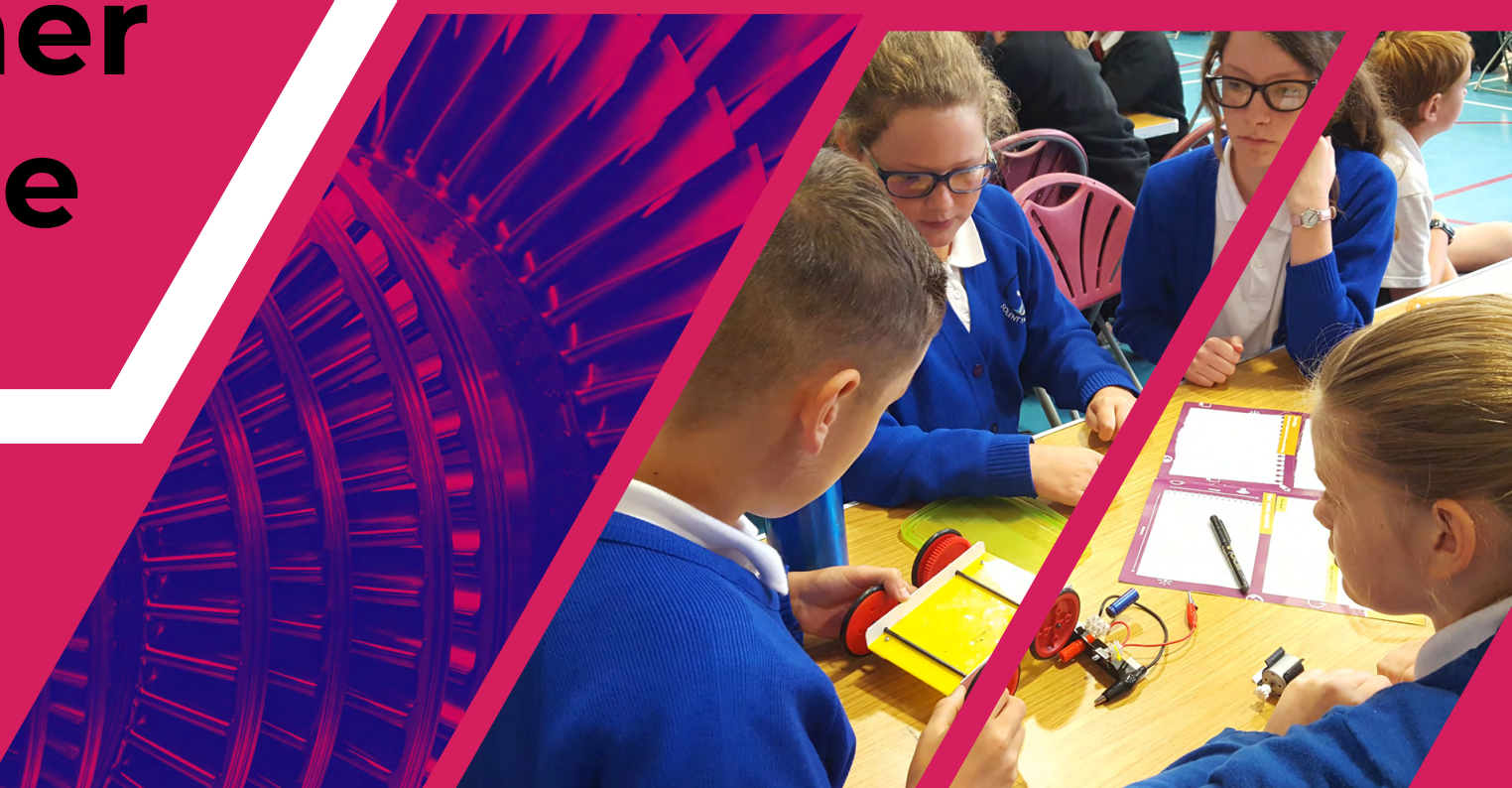# Royal Academy of Engineering

Employer Engagement Challenge

Teacher Guide

Ariennir gan
Lywodraeth Cymru
Funded by
Welsh Government

THIS IS ENGINEERING

Introduction

Welcome to the Royal Academy of Engineering's set of 10 challenge resources funded by the Welsh Government. These resources have been co-developed by engineers and teachers based in Wales, specifically for primary and secondary school children.

Each challenge offers a range of project-based and industry-focused activities that bring together science, design and technology, computing, and mathematics to help learners discover the world of engineering.

They are designed to help primary school pupils and secondary school pupils develop their problem-solving, critical thinking, collaboration and communication skills, so they can develop their understanding and mindsets to become future engineers in the making.

Additionally, these challenges provide learners with an insight into STEM careers in the engineering sector, which are highly sought after by businesses locally and world-wide.

We hope that these resources will be of great value to you and your school children.

The Royal Academy of Engineering.

The Curriculum for Wales, Science and Technology area of learning and experience encourages the use of industrial facilities to bring learning to life in the area of science and technology.

Industry engagement plays an important role in supporting and engaging with educational activities within schools.
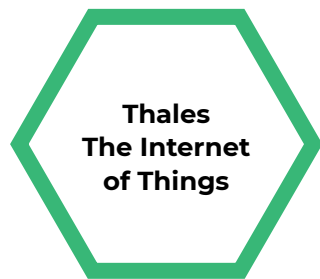
This includes industry-specific projects to provide young learners with an understanding of how science, technology and engineering is used in a real-world setting.

This set of challenge resources from The Royal Academy of Engineering gives learners access to the knowledge and experience of professional engineers, gives them authentic real-life experiences and brings the world of work into the classroom.

The ambition is to inspire and encourage more pupils to take up STEM subjects – subjects which lead to exciting STEM careers and are highly sought after by businesses locally and world-wide, now and in to the future.

Welsh Government.

Engineering challenges for primary schools

Thales Digital forensics

Thales The Internet of Things

Vishay Assembly line

Tata Steel Upcycled structures

Zimmer Biomet Bionic Barbie

Challenge resources

There are 10 challenges in total, five of which are designed for teachers to deliver to primary school pupils and five for secondary school students. Each challenge can be adapted, changed and extended to suit the school's learning style, age group and ability of the learners.

These challenges are based on real-world problems and tasks set by engineers within each company, designed collaboratively with schools. Teachers do not need to be engineers or STEM specialists, and the challenges do not require specific machinery or equipment. Teachers are provided with the necessary amount of time to deliver them to their classes, and can choose to teach these challenges over a series of lessons within a few weeks, or devote an entire day or week to the project.

Ultimately, these challenges put a spotlight on what modern day engineering looks like and provides learners with the opportunity to apply their skills to the world around them, gaining a better understanding by reflecting upon their learning and mistakes.

These challenges benefit teachers by:

- following Curriculum for Wales' careers and work-related experience guidance

- aligning with Gatsby benchmarks and provides engineering careers information in schools

- being based on real-world problems, so learners can see how their skills can be applied to the world around them

- being open-ended, so learners can explore different solutions and find their own unique way to complete the challenge

All challenge resources are available to download at https://raeng.org.uk/wvep.

Engineering challenges for secondary schools

Panasonic Weather station

Panasonic Toughbook

Concrete Canvas Bridge building

General Dynamics Payload

Safran Egg drop

Supporting videos

Each challenge is supported by a set of informative videos designed to provide teachers and students with a comprehensive understanding of the challenge ahead.

The **employers and schools films** are intended to be watched only by teachers and STEM leads who will be delivering this challenge in the classroom. They are not designed to be shown to learners

Employer films. In these short videos, we introduce you to the company that has collaborated with schools to co-develop this challenge. You'll get to know the industry they operate in, their services within engineering and most importantly, how these aspects are linked to the theme of the challenge.

School films are presented by teachers who actively developed and delivered each challenge, this set of videos serves as a practical guide on how to successfully run the challenge in your classroom. Discover the key areas of learning and the valuable skills your class will acquire throughout the challenge.

Engineer films are a series of short videos from real-life engineers. They showcase a diverse range of roles within the company, emphasising that engineering can be for everyone and that there are numerous pathways into this exciting profession. They provide inspiration by breaking down stereotypes and demonstrate the wide variety of opportunities within the world of engineering.

CREST Awards

CREST Awards is a nationally recognised scheme for pupil-led project work in the STEM subjects. They are run by the British Science Association and are open to school children aged 5 to 19. Awards can be applied for individuals or as a team and are a great way for learners to develop their STEM skills and to learn more about the world around them.

CREST Awards are recognised by universities and employers, so they can also help pupils to enhance their school record of achievement and personal statements. CREST Awards are free to schools in Wales. The Welsh Government provides funding to cover the cost for all school children in Wales.

Find out more and apply for CREST Awards by visiting the website: https://www.crestawards.org/

Competition entry

Entering challenge outcomes into STEM competitions can be a great way to learn new things, meet new people, gain experience and win prizes.

Here are a couple of nationally recognised ones to get you started.

Sustainable Futures Innovation Challenge – open from October to the start of May each year

**The Big Bang Competition** – open from October to the end of March each year

Resource library

The Royal Academy of Engineering has a comprehensive collection of STEM resources designed to engage and inspire young learners with engineering activities and career pathways.

All of our resources are linked to the curriculum and provide opportunities for school children to explore, tinker and express their thoughts and ideas. Pupils develop their creativity and practical skills, helping them to understand, change, and make a difference in the world around them.

The resources can be used flexibly, embedded in lessons to enhance the curriculum or to engage learners in enrichment clubs. Each resource is supported with a set of tutorial videos demonstrating how to deliver activities.


Explore and download from our resource library
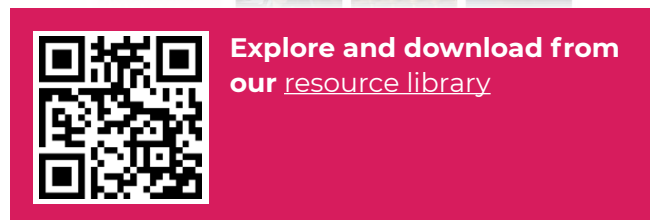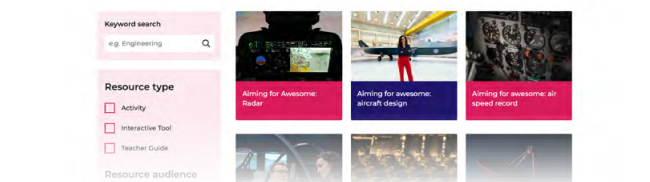
Careers resources

Neon futures

Neon futures helps primary and secondary teachers introduce learners to future STEM careers, raise aspirations and explore the excitement of engineering through inspiring case studies and supportive resources.

Find '10 good reasons to become an engineer' and 'plan your route to a career in engineering'. These can be downloaded or printed copies ordered from the **Neon futures** website.
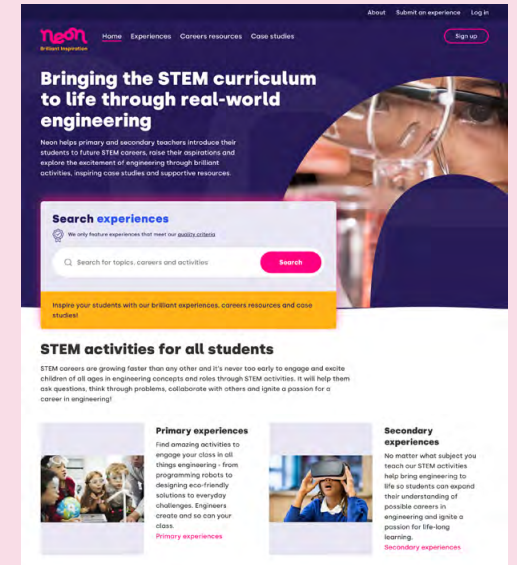
This is Engineering

This is Engineering is a campaign to inspire young people to consider careers in engineering. The campaign is led by the Royal Academy of Engineering and features a series of short videos that showcase the work of real engineers. The videos cover a wide range of engineering disciplines, from civil engineering to software engineering.

The engineers featured in the videos are from all walks of life, and they share their passion for engineering and their advice for young people who are considering a career in the field.

Progressing to be an engineer framework

Each challenge resource is underpinned by the Progressing to be an Engineer framework (Bianchi & Wiskow, 2023) (page 6). This details the learning outcomes for an embedded approach to engineering education in mainstream classroom settings from 5 to 14 year olds. It is a planning tool for teachers when designing lessons to deliver the challenge resources.

It is progressive by outlining learning outcomes for 5 to 7 years, 7 to 11 years and 11 to 4 years. The age boundaries are not discrete or limiting, and teachers should consider the ability of their pupils as the key driver for planning.

It is aligned to practices within the Curriculum for Wales, Science and

Technology area of learning and experience which means that teachers can capitalise on pupils' prior learning and skills and integrate engineering education into mainstream curriculum lessons.

It is incremental – the framework is carefully structured to provide a developmental programme of learning to fit within curriculum requirements.

The Progressing to be an Engineer cycle enables teachers to embed STEM knowledge, skills and understanding reflective of real-world engineering. The process is iterative, meaning that the steps may be repeated in order to refine the solution until it meets all the requirements.

Engineering Habits of Mind (EHoM)

Engineering Habits of Mind (EHoM) refer to the set of six skills and practices that engineers use when engaging in the engineering process. The framework develops the work on EHoM by linking them with the engineering design process.

The cycle shows how the engineering habits: *Problem finding*, *systems thinking*, *creative problem solving*,

visualising, adapting and improving are embedded within the stages of the engineering design process: *Ask, Imagine and plan, Create,* and *Improve*.

The cycle may not encompass the practices of all engineering disciplines, but it has been shown to be accessible and relevant to teachers planning for engineering in school contexts.

The Progressing to be an Engineer cycle
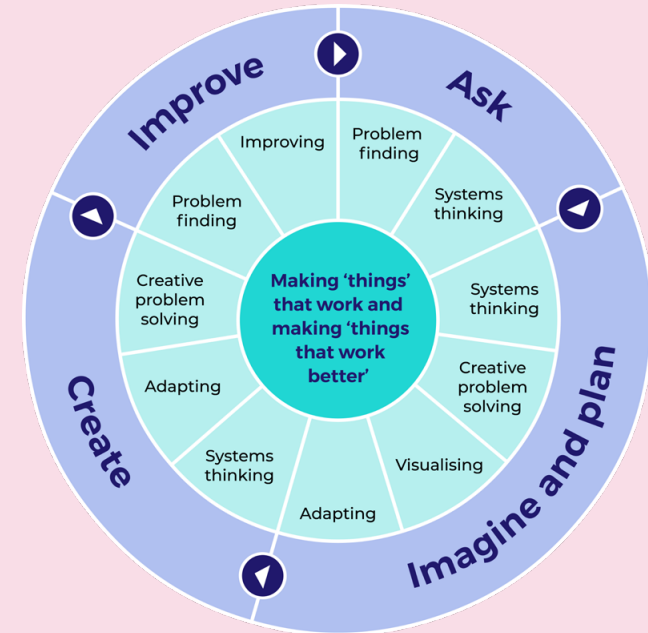
EHoM applied to the engineering design process	
PEng	**EHoM**
Ask	Problem finding | Systems thinking
Imagine and plan	Systems thinking | Creative problem solving Visualising | Adapting
Create	Systems thinking | Adapting Creative problem solving
Improve	Problem finding | Improving

To read more about this area download Bianchi, L. & Wiskow, J (2023) Progressing to be an Engineer.

Progressing to be an Engineer framework

Purpose	Making 'things' that work and making 'things' work better										
Engineering design process	**Ask**		**Imagine and plan**				**Create**			**Improve**	
Engineering Habit of Mind	Problem-finding	Systems thinking	Systems thinking	Creative problem-solving	Visualising	Adapting	Systems thinking	Adapting	Creative problem-solving	Problem-finding	Improving
5–7 years	Make observations to inspire the asking of simple questions, finding out more information about how things work.	Explain how simple systems work.	Draw and label a design with different parts, showing how they connect together.	Come up with and describe how different ideas can solve a problem.	Communicate ideas in words and simple sketches.	Observe a range of mechanisms (how things are made to work), suggesting ideas for how they could be used for a different purpose.	Use components to create a product with multiple parts.	Take an existing product and repurpose it by using it in a different way.	Create a prototype by taking a 2D design into 3D.	Check things work by testing.	Identify areas for improvement in a product and suggest changes to make it work better.
7–11 years	Identify problems and ask questions to better understand their cause.	Explain how simple systems work, identifying how each part depends on another and predicting what would happen if there is a missing piece or link.	Draw and label a design that uses a system, explaining the role of each part.	Generate multiple ideas, effectively communicating their 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 an existing mechanism (natural or man-made).	Use knowledge of how components work and interact to create a product that achieves a specific purpose.	Repurpose an existing product so that it can be used it in a different way, tailored to the needs of a specific user or purpose. Evaluate its fitness for purpose.	Create and evaluate a series of prototypes, taking 2D designs into 3D, making improvements based on observations and feedback.	Test that things work using a logical approach, gathering evidence to make an informed decision.	Evaluate how the product is working, identifying areas for improvement in a product and describing possible changes that can enhance the design.
11–14 years	Critically examine problems, asking questions to understand their cause and how they impact different users.	Explain complex systems, including subsystems, describing how they depend on each other and predicting what can happen if there is a missing piece or link.	Draw and label a design that includes a system, justifying why each part is there, and how it best suits a user.	Use research and experience to come up with designs to solve a problem, justifying choices by applying scientific knowledge and evidence.	Use detailed annotated sketches to turn ideas into words and drawings to create a design specification.	Plan and evaluate designs that aim to solve a problem or tasks by transforming existing mechanisms (natural or man-made), suggesting alternatives and trade-offs with due regard for criteria such as cost and safety.	Create a product for a specific purpose, justifying the suitability of choices based on local and global issues - e.g. sustainability, energy, circular economy.	Repurpose an existing product, tailored to the needs of a specific user or purpose. Evaluate based on ethical, social and economic aspects.	Create a series of prototypes, taking 2D designs into 3D. Use cycles of self and peer-evaluation to identify and make improvements based on testing, observations and feedback.	Test and evaluate products against a specification reacting to the views of intended or specific user groups.	Identify areas for improvement in a product and describe changes to enhance the design, recognising the ideas that are most feasible and desirable.

Thank you

Royal Academy of Engineering

This set of employer engagement challenge resources has been developed by the Royal Academy of Engineering as part of the **Welsh Valleys Engineering Programme (WVEP)**.

WVEP is a long-term project with the aim of creating school centres of excellence in STEM teaching and improving learning opportunities in the South Wales valleys by bringing real-world engineering practice into schools and colleges.

It has helped to raise awareness of engineering among young people, improve STEM teaching in schools and colleges and created new career opportunities for STEM graduates.

The programme would not be possible without the significant support of its funders:

**Llywodraeth Cymru
Welsh Government**

WVEP is also generously supported by the Panasonic Trust.

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.