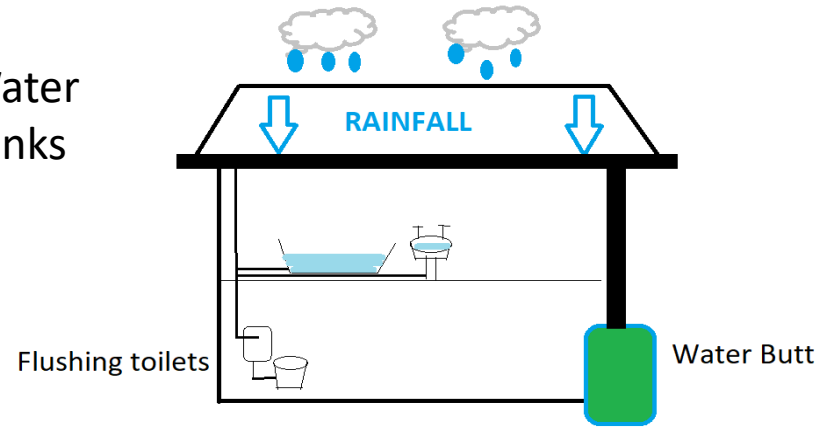


Image: Sarah Behenna, used with permission

Image: Sarah Behenna, used with permission

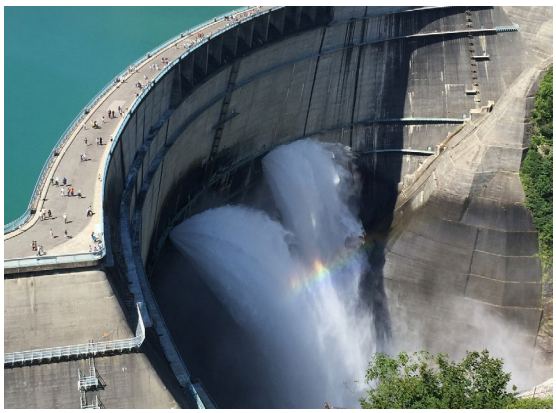
Rainwater harvesting: Collecting rainwater off the roof into gutters and then storing it in water butts. The water can then be used, for example in gardens.

Hydroelectric dams

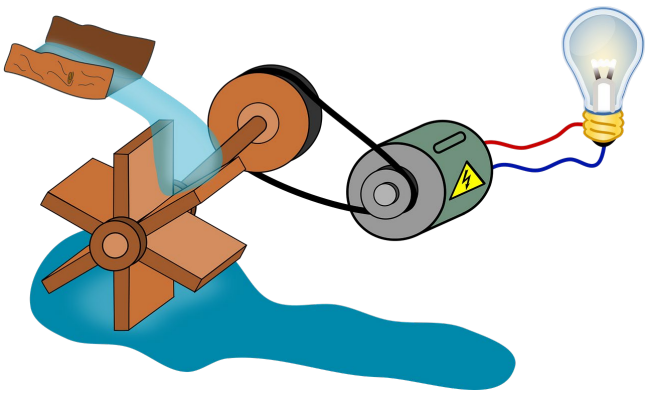
Hydroelectric dams generate electricity by using the flow of water to spin turbines connected to generators.

These dams help **manage water resources**, **control flooding,** and provide a **reliable source of clean energy**.

Engineers design dams to maximise energy production while minimising environmental impact.



A dam in Japan. Image: funario from Pixabay.



An illustration of hydroelectric power generation. Image: Juhele from Pixabay.

Renewable source generate more energy at some times than others, and we use more energy at different times of day. These don't always match up, so sometimes energy has to be stored until it is needed.

Energy storage facilities, such as Dinorwig Power Station in Wales, can be used alongside hydroelectric dams. They act as a reserve, quickly responding to rapid changes in power demand, and store excess energy produced at night.

During advertising breaks in popular TV shows, millions of people turn on electric kettles, causing a huge surge in electricity demand that Dinorwig helps manage.

Minecraft Challenge

Option 1: Design and build a **water conservation system** in Minecraft that serves a community of villagers.

Think about:

- **Greywater recycling**
- **Rainwater harvesting**
- **Drip irrigation**

Image: Sarah Behenna, used with permission

Option 2: **Manage a water source** such as a river or rain and show how it is conserved, used efficiently, and harnessed for energy.

For example, you could make a **hydroelectric dam**. You could watch our engineer Daisy's YouTube tutorial to help (from 10:00). Would you include a power storage facility?

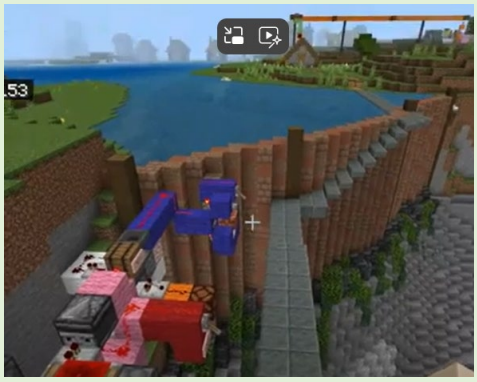


Image: Daisy Bristow, used with permission

If you do not have access to Minecraft you could:

- draw your design
- build your own using simple materials.

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Waste Management and Recycling

Waste management is how we handle all the rubbish that we create every day. It involves collecting waste, transporting it to the right places, treating it to make it less harmful, and sometimes even recycling it into something new.

Managing waste properly is important because if we don't, it can harm the environment.

Engineers design systems to manage waste and create recycling processes that help protect the environment.

The Sustainable Development Goals

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Waste Management, Recycling and the SDGs

Effective waste management supports **SDG 12 (Responsible Consumption and Production)** by promoting recycling and reducing waste.

It also supports **SDG 13 (Climate Action)** by reducing greenhouse gas emissions from waste.

Engineers contribute to **SDG 9 (Industry, Innovation, and Infrastructure)** by developing new recycling technologies.

Types of waste

- **Organic:** Waste from plants and animals, like food scraps and garden clippings. This waste can often be composted to help grow new plants.

- **Recyclable:** Paper, glass, plastic, and metals can be recycled. Turning old items into new products saves resources and reduces the amount of rubbish we need to get rid of.

- **Non-Recyclable:** Certain types of plastics and packaging, which cannot be recycled easily and usually end up in landfills.

- **Hazardous:** Some waste, such as batteries, chemicals, and old electronics, can be dangerous. These need to be disposed of very carefully so they don't harm people or the environment.

The 3 Rs: Reduce, Reuse, Recycle

These three steps can be followed to reduce waste:

Reduce: Use fewer resources to generate less waste (the best way to manage waste is to create less of it in the first place).

Reuse: Find new ways to use items instead of throwing them away.

Recycle: Process materials so they can be used to make new products.

Image: cottonbro studio via Pexels.

Waste and the environment

If waste can't be reused or recycled, it can sometimes be burned to create energy. This must be done carefully to avoid pollution.

Another option is to bury waste in landfill sites. Landfills take up space, and sometimes harmful chemicals can leak into the ground and water. When waste rots in landfills, it creates methane gas, which traps heat in the atmosphere.

Not disposing of waste properly can cause issues for wildlife, such as:

- Animals can mistake rubbish for food or get tangled in it. For example, birds might eat plastic, making them sick, or sea turtles can get stuck in plastic rings.

Image: Ilie Barna from Pixabay.

- A lot of rubbish, especially plastic, ends up in the ocean. This plastic breaks into tiny pieces called microplastics, which harm fish and other sea animals, and can even end up in our food.

- **What else can you think of?**

Find out how Lucy Hughes is creating a plastic made from natural marine materials, so even if it isn't recycled properly and does end up in the sea, it won't harm the wildlife there: https://www.youtube.com/watch?v=Q_vhDAZnH0g

Minecraft Challenge

Use your engineering skills to design and build a **recycling centre** in Minecraft that processes different types of waste.

Think about how you can design sections for sorting, processing, and storing different types of materials like plastic, metal, and food waste.

Consider the layout of your recycling centre as well. How will you ensure it operates efficiently and sustainably?

Include features like **composting for food waste** and **smelting for metal recycling**.

- Add anything else you think of!

You could use:
- some of the engineering techniques we have covered
- your own ideas

If you do not have access to Minecraft you could:
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Food Security

What does 'food security' mean?

Food security means that everyone has enough safe and nutritious food to be healthy, both now and in the future.

This video from the Biotechnology and Biological Sciences Research Council explains more:
https://www.youtube.com/watch?v=0emw7IkFdK8

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You can find out more here:
https://www.undp.org/sustainable-development-goals

Food security and the Sustainable Development Goals

Food security is a key part of **SDG2**. This is **Zero Hunger**: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

It can also be linked to **SDG3**. This is **Good Health and Well-being**: Ensure healthy lives and promote well-being for all at all ages.

What's the challenge?

Earth's population is increasing and is expected to be 9.7 billion by 2050[1].

All those people will need safe, healthy food. This means that food production will need to increase by around 70% to meet this extra demand[2].

[1]United Nations, 2019: https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html
[2]United Nations, 2013. https://news.un.org/en/story/2013/12/456912

As well as more food, our population will also need more of other things that we need to survive and be healthy.

This includes:

- Shelter – homes to live in
- Infrastructure – things like roads, schools and hospitals
- Safe drinking water
- Can you think of anything else?

All of these things take up space on the ground!

If we expand towns and cities out into the countryside, we leave less space for farms…

We can't increase the size of the Earth, so to support our future societies, we have to find ways to produce more food without taking up lots more space.

Possible solutions

What have people tried so far?

- **Underground farming:** These '**deep farms**' can use places like tunnels that already exist.

    - These farms are naturally **warm** as they are underground
    - Being underground avoids being very affected by **seasons and climate**
    - Because plants need **light** for photosynthesis, underground farms need to be lit

  Could they be built under cities? What might be the benefits of doing this?

- **Home growing:** People find ways to grow their own crops. This could include using some very small spaces that aren't being used for other things, such as **rooftops** and **windowsills**.

Image: rybson4891 from Pixabay

Can you think of any others?

- **Vertical farming:** growing crops in columns, instead of spread out across the ground.
    - **'Hydroponics'** (giving plants nutrients in liquids) can be used to do this without soil!

Image: **BrightAgrotech** from Pixabay

What else can you think of?

How else could we save space?

Do farms have to be on land?

Where else could they go?

The solutions above are all for growing plants. What do you think the future might hold for farms with animals?

How can engineers help?

Engineers can help find ways to farm in the future to support food security. For example, this video from This is Engineering shows how robots can help feed the world: https://youtu.be/fFoTD_UQIaw

You can also find out more about another **real-life 'farming futurist'** here: https://www.thisisengineering.org.uk/meet-the-engineers/ben/

Minecraft Challenge

Starter: Plant some seeds in Minecraft. **What is essential for them to grow?** Is this the same in Minecraft and the real world?

Medium: Conduct an experiment. Choose a type of seed to plant from the inventory. Plant the seeds in two groups. Give fertiliser (bone meal) and water to one of the groups. **Which grows faster? Why?** How does this compare to the real world?

Advanced: As the world's population grows, there will be more people needing food and less space to produce it in. **Design a space-saving farm** to solve the problem. It could be on land, at sea, in trees…

You could use:

- some of the engineering techniques we have covered
- your own ideas

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