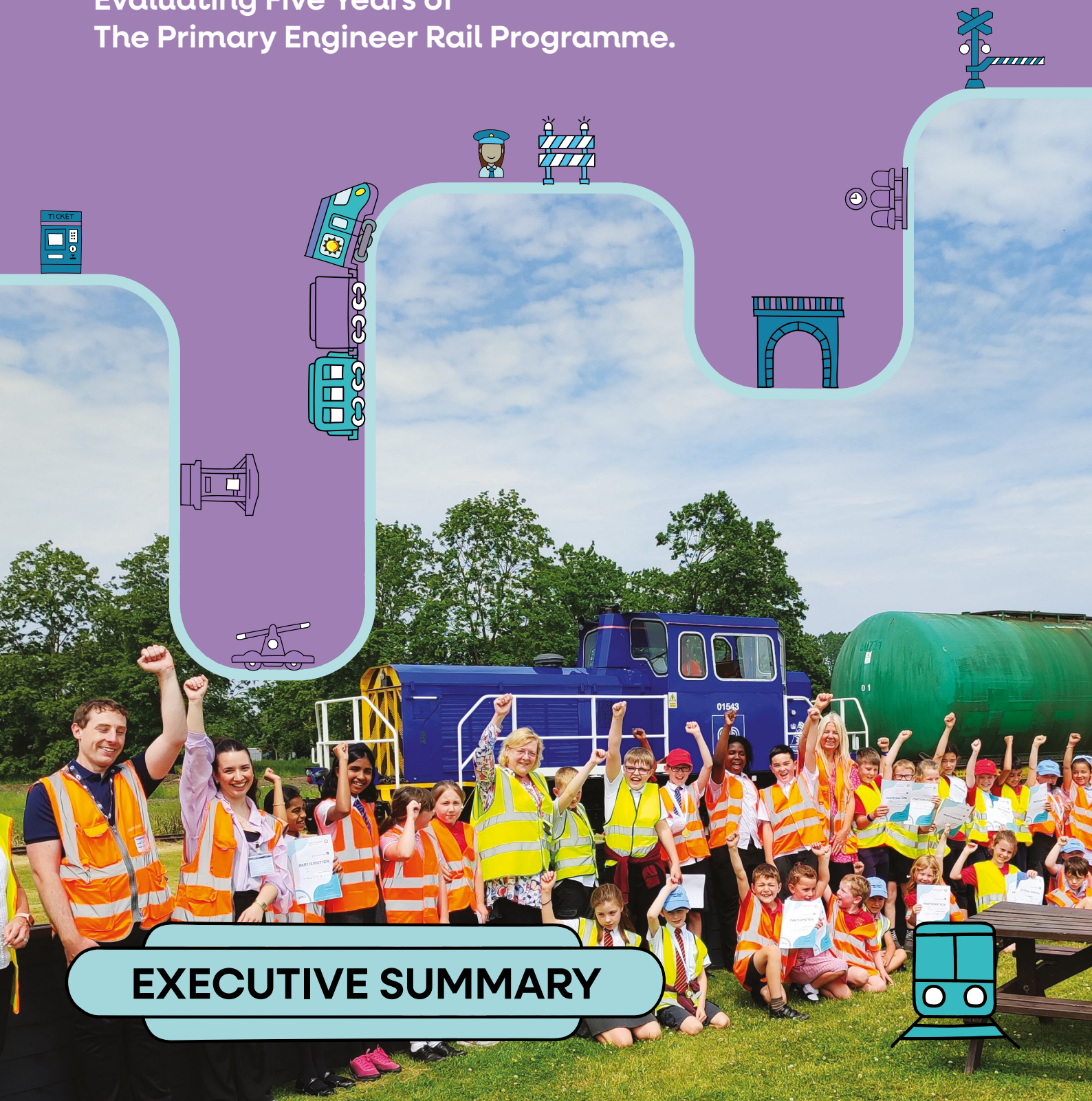
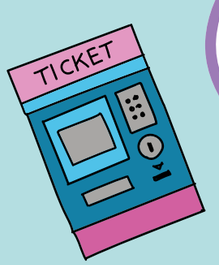
Primary Engineer®
...the first step

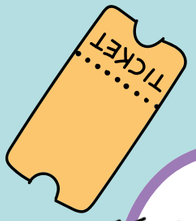
Keeping Kids On Track: #EngineersInTheMaking

Evaluating Five Years of The Primary Engineer Rail Programme.



EXECUTIVE SUMMARY





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1. RATIONALE

The Primary Engineer Rail Programme Rationale

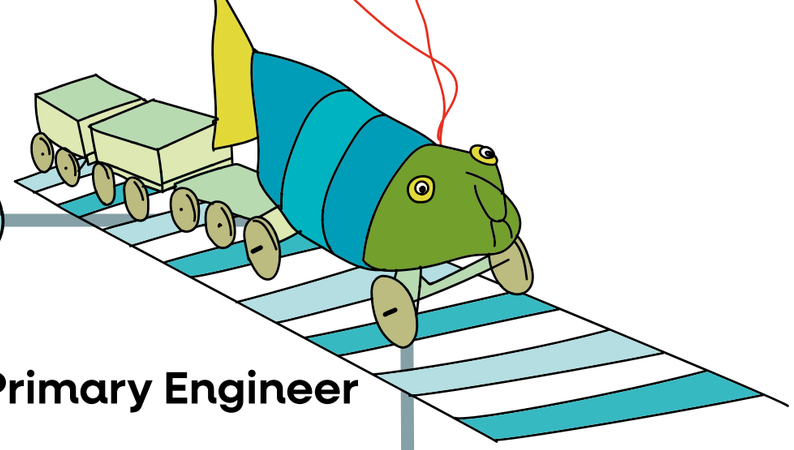
There is a shortfall of workers in Science, Technology, Engineering and Maths (STEM), with almost 50% of engineering and technology businesses reporting difficulties in attracting skilled candidates. This has been translated into a loss of £1.5b per year to the economy[1]. The continued shortfall in Engineering graduates contributes to a lack of skills and diversity in the workforce[2]. Women make up just 16.5% of all engineers[3].

Most career and education initiatives are aimed at teenagers, which is arguably too late, and the reason why Primary Engineer has engaged directly with primary school pupils since 2005. To ensure a pipeline of diverse talent, children need to be inspired by Engineering at an early age. This evaluation demonstrates that the *Primary Engineer Rail Programme* tackles these issues head on.

[1]Institution of Engineering and Technology, 2023: Engineering Kids' Futures. Available from: https://www.theiet.org/media/11077/engineering-kids-futures.pdf
[2] Perkins, J, 2013: Review of Engineering Skills. Available from: https://www.gov.uk/government/publications/engineering-skills-perkins-review
[3] Royal Academy of Engineering, 2019: Engineering Skills for the Future. Available from: https://raeng.org.uk/media/hn4hdep3/perkins_report_jan19_final-web.pdf

03.

2. FIVE YEARS



Five Years of the Primary Engineer Rail Programme

The *Primary Engineer Rail Programme* aims to inspire the next generation of engineering professionals and show how Engineering can sit at the heart of the curriculum. Over the course of five years the *Primary Engineer Rail Programme* has provided 40,000 Rail Engineering learning opportunities across England and Scotland, expanding its reach to Wales since 2023. These experiences are not one-off visits to schools by Engineering professionals. Rather, they are ongoing, hands-on sessions throughout the school year, led by the teachers themselves and accompanied at points through the programme by engineering professionals, that leave a lasting impression with the pupils.

The *Primary Engineer Rail Programme* provides children with a real-world context for project-based learning. Children are encouraged to think like engineers – identifying problems, designing and visualising creative solutions, making, reviewing, improving and adapting in stimulating practical activities that consolidate knowledge and understanding from across their curriculum.

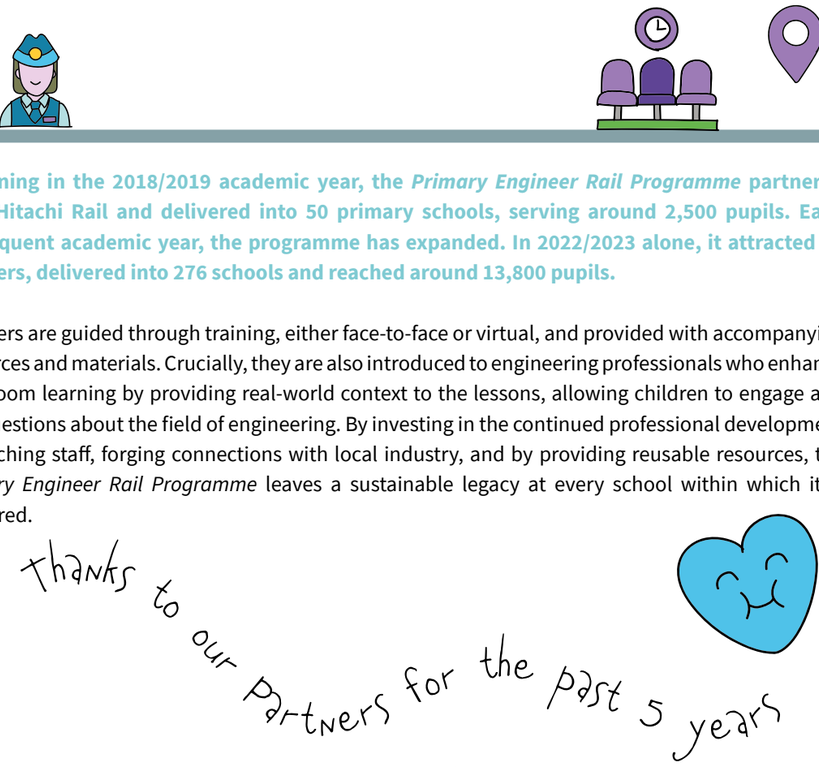
The process of reviewing and adapting helps children to believe they can improve through applied effort. This 'growth mindset[4]' contributes to the development of more resilient students. They grow in self-esteem through their accomplishment and hone skills for learning that can be applied throughout their education.

Pride and self-esteem are purposefully amplified in a series of high-profile, regional and in-school celebration events that leave children walking just that little bit taller, according to teachers. The events ensure that the fun of Engineering is secured as a lasting memory for children – one that may well endure when later they are beginning to make career choices.

[4] Dweck, C.S. (2008) Mindset. Balantine Books

Beginning in the 2018/2019 academic year, the *Primary Engineer Rail Programme* partnered with Hitachi Rail and delivered into 50 primary schools, serving around 2,500 pupils. Each subsequent academic year, the programme has expanded. In 2022/2023 alone, it attracted 18 partners, delivered into 276 schools and reached around 13,800 pupils.

Teachers are guided through training, either face-to-face or virtual, and provided with accompanying resources and materials. Crucially, they are also introduced to engineering professionals who enhance classroom learning by providing real-world context to the lessons, allowing children to engage and ask questions about the field of engineering. By investing in the continued professional development of teaching staff, forging connections with local industry, and by providing reusable resources, the *Primary Engineer Rail Programme* leaves a sustainable legacy at every school within which it is delivered.



PROGRAMME TIMELINE

The Journey So Far

2018/19

Partner(s)
1

HITACHI Inspire the Next

Primary Engineer launches the Primary Engineer Rail Programme in collaboration with Hitachi Rail.

50 SCHOOLS

circa **2500 PUPILS**

2019/20

Partner(s)
2

HITACHI Inspire the Next · NetworkRail

The Primary Engineer Rail Programme is launched for a second year. Adjustments to the programme are made to support online delivery in response to the Covid-19 pandemic.

60 SCHOOLS

circa **3000 PUPILS**

2020/21

Partner(s)
3

HITACHI Inspire the Next · NetworkRail · Doncaster Council

Despite ongoing interruptions due to the Covid-19 pandemic participation with the Primary Engineer Rail Programme grows. Network Rail and Doncaster Council join Hitachi Rail as key partners.

150 SCHOOLS

circa **7500 PUPILS**

Wabtec Corporation · VolkerRail StoryJV · UKRRIN UK Rail Research and Innovation Network · BCRRE · SIEMENS · ScotRail Scotland's Railway

2021/22

The Primary Engineer Rail Programme grows further with thirteen new partners and reaching 269 schools across the England and Scotland.

Rail Forum Midlands

Department for Business, Energy & Industrial Strategy · Burnley · Chilternrailways by arriva · crosscountry · The University of Edinburgh · Kirklees Council

BEACON · Avanti West Coast · ALSTOM mobility by nature · NetworkRail · HITACHI Inspire the Next

circa **13,450 PUPILS**

269 SCHOOLS

Partner(s)
16

2022/23

Scottish Engineering · The University of Edinburgh · STADLER · Department for Business & Trade · C2C · BCRRE · ALSTOM mobility by nature

The Rail Programme continues to grow with new partner organisations supporting contact with 276 schools. The Programme is launched in Wales for the first time with Welsh language resources.

porterbrook · Rail Forum Midlands · REECE FOUNDATION · SIEMENS · UKRRIN UK Rail Research and Innovation Network · ADC Electrical

crosscountry · Chilternrailways by arriva · BEACON · Avanti West Coast · NetworkRail · HITACHI Inspire the Next

Partner(s)
18

circa **13,800 PUPILS**

276 SCHOOLS

3. PRIMARY ENGINEER RAIL PROGRAMME

The programme comprises of the following elements:

Teacher Continual Professional Development (CPD)

Full-day training for teachers, in which they are connected with engineering professionals, where they learn the skills required to teach pupils how to build working models, as well as how to address the practical challenges they will face during the design and make process.

Collaboration with Engineering Professionals

The teachers are encouraged to link with the engineer so they can gain a deeper insight into their work. These engineering professionals then support in the classroom to not only contextualise the project-based learning but also to enable their pupils to engage with an engineering professional, becoming role models for the sector and profession.

Resources and Materials

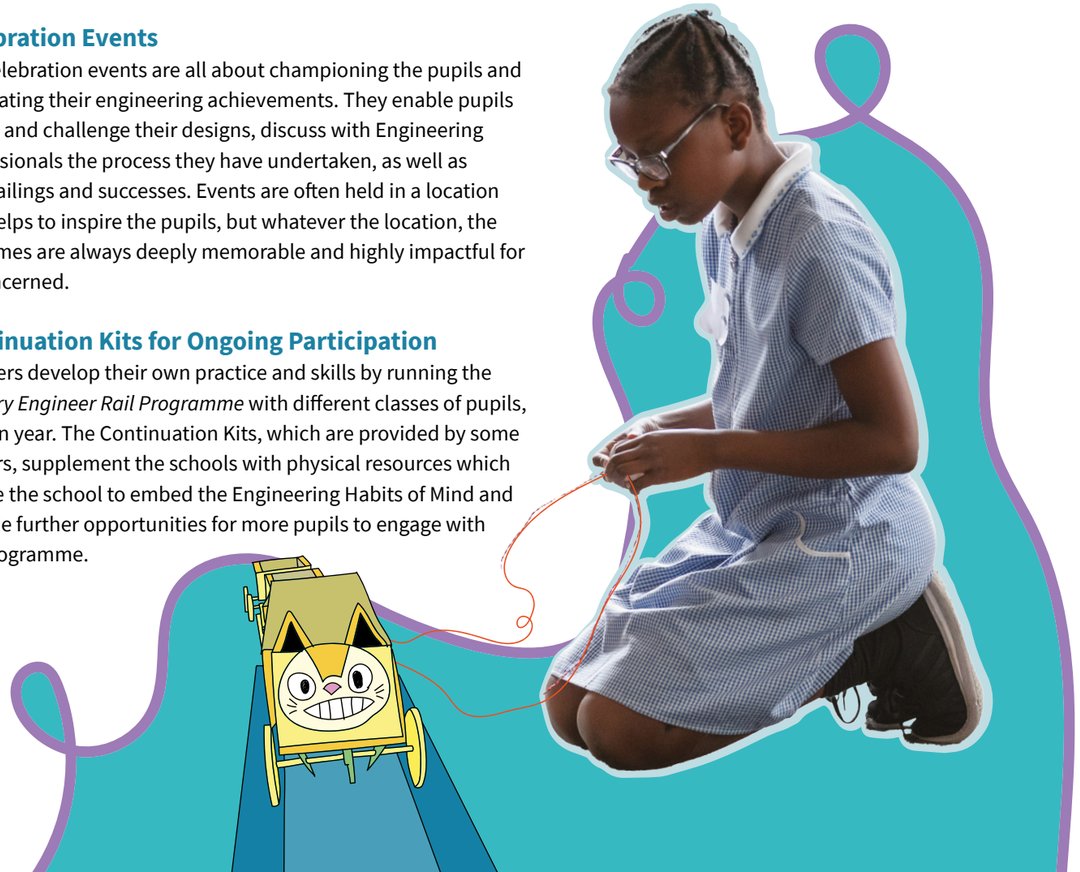
Each school is provided with enough materials for 60 pupils working in pairs of two. They are given access to a digital library of resources such as lesson plans and cross-curricular teaching ideas to ensure the teacher has the ability to run the project in class in a way that suits them.

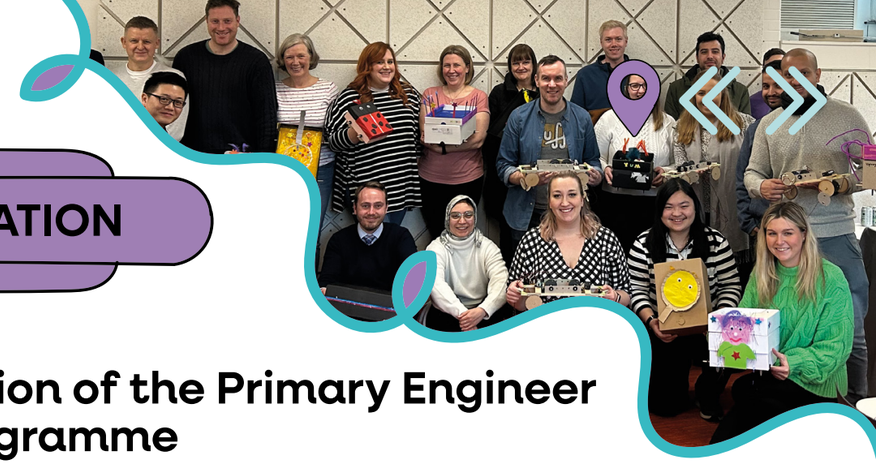
Celebration Events

The celebration events are all about championing the pupils and celebrating their engineering achievements. They enable pupils to test and challenge their designs, discuss with Engineering professionals the process they have undertaken, as well as their failings and successes. Events are often held in a location that helps to inspire the pupils, but whatever the location, the outcomes are always deeply memorable and highly impactful for all concerned.

Continuation Kits for Ongoing Participation

Teachers develop their own practice and skills by running the *Primary Engineer Rail Programme* with different classes of pupils, year on year. The Continuation Kits, which are provided by some funders, supplement the schools with physical resources which enable the school to embed the Engineering Habits of Mind and provide further opportunities for more pupils to engage with the programme.





4. EVALUATION

Evaluation of the Primary Engineer Rail Programme

The evaluation report draws on five years of annual evaluation survey data, testimonials and other communications. It examines the outcomes for teachers, schools and pupils in relation to Rail Engineering, focusing on:

- **Impact for teachers and schools in terms of knowledge, skills and confidence.**
- **Impact for pupils in terms of enjoyment, curiosity and understanding of Engineering.**
- **Impacts specific to Rail Engineering in terms of stimulating children's interest and curiosity in engineering careers.**

4.1. Impact for Teachers

Teachers improved not only in their Engineering knowledge and confidence but also more generally in their approach to teaching and their understanding of the potential of Engineering in the curriculum. They gained a closer understanding of the value of representation in diversifying the Engineering sector.

The *Rail Programme* achieved the following outcomes for teachers:

- **94% Better understanding of engineering**
- **93% Greater confidence to approach the subject of engineering**
- **100% Very high satisfaction with the training programme**
- **94% Better understanding of diversity and the importance of representation**
- **85% Increased confidence in Design and Technology/ Technology teaching**
- **91% Teachers were more convinced of the cross curricular potential of engineering**
- **98% Teachers had a better understanding of the benefits of teaching engineering**
- **Teachers gained confidence with Science and Mathematics too.**
- **CPD ensured learning was embedded in the schools by investing in the staff. This sustained engineering in the curriculum beyond the lifespan of the Primary Engineer intervention**
- **Effective elements of the training were: addressing concerns and misconceptions; supporting key skills; collaborating with a professional engineer; and experiencing the activities first hand.**

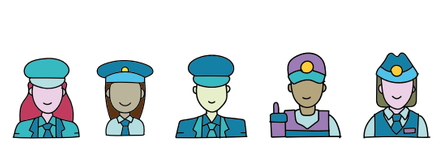
4.2. Impact for Pupils

Engineering is not a statutory curriculum subject in England, Wales or Scotland, and this is a major barrier to attracting young people into Engineering careers. Primary Engineer aims to offer an enjoyable first experience of Engineering for the children who take part, providing a variety of role models to inspire the full diversity of career entrants.

Teachers reported the following outcomes for children:

- **93%** Children had a greater understanding of engineering and its role in society
- **90%** The programme had a strong impact on children's learning
- **99%** Children enjoyed learning
- **91%** The programme stimulated children's curiosity and they wanted to learn more about engineering
- **85%** The programme positively affected children's career aspirations in relation to engineering
- **83%** Children's stereotypes about who can be an engineer were challenged
- **91%** Children developed Engineering Habits of Mind[5], the ways of thinking and doing that are characteristic of engineers. The programme was especially strong in developing problem finding and problem solving.
- The programme supported all six Engineering Habits of Mind (systems thinking, problem finding, visualising, adapting, improving, and creative problem solving). These characteristics are specific to engineering but also transferable as learning skills across the curriculum.
- Teachers reported benefits to pupils not only in Engineering, but in Design and Technology, Science and Mathematics.

[5]Royal Academy of Engineering, 2014: Thinking like an engineer, implications for the education system.



4.3. Impacts Specific to Rail Engineering

- The rail sector has a long heritage in the UK and continues to play a crucial role in society and in the economy, as well as the oncoming transition to NetZero.
- Railways are familiar to most children, and most will have experienced rail travel. Rail engineering is well placed to pique the curiosity of children, as it is closely related to their real world.
- Children meet industry professionals who provide insight into engineering careers and can act as role models.

Teachers reported the following outcomes:

- **85%** The programme positively influenced the STEM aspirations of children
- **83%** Pupils felt engineering is a career anyone can pursue
- **75%** Pupils understood more about jobs in the rail sector
- **91%** Children were curious to learn more about engineering

5. NEXT STEPS ON THE JOURNEY

Following the conclusions drawn from this report, a series of strategic actions will be undertaken to fortify the effectiveness of the *Primary Engineer Rail Programme*:

1. Launch two new *Rail Programme* extension activities focusing on Tunnelling and Signalling to broaden pupils' rail-related experiences.
2. Launch a brand-new course for careers leads and guidance teachers called "Engineering a Career" to offer training and experiences for teachers in linking engineering to all secondary subject areas. This course is designed to help teachers and career leaders in school identify how any subject can be linked to engineering.
3. Increase funding from industry, educational institutions, and local authorities to facilitate broader adoption of the *Primary Engineer Rail Programme* across UK schools.
4. Extend the reach of the *Primary Engineer Rail Programme* UK wide by launching in Northern Ireland and collaborating with additional partners in England, Scotland, and Wales.
5. Expand the network of engineering professionals available to mentor and support during the delivery of the *Primary Engineer Rail Programme*.

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