

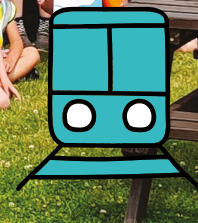
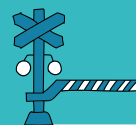
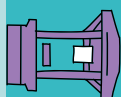
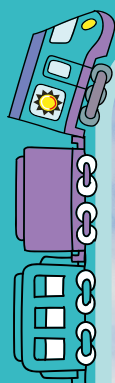
Primary Engineer®
...the first step

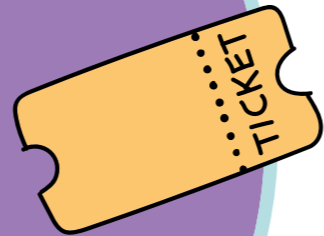
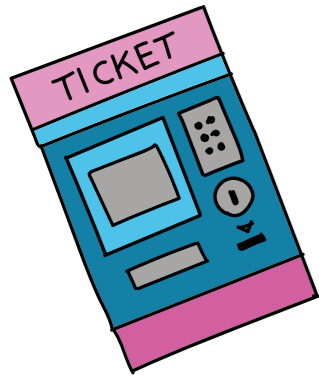


Keeping Kids On Track:

#ENGINEERSINTheMaking

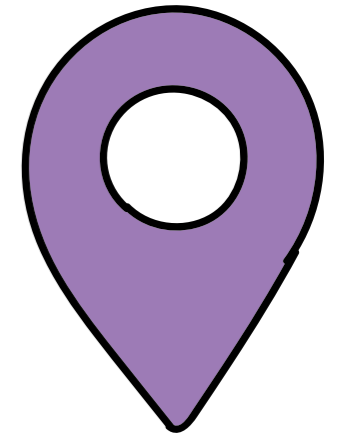
Evaluating Five Years of
The Primary Engineer Rail Programme.





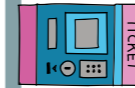
ENGINEERS IN THE MAKING®

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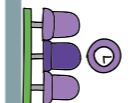
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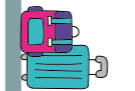
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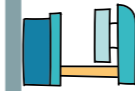
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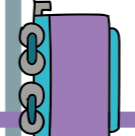


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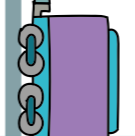
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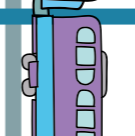
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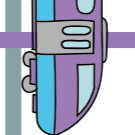
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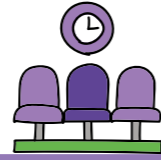


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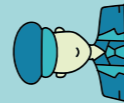
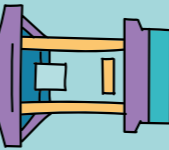
SUMMARY



For five years, Primary Engineer has offered the *Primary Engineer Rail Programme*: a creative, practical Rail Engineering education programme for primary schools across the UK – first introduced in England and Scotland and more recently in Wales. Originally launched in 2018 in collaboration with Hitachi Rail, this programme is designed to inspire future engineering professionals by bringing Rail Engineering to the heart of the Science, Technology, Engineering and Mathematics (STEM) curriculum. Young pupils take on the role of rail engineers to collaboratively design, build, test and refine rail vehicle models in a comprehensive Engineering learning experience.

Participating schools are provided with a suite of resources, including teacher training, tools, physical materials, lesson plans and curriculum teaching guidance. Teachers are supported through contact with engineering professionals, who provide real-world insights and support pupils as they design and build their models. The programme culminates in celebration events, organised by Primary Engineer, that bring pupils, teachers and engineering professionals together to share and celebrate the work of pupils. These events help to reinforce the link between the classroom and engineering professionals, which may further support the development of Engineering interest, knowledge and skills amongst young pupils.

The following report outlines a detailed evaluation of the *Primary Engineer Rail Programme* and its impacts from 2018–2023. Drawing on five years of evaluation data, this report illustrates how teachers and young pupils benefit from their programme experience. Teacher knowledge, skills and confidence are explored and commented on, alongside examinations of pupil enjoyment, understanding and interest in Engineering careers, and development of skills in pupils.



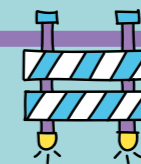
This analysis provides a deeper perspective on how the programme has inspired and developed greater understanding of Rail Engineering amongst young pupils and has supported schools to bring real-world Engineering into classroom experiences. Current research literature is considered to understand how the *Primary Engineer Rail Programme* has supported teachers and pupils to engage in Engineering practices. The report identifies a range of positive impacts that validate the *Primary Engineer Rail Programme* and support its continuing efforts to nurture future engineers:

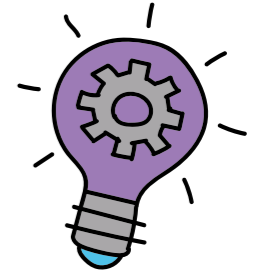
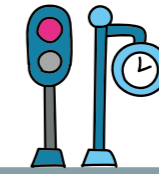
The *Primary Engineering Rail Programme* was found to positively represent Rail Engineering to young people in UK schools. Teachers report that their pupils enjoy learning about Rail Engineering and are often curious to learn more. These teachers also often report positive effects on career aspirations and knowledge of the rail sector amongst pupils.

Teachers who take part in the *Primary Engineer Rail Programme* develop a greater understanding of Engineering and develop confidence with the subject in the classroom. In addition, their experiences often support greater confidence with practical making, as well as with curriculum subjects, such as Design and Technology, Science and Mathematics.

Pupils are seen to widely benefit from their *Primary Engineer Rail Programme* experience, with teachers reporting positive impacts on Engineering learning, curiosity, enjoyment, aspirations and ways of 'thinking and doing' that are central to Engineering practices. Also, teachers often report benefits to pupil knowledge and skills in curriculum subjects, such as Design and Technology, Science and Mathematics.

The *Primary Engineer Rail Programme* has successfully supported Engineering learning in both England and Scotland, and, as of 2022, it is also offered in Wales. This ability to respond to devolved education systems and differing curricula highlights the value and effectiveness of its approach and content. These findings support its continued growth and application in new settings for new audiences of potential engineers.





INTRODUCTION

An Introduction from our Founder and CEO

Primary Engineer has a long history of developing impactful programmes, competitions and qualifications that support and enhance Engineering education in primary schools. In 2017, we identified that the theme of 'rail' would be attractive to primary teachers and, with the support of Hitachi Rail, designed and created The *Primary Engineer Rail Programme*. This programme has evolved to become one of the most popular and impactful ways we bring Engineering into the classroom.

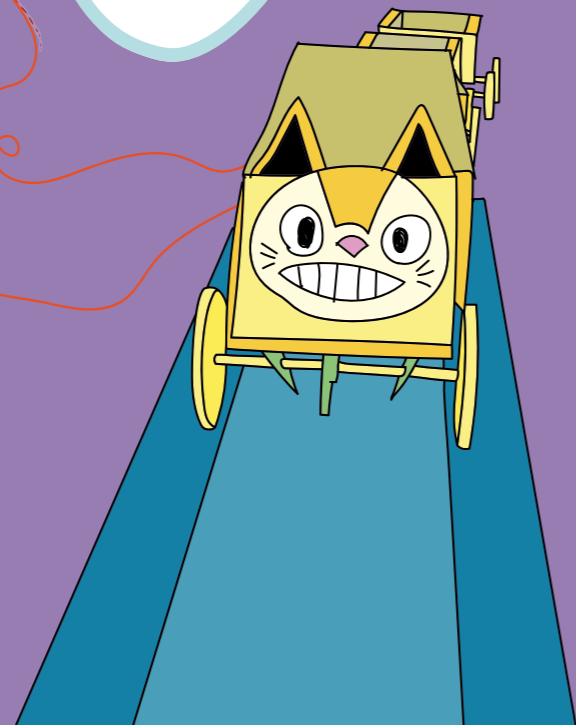


The underlying structure of this programme is project-based learning, the development of teachers, and linking engineering professionals with schools. These professionals not only support teachers during training but also help deliver Engineering practices in the classroom by working with pupils. This strong sector link ensures both the teachers and the pupils have contact with the real world of rail in all its diversity of careers and people. This core structure has enabled the programme to align with the different curricula of the UK's devolved nations. This approach has been welcomed by teachers, who have often taken advantage of the Continuation Kits industry has provided to take part in the programme again. This maintains the programme annually, introducing a new group of pupils and pupils to the sector every year, as well as compounding the skills of the teachers and maintaining the relationships with Engineering professionals.

Whilst we have delivered this programme successfully in England and Scotland, we have more recently deployed the programme in Wales with resounding success, thanks to the support of The Department for Business and Trade (DBT), The Global Centre of Rail Excellence (GCRE), Network Rail, Innovate UK, Stadler Rail and the Welsh Government. We look forward to growing our work in Wales, as well as expanding into Northern Ireland.

This impact report not only tells the story but is a thank you to those organisations that have funded and supported us, as well as being a call to action to those who are thinking about it.

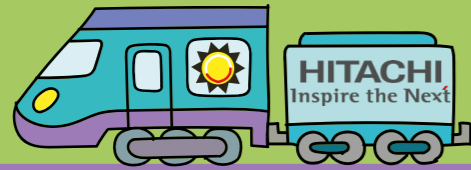
Dr Susan Scurlock MBE



PROGRAMME TIMELINE

The Journey So Far

Partner(s)
1



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

2018/19

50
SCHOOLS

circa **2500** PUPILS

Partner(s)
2



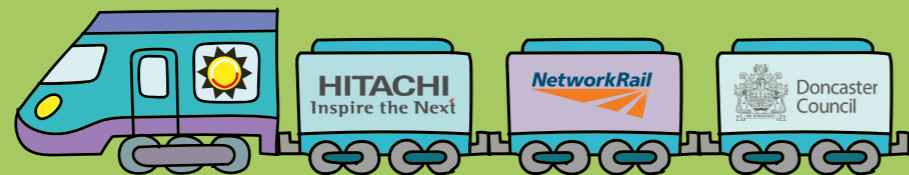
The Primary Engineer Rail Programme is launched for a second year. Adjustments to the programme are made to support online delivery in response to the Covid-19 pandemic.

2019/20

60
SCHOOLS

circa **3000** PUPILS

Partner(s)
3



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.

2020/21

150
SCHOOLS

circa **7500** PUPILS



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

2021/22



circa **13,450** PUPILS

269
SCHOOLS
Partner(s)
16

2022/23



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.

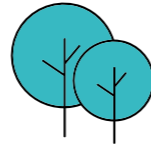
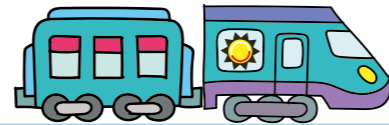


circa **13,800** PUPILS

Partner(s)
18

276
SCHOOLS

PROGRAMME OUTLINE



The Primary Engineer Rail Programme

The *Primary Engineer Rail Programme* offers schools an exciting project-based learning experience that delivers Engineering to the heart of the curriculum. Through this programme, primary school teachers are supported to introduce Rail Engineering and practical making to their pupils. Classrooms become design workshops, and pupils become ‘Engineers in the Making®’ as they collaboratively design, build and test their own rail vehicles. A series of structured lessons guide pupils to develop Engineering knowledge and skills such as problem finding, problem solving, adapting and improving, while discovering insights about the rail sector and modern engineering in the world around them.

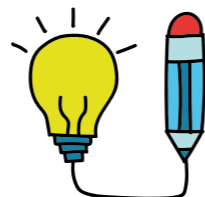
Designed by Primary Engineer and pioneered in collaboration with Hitachi Rail, the *Primary Engineer Rail Programme* is now funded and supported by many key partners across the UK. It is estimated that over 40,000 Rail Engineering learning experiences have been provided by this programme across England and Scotland, and more recently in Wales. More than 13,000 experiences were provided in 2022–2023 alone. Despite its growth, the objectives of this programme remain the same: to inspire the next generation of engineers, to support a greater understanding and interest in Rail Engineering and to deliver Engineering into the heart of the school curriculum.

Although designed with a focus on Engineering, this project-based learning experience can also support interdisciplinary learning in other subject areas. Science and Mathematics can be used to explore the theory and design of rail systems and vehicles, while Art and Design and Technology/Technologies can be drawn on to build and test rail models. Geography and History can also be drawn on to understand the heritage of the rail sector in the United Kingdom, while Literacy skills are developed through collaborative working and the communication of ideas. These cross-cutting connections between subjects demonstrate the utility of bringing Engineering learning into school settings and the value offered by the *Primary Engineer Rail Programme*. The project-based approach to learning the topic of ‘Rail Engineering’ also allows the *Primary Engineer Rail Programme* to remain accessible across the devolved education systems of the United Kingdom, supporting a rich and far-reaching learning experience across nations. The successful participation of schools in England, Scotland and Wales demonstrates this capacity to support rail-themed Engineering learning across educational settings and curricula.

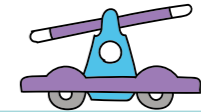
“I loved the practical approach of the course and the overall idea of bringing engineering into the classroom. Thank you.”
Teacher, England.

“It works! That moment when a child connects everything up and the train starts moving for the first time is very special.”

The realisation that they can successfully build a moving vehicle is inspiring, helping to build confidence and ambition in the field of STEM.”
Teacher, Scotland.



SUPPORT FOR SCHOOLS



Support for Schools Throughout the Primary Engineer Rail Programme:

Primary Engineer offers a suite of resources and guidance to schools as they journey through the *Primary Engineer Rail Programme*:

Teacher Continuing Professional Development Training:

Each participating school is offered the opportunity to send up to two teachers to a one-day training session, funded by either sector, government or universities, to develop and hone their Engineering teaching knowledge and skills. These training events offer a supportive and collaborative learning environment where experienced Primary Engineer Teacher Trainers guide teachers through the delivery of the classroom activities. Teachers are provided with the opportunity to develop a connection with Engineering professionals from rail sector partner organisations, who can support the delivery in UK classrooms with sector insights and knowledge. Materials are provided to teachers, who themselves complete the design and build elements to create their own rail vehicle. This experience involves the same challenges their pupils will be expected to take on during the *Primary Engineer Rail Programme*. The objective of these training sessions is to provide knowledge and confidence in the teachers to support a greater presence of Engineering in UK classrooms. The models created by teachers during their training can then be taken into classrooms as learning tools to aid in the design and making of pupils’ own trains.

“It was great to build a working vehicle and to experience the problems that could arise when trying to build something. This helped me to understand what it might be like for the learners and will help me teach them better. It is an area of the curriculum I feel quite inexperienced in and this has helped give me more confidence in [Science, Technology, Engineering, Arts and Mathematics (STEAM)] projects in the classroom.”
Teacher, Scotland.

“Seeing children make mistakes and then overcome them and succeed with their project, despite the problems, has made me immensely proud of them. It gave them huge confidence in themselves not only with engineering but in other areas too. It was a very positive project.”
Teacher, England.



“It is good to make contact with engineers and be able to utilise them in the school environment in the future.”

Teacher, England.

Collaboration with Engineering Professionals:

During the one-day training event, teachers meet and are paired with local Engineering professionals connected to the rail sector, who can support the delivery of the programme. Primary Engineer facilitates this introduction and encourages a collaborative relationship to develop between teachers and Engineering professionals. The engineer represents a key source of knowledge that can be drawn on by teachers to aid in the delivery of the programme. Organising this introduction during the training session provides teachers with a relaxed environment, away from pupils, to engage with a engineering professionals and further their understanding. This relationship can provide teachers with a rich source of insight into the world of Engineering and the rail sector. Teachers are encouraged to organise a classroom-based interview with their partner engineer to extend the benefit of meeting an engineer to the young pupils completing the programme.

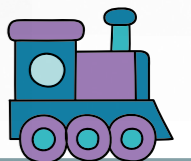
Knowing an engineering professional or ‘knowledgeable other’ in Engineering is deeply influential for young pupils. Young people who aspire to Engineering-related careers will more often possess a social connection to people employed in Engineering roles. Research suggests suggest that role models and sources of first-hand experience with Engineering are deeply influential and supportive for pupils¹. Yet access to ‘knowledgeable others’ for engineering is rare: teachers and parents are trusted sources of career information but are acknowledged as possessing a somewhat limited understanding of Engineering and Engineering careers². The introduction to Engineering professionals offered by Primary Engineer is thereby a valuable learning resource that encourages partnership between engineers and teachers. This resource can then be drawn on to support the development of young people during their *Primary Engineer Rail Programme* experience and beyond.

“The children loved asking the engineers questions about their jobs. They were really proud of themselves for learning new skills like sawing.”

Teacher, England.

Resources and Materials:

Following the teacher training session, schools are provided with a supply of materials and resources to enable them to deliver the programme in their classrooms. This includes a box of tools and consumable materials. This supply of resources allows the creation of one train per two pupils, ensuring many trains can be developed in each classroom and that every pupil receives a hands-on experience with the Engineering design process. Teachers are also provided with access to a library of digital resources, including lesson plans to guide the delivery of the programme within classroom settings. The supplied resources also outline how taking part in the programme can meet curriculum requirements and develop key learning skills, supporting the integration of the programme with wider school activities. The resources provided by Primary Engineer are designed to remove barriers to participation and widen access to Engineering learning in schools. With the lesson plans and materials provided by Primary Engineer and the insights and engineering expertise offered by the engineering professionals, teachers are ready to deliver the *Primary Engineer Rail Programme* in their schools.



¹Takruri-Rizk et al., 2008: Gendered learning experience of engineering and technology students.

² EngineeringUK, 2019: Engineering Brand Monitor 2019.

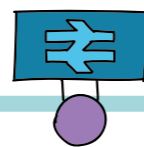
“ A team from our class won best train. It was wonderful to see the pride and delight on our whole class’s faces when they found out when we returned from the trip. We also had a train exhibition for the parents and demonstrated our trains. It was wonderful to see how impressed and proud they were of the children. ”

Teacher, England.

Rail Programme Celebration Events:

Schools that participate with the *Primary Engineer Rail Programme* are also invited to attend celebration events to complete their experience. These events see a selection of teams, from a number of schools in a region, brought together to compete in a series of challenge tests with their crafted models. Where possible these events take place within a rail-related setting to encourage pupils to develop a wider understanding of Rail Engineering. Each rail vehicle is tested and judged against performance criteria to determine the effectiveness of the developed rail vehicles. During the celebration event, pupils are interviewed by engineering professionals, facilitating reflection on their learning journey while fostering a social connection with an engineer that can leave a lasting impact. Prizes are awarded for a number of categories, with all participants recognised for their contributions and efforts in the *Primary Engineer Rail Programme*.

These events provide pupils with a rich, collaborative social learning experience to draw together their Rail Programme participation. By providing both an out-of-school and inter-school experience, pupils are given the opportunity to further recognise the dynamic and real-world significance of Rail Engineering. Given the limited presence of Engineering within much of curricular learning, these events offer a special and memorable experience for pupils to associate with Engineering as they move through education towards future employment.



“ The celebration event was really good this year, the model train was excellent! ”

Teacher, England.

Continuation Kits for Ongoing Participation:

Participating schools may also be offered the opportunity to access Continuation Kits to support future involvement with the *Primary Engineer Rail Programme*. These kits include consumable materials to facilitate further participation in subsequent academic cycles. As teachers will not require further training to participate with the programme, these kits offer a cost-effective stream of support to encourage lasting change in schools. Continuation Kits represent a key method of developing sustainable change to support the place of Engineering within school settings.

“ A Year 5 pupil took his rail model home and continues to adapt it and improve it. He has now returned it to school and asked me to support him with adaptations. A definite engineer in the making! ”

Teacher, England.

“ An amazing range of resources and easily transferable to other staff and into the classroom to raise the STEM profile within the school. ”

Teacher, England.

“ All pupils said that they wished they were able to do projects like this every year. ”

Teacher, Scotland.

EVALUATING

Evaluating the Primary Engineer Rail Programme

Each year, the *Primary Engineer Rail Programme* is evaluated through teacher surveys to determine the impact of the programme and to identify improvements for the year ahead. The following analysis outlined in this report is offered as a synthesis of evaluations, drawing on data from annual evaluations completed from 2018–2023. These yearly evaluations have evolved over time in response to insights from previous evaluations and new research findings in wider literature. As a result, richer evaluation data is available for more recent years. Data collected from 2018–2023 was collated and examined to identify the outcomes offered by the *Rail Programme*. This analysis draws on voluntary responses from teachers (N=310) who participated in post-programme evaluations (a number of teachers each year did not participate in the evaluations). Operational participation data and testimonials collected through contact with teachers are also drawn on to explore the impact of the programme. Findings from these synthesised datasets are offered as a snapshot overview of the *Primary Engineer Rail Programme* and its impact.

Three evaluation topics are identified and examined in detail within this report.

First, the programme's impact on teachers is explored to identify how knowledge, skills and confidence with Engineering teaching are developed through training and delivery of the *Primary Engineer Rail Programme*.

Second, pupil enjoyment, curiosity and Engineering learning are explored through teacher-led assessments of pupil experiences. Understanding and interest in Engineering careers are also examined.

Finally, data is examined to consider the Rail Engineering-specific outcomes of the *Primary Engineer Rail Programme*. Enjoyment of the programme and curiosity for more Rail Engineering experiences are considered, alongside an assessment of impact to the career aspirations of young pupils. Commentary is outlined on the significance of the programme to rail-specific outcomes in UK education.

A conclusion draws together these insights to highlight the value offered by the *Primary Engineer Rail Programme* to schools, teachers, pupils and the rail sector in the UK.

“We’ve been part of this project now for the last two years and we’ve really up-skilled our staff on delivering fantastic Technology to our children. As primary teachers, you have to teach everything. You can’t be an absolute expert in all those areas, so we’ve reached out with the support of Siemens. We’ve really promoted Technology and Engineering within our schools.

[The children] worked really hard together as a team. It’s built perseverance, team building, all of the basic skills that well-rounded individuals would have. It’s also up skilled them in Technology in creating the circuits, in creating the mechanisms, and they’ve worked phenomenally hard with the staff to create these trains.

It’s really up-skilled the teachers too helping them to deliver high-class, high-end lessons to our pupils which we endeavour to do in all subject areas. Technology is always one of those that you know it doesn’t have so much of a high profile as Maths and Literacy, so it has really up-skilled with the support of the training sessions. It’s all been a fantastic experience.

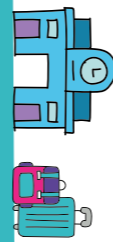
I think it’s a fantastic project, giving children - whether they’re girls, boys, children with any additional needs - the opportunity to get involved. We’ve got a group of children today, predominantly girls, who are really inspired to be engineers, and that’s what we hope that we can inspire for the engineers of the future.”

IMPACT FOR TEACHERS & SCHOOLS

The Primary Engineer Rail Programme Impact for Teachers and Schools

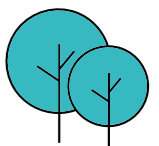
Past research shows that teachers in the United Kingdom possess a somewhat limited understanding of Engineering and a low confidence talking about the subject with pupils³. This lack of confidence is understandable given that Engineering learning is rarely prioritised within national curricula or initial teacher training programmes. However, given the influential role teachers play in the career education and guidance of young people, this lack of confidence must be acknowledged as a risk to the development of future engineers.

The *Primary Engineer Rail Programme* addresses this challenge by offering CPD training to teachers from participating primary schools. Teacher feedback evaluations reveal that this training is successful at supporting Engineering confidence and knowledge. **In 2019/2020, 94% of teachers who responded reported that their understanding of Engineering had grown, and 100% indicated a high or very high level of satisfaction with their training session. In 2022/2023, 93% of responding teachers reported a greater confidence approaching the subject of Engineering within the classroom following their Rail Programme experience.** By addressing concerns and misconceptions, providing key skills support, collaborating with an engineering professional and experiencing an Engineering learning activity first-hand, this training is successful in building the Engineering understanding and confidence of teachers. Not only will this support the delivery of the *Primary Engineer Rail Programme*, but it may also support a legacy of future Engineering teaching and learning capacity in participating schools.

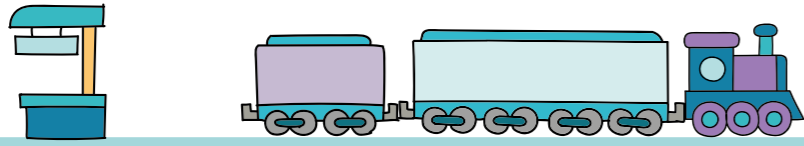


The programme also supports teachers to recognise the need for greater diversity within Engineering. Following their training **in 2019/2020, 94% of responding teachers reported a greater understanding of the diversity challenges within Engineering and the important role that they as teachers can play in nurturing career aspirations.** As trusted sources of career information, teachers are a key partner in efforts to address Engineering inequities among their pupils from an early age. The *Primary Engineer Rail Programme* training is successful in raising this issue with teachers and encouraging greater care in the representation of Engineering within classrooms.

Further analysis also highlights the benefits the programme can offer to curriculum delivery and outcomes in participating schools. **Evaluations returned in 2020/2021 show that, following their training, participating teachers were more confident in areas such as Design and Technology/Technologies and teaching with practical making. In 2021/2022, 85% of teachers who participated in programme evaluation reported an improvement in their confidence for delivery of key curriculum skills for Design and Technology/Technologies. A similar rate of improvement was noted in 2022/2023, with 92% of teachers reporting an improvement in Design and Technology/Technologies confidence.** An improvement in teacher confidence is also noted more generally beyond the Engineering context. **Annual evaluations have also identified increased teacher confidence with subjects such as Science and Mathematics.**



³EngineeringUK, 2019: Engineering Brand Monitor 2019.



These findings show a cross-cutting benefit to teachers who take part in the *Primary Engineer Rail Programme*. This indicates that the curriculum-mapped design is successful and that schools can integrate this programme in a way that supports multiple learning outcomes across the curriculum. Given the limited presence of Engineering in much of the UK national curricula, these findings highlight a deeply important aspect of the programme.

In 2020/2021, 98% of responding teachers agreed that there was value to including Engineering in curricular learning to benefit pupils both in their educational experiences and future careers. Similarly, in 2021/2022, 81% of teachers reported a greater understanding of how Engineering could support 'cross-curricular' learning following their training. This shows that teachers who took part in the *Primary Engineer Rail Programme* improved not only in their Engineering knowledge and confidence but also more generally in their approach to teaching. Engineering can be understood as an 'integrative practice,' with Science, Technology and Mathematics playing important roles in Engineering activities. The improvements in teacher confidence with Science and Mathematics show that the *Primary Engineer Rail Programme* is a valid and true-to-life Engineering experience that integrates learning (and training) for many subject areas.

Evaluation of the *Primary Engineer Rail Programme* indicates a strong benefit to teachers and schools who participate with this programme. A limited Engineering confidence and knowledge amongst teachers is acknowledged as a threat to the development of future engineers. But evaluation data demonstrates that the teacher training and wider programme experience offered by Primary Engineer can address this challenge. Following their training, teachers report greater confidence and knowledge with Engineering and other subject areas, such as Science, Design and Technology/Technologies, and Mathematics. They also report a greater awareness of Engineering diversity challenges and the important role that teachers play in shaping these patterns of future participation in Engineering. Although the evaluation of this programme does not track long-term development of teachers, it is reasonable to expect that the training and successful completion of the programme could support teachers in the future, suggesting a legacy of positive impact. Schools who participate in the *Primary Engineer Rail Programme* not only benefit from resources and guidance but also staff development that can support curriculum objectives and wider STEM learning strategies throughout the school.

“It was particularly helpful to hear practical suggestions for how we might use this in a Primary setting - e.g. through topics, making curricular links and skills as well as finding out about the events and projects that Primary Engineers hold.”

Teacher, Scotland.



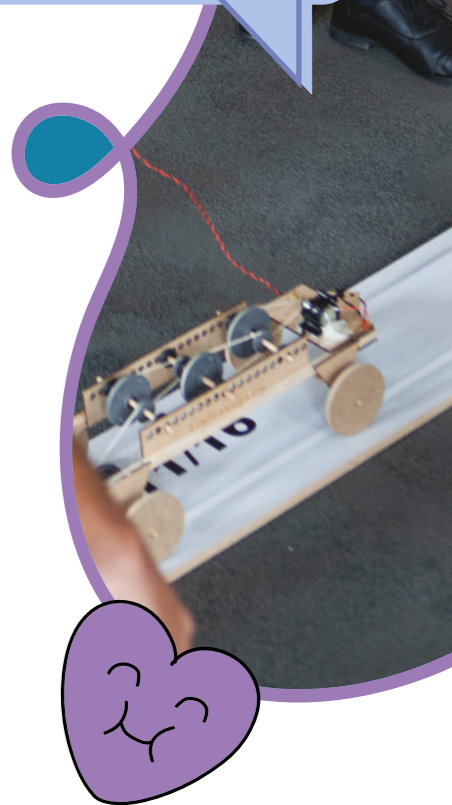
“I am the DT lead, so I decided to [participate with] my year five class of 21 children and one of the engineers actually came in for a full day, which was absolutely amazing. We focused on building the frame first and some of the stumbling blocks along the way, [including] measuring accuracy.

The children absolutely loved the day. They were thrilled, and at the end of the day, they sort of said we've not done real lessons today. We reflected on that, and we went through what lessons and subject knowledge we actually needed to produce the frame: we had done lots of maths, lots of science, lots of Design and Technology. It was just a fantastic day all round. We then spent further afternoons working on the design and the actual model itself.”

“I'm a Year Two class teacher and we actually paired up with the mixed Year 5-6 class, so we had sixty children all in all at the same time and it was just enormous fun. We worked together, we took it step by step, the relationships that the children built because of that was incredible.

It was such a relaxed atmosphere, yet the learning was so purposeful. We learned skills that actually would have been really difficult to bring about, it was just such enjoyable experience. We also got together again to test, sort of see how far we can get the shoebox trains to move and it has just been such a wonderful experience.

In fact, we are actually going to roll it out in the rest of the school. We're going to gather the resources because the rest of the school really wants to take part in it - it's been such a positive and just a great experience, so thank you.”

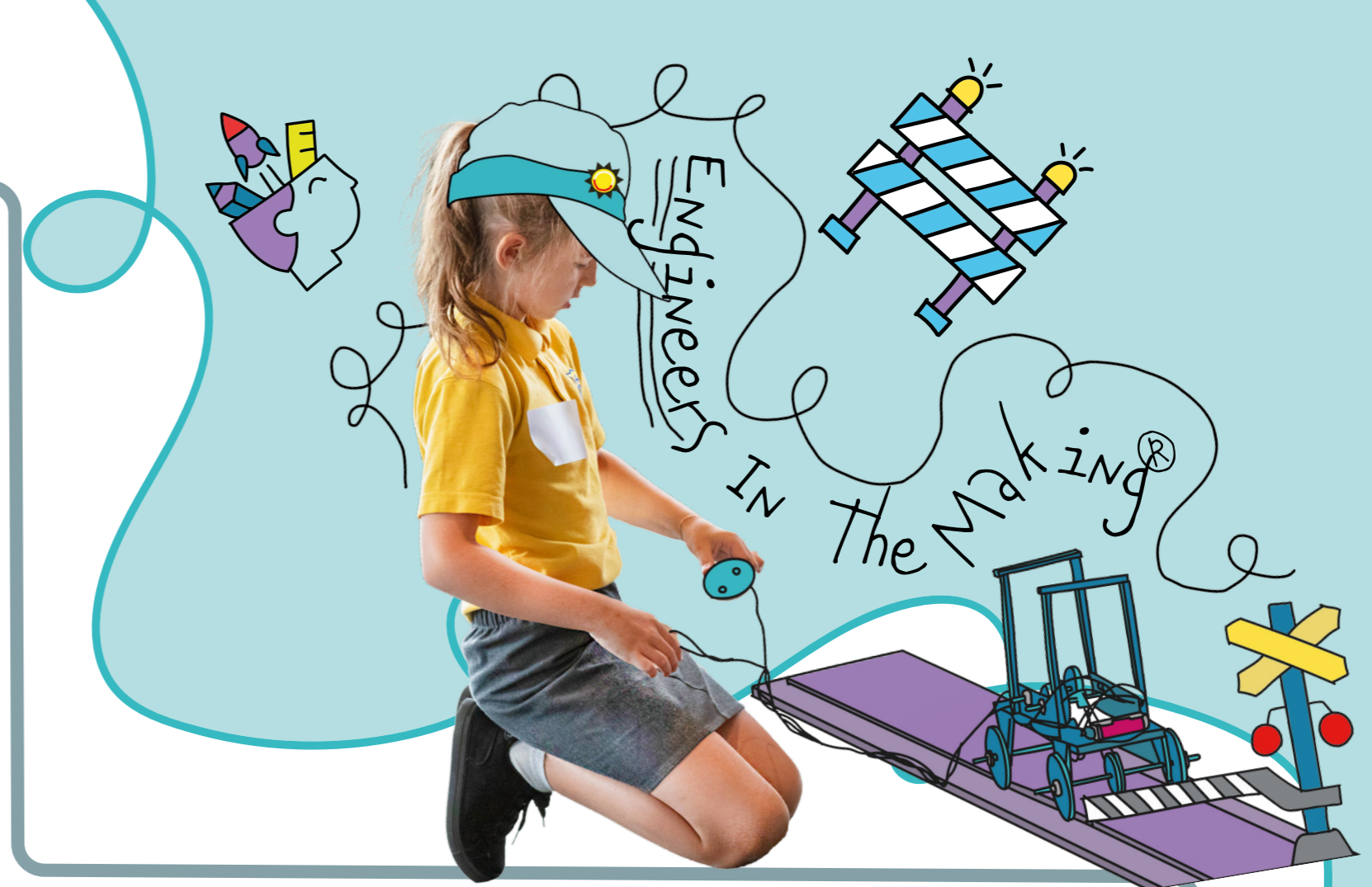


IMPACT ON PUPILS

The Primary Engineer Rail Programme Impact on Pupils

For many young people in the UK, Engineering remains an unknown subject. Young people in the UK have historically possessed only a limited understanding of Engineering that may carry misconceptions based on dated stereotypes^{4,5}. The limited presence and focus on Engineering in UK schools likely contributes to this enormous challenge and must be addressed if more young people are going to consider an Engineering-related career. It is very possible that the *Primary Engineer Rail Programme* will be the most comprehensive Engineering experience young pupils will have yet encountered in their lives. For this reason, it is crucial that pupils receive a positive and supportive first impression, illustrating a variety of roles to inspire the next generation of engineers.

The impact of the *Primary Engineer Rail Programme* on pupils is evaluated through teacher-led assessment of pupil experiences and outcomes. These evaluations show that pupils benefit greatly from taking part. **In 2022/2023, 90% of responding teachers reported that the programme had a strong impact on pupil learning**, while **93% reported that, after taking part, pupils had a greater understanding of both Engineering and its importance in society**. This pattern of results is consistent with evaluations conducted in other years, which also establish a benefit to learning. Taking part in the Rail Programme is also a fun experience for pupils, with **99% of responding teachers in 2022/2023 agreeing that their pupils enjoyed learning about Engineering during the programme**. Pupils not only enjoyed the experience but were left curious for more: **91% of teachers in the same year reported that their pupils wished to learn more about Engineering after taking part in the *Primary Engineer Rail Programme***. These results show that it is successful in its key aim to inspire young pupils through a creative Rail Engineering experience.



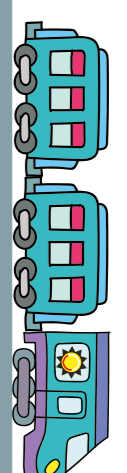
These positive impacts are also found in relation to Engineering careers. **In 2022/2023, 85% of teachers who participated in programme evaluation felt that the programme had positively influenced the Engineering and STEM career aspirations of their pupils**. The programme was found to challenge the idea that Engineering is only for certain types of people, with **83% of teachers reporting that, following the programme, their pupils felt that Engineering is a career that anyone can pursue**. Such findings support that the *Primary Engineer Rail Programme* is successful in its aim to support greater participation and diversity within future rail engineers.

These encouraging findings support that young people enjoy their experience as 'Engineers in the Making®' through the design, building and testing of their own rail vehicles. Further evaluation highlights how participating pupils can develop Engineering Habits of Mind (EHoM)⁶, or 'ways of thinking and doing' that are characteristic of engineering professionals. These characteristics (such as creative problem solving and systems-thinking) are fundamentally important to Engineering practices and are a key outcome of Engineering learning. Teachers report that pupils who participate in the *Primary Engineer Rail Programme* successfully adopt these ways of 'thinking and doing' through their participation in the programme.

⁴ Marshall et al., 2007: Public Attitudes to and Perceptions of Engineering and Engineers 2007.

⁵ Bevins et al., 2005: A study of UK secondary school students' perceptions of science and engineering.

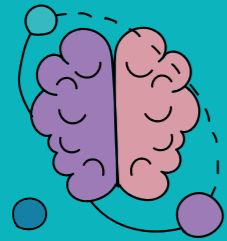
⁶ Royal Academy of Engineering, 2014: Thinking like an engineer, implications for the education system.



ENGINEERING HABITS OF MIND

Percentage of Teachers Reporting Successful Adoption of Engineering Habits of Mind by Pupils

Systems Thinking



77%

Playing with ideas, fitting concepts together, building rich networks of understanding.

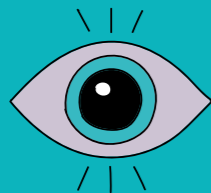
Problem Finding



91%

Testing and identifying problems, acknowledging areas of improvement, exploring opportunities for innovation.

Visualising



79%

Imagining solutions, exploring ideas, planning and rehearsing actions.

Adapting



89%

Trying new things, adapting to change, reflecting on own approaches to work.

Improving



90%

Experimenting, learning from mistakes, exploring other ways of thinking

Creative Problem Solving



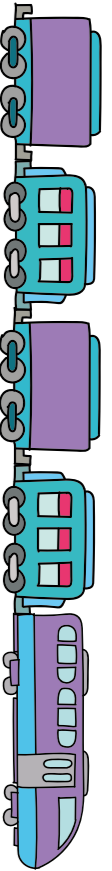
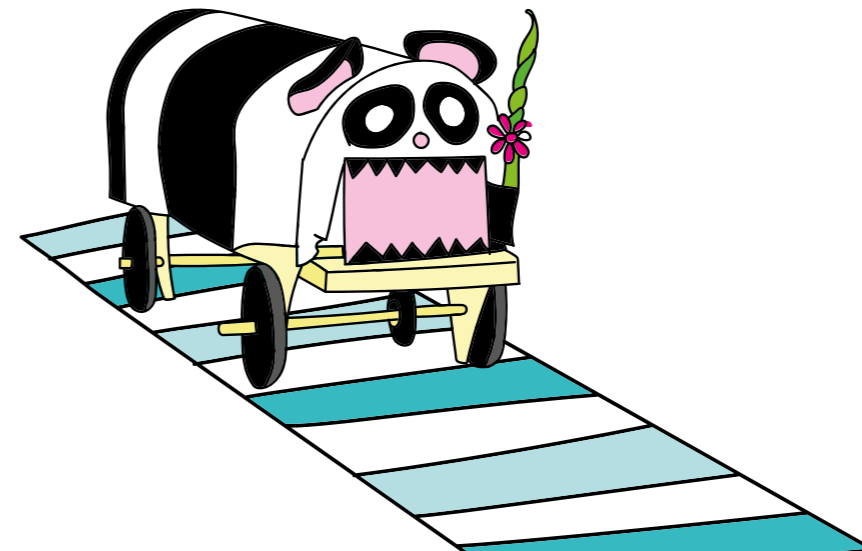
91%

A vital process that lies at the heart of engineering practice.

These teacher-led assessments of pupil behaviour show that the *Primary Engineer Rail Programme* is successful in providing a robust and true-to-life Engineering learning experience for pupils. By designing, building and testing a rail vehicle model, pupils receive an Engineering design process experience that challenges them to think like engineers in an age-appropriate way. Each of these habits of mind are featured within the *Rail Programme* pupil journey, providing the opportunity for pupils to embody Engineering practices and challenge their ways of approaching thinking and learning. Not only do these ‘ways of thinking and doing’ support future engineers but they may also represent useful thinking tools to support pupils throughout their education.

For example, EHoM, such as ‘Creative Problem Solving’, ‘Adapting’ or ‘Improving’, may offer pupils the opportunity to develop resilience and focus within the classroom. The *Rail Programme* introduces a structured context for pupils to develop new skills, as well as allowing them to apply themselves in a novel learning experience. The hands-on Engineering experience, which requires and encourages trial and error, may be unlike other experiences that pupils have encountered within the classroom. The adoption of EHoM during the programme may offer pupils the opportunity to develop as more robust pupils through the medium of practical making and Rail Engineering learning. The general educational benefits of the *Primary Engineer Rail Programme* are clearly demonstrated in teacher-led evaluations of pupil development in subject learning. **In 2021/2022, responding teachers who observed their pupils complete the *Rail Programme* reported benefits to pupil knowledge and skills in: Engineering (93% of teachers reported a benefit to pupils), Design and Technology/Technologies (94% of teachers reported a benefit to pupils), Science (74% of teachers reported a benefit to pupils) and Mathematics (69% of teachers reported a benefit to pupils).** These findings suggest that pupils widely benefit from participating in the programme. Despite its focus on Rail Engineering, pupils benefit from cross-curricular subject learning during this creative and practical experience. The benefit to high-priority subjects, such as Mathematics, demonstrates a particularly valuable transferable benefit for schools who take part in the programme.

Collectively, these findings demonstrate a consistent and positive benefit to young people who take part in the *Primary Engineer Rail Programme*. Pupils enjoy learning about Rail Engineering and are reportedly curious for more knowledge following the programme. Following the experience, career aspirations for Engineering are positively impacted, with indications that pupils better understand that Engineering is a career for anyone. The programme is successful in providing a ‘true’ Engineering experience, with young people supported to embody the ways of ‘thinking and doing’ found within real-world Engineering practices. If this programme represents the first meaningful Engineering learning experience encountered by pupils, then these evaluations suggest the impression is a good one.



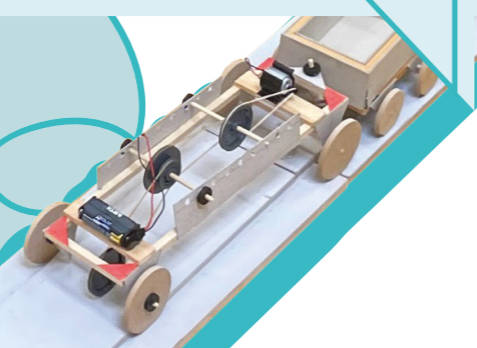


“ [The pupils] really love the practical side of things, getting stuck in problem-solving, all of those sorts of things, getting in and using all the tools and learning different skills and absolutely loved it.

[Our staff] definitely became more confident. We wouldn't have let [the pupils] anywhere near a hack saw or even glue sometimes. We've really enjoyed it. And we'd absolutely run it again without a doubt.

I think particularly when it came to things as basic as making the battery packs stick and things like that, [the pupils] really had to come up with alternative solutions to what they would normally do. They would normally just use glue or cellotape or things like that, but they really have to think out-of-the-box, so it's been fantastic watching them. Even really small things like the size of elastic bands where they've just used what they've picked up first to realise it's not worked and we've been quite quiet to let them sort it all out themselves.

It's been such fun and something so different. We really enjoyed the training for this as well. The training day was brilliant. It's really up-skilled us and enthused us and motivates us to run the club.”



21/7/17
21/7/17

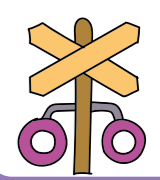
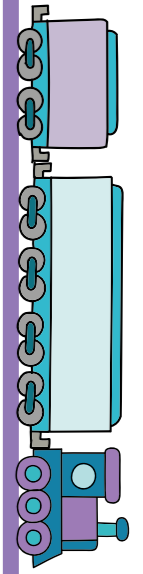
RAIL ENGINEERING-SPECIFIC IMPACTS

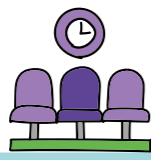
The focus on Rail Engineering in the *Primary Engineer Rail Programme* is an important aspect that underpins the entire teacher and pupil experience. The UK has a long heritage in the development and innovation of Rail Engineering. The rail sector continues to play a crucial role in the society and economy of the UK. As a result, Rail Engineering can be seen as a very present and important topic from which to build Engineering learning. Young people in the UK will almost certainly carry some cultural awareness of railways and may have first-hand experience as a user of rail travel. From this strong cultural foundation, an accessible and exciting project-based experience can be developed that ties pupils' learning to the world around them.

Like many Engineering sectors, the rail sector must contend with the challenges of poor diversity and skill supply within the UK engineering workforce⁷. An important aim of the *Primary Engineer Rail Programme* was, therefore, to provide an engaging Rail Engineering learning experience that would encourage more young pupils to consider that path in their future or raise understanding and interest in rail-related Engineering.

Evaluations suggest that young people are receptive to a focus on Rail Engineering in their learning. In 2022/2023, 99% of teachers who participated in post-programme feedback reported that their pupils enjoyed taking part in the rail programme and found its contents interesting. In this same year, 91% of teachers reported that their pupils were curious about the contents of the programme and wanted to learn more. Positive responses were also reported in 2021/2022. Such findings provide a strong indication that the rail sector is presented in an accessible and engaging way to young pupils during the *Primary Engineer Rail Programme*. Not only do pupils enjoy their experience but many are reported to express curiosity for more learning. This is a vital distinction, as it demonstrates not only a positive experience of past events (enjoyment of the programme) but also shows a lasting impression that may shape future behaviour (curiosity for more Engineering/Rail Engineering experiences). This would indicate that the *Primary Engineer Rail Programme* is encouraging pupils to be receptive towards new opportunities to learn about Rail Engineering – an important foundation for primary school-aged pupils and for potential future trajectories into Rail Engineering careers.

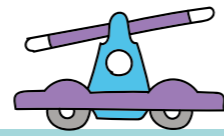
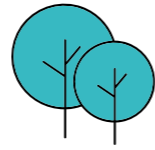
⁷EngineeringUK, 2018: The state of engineering.





The *Primary Engineer Rail Programme* approaches career aspirations in a dynamic way. Pupil understanding of Engineering careers can be explicitly supported by contact with an Engineering professional who provides key insights and is a living example of what an engineer is like. Understanding is also implicitly supported by fostering a positive experience with Rail Engineering learning. Evaluations suggest that young people are supported to consider Engineering careers through the programme. **In 2022/2023, 85% of responding teachers felt that the programme had positively influenced the Engineering and STEM career aspirations of their pupils, and 83% of teachers reported that, following the programme, their pupils felt that Engineering is a career that anyone can pursue.** Aspirations to Engineering are positively supported by the *Primary Engineer Rail Programme*, with further indications that the programme supports knowledge development. **Seventy-five per cent of teachers reported that, after taking part in the programme, their pupils understood more about jobs in the rail sector.** While this is a weaker result compared to earlier aspirational responses, this should be expected given that knowledge development is a more complex outcome than interest. The improvement in understanding reported by 75% can be considered a positive development that pairs well with the curiosity of pupils to learn more about Engineering, as reported by 91% of teachers.

These findings offer a promising indication that the *Primary Engineer Rail Programme* is positively supporting young pupils in the UK with an engaging experience centred on Rail Engineering. The use of Rail Engineering as a learning topic allows this programme to cross boundaries between differing contexts and reach a wide array of pupils. For example, the same programme is capable of being delivered in English, Scottish, Welsh and Northern Ireland schools. The capacity for this programme to navigate national differences in education systems supports its rigour, and the wide-reaching value offered, by adopting Rail Engineering to support young pupils.



“Genuinely the most interesting and fun course I have been on as this is a new skill for me and a project which the children in my class will love. We are learning about Modern Europe so we will be making our own Eurostar trains and maybe even trying to make our own Eurotunnel!”

Teacher, England.

THE JOURNEY SO FAR

Over the past five years, the *Primary Engineer Rail Programme* is estimated to have provided over 40,000 exciting and creative Rail Engineering learning experiences to primary school-aged pupils in the UK. Evaluation data captured over this period and examined in this report has offered a unique insight on the impact of this programme and its value. A wealth of evidence within this report supports that the *Primary Engineer Rail Programme* is successful in its aims to inspire young pupils, bring a greater presence of engineering to UK classrooms, and support a growing interest within the next generations of Rail Engineering professionals.

The programme has been found to greatly benefit teachers, who develop greater confidence and knowledge in Engineering teaching through their experiences. Teachers also grow more confident delivering curricular subjects, such as Science or Mathematics, and see value in bringing Engineering into the classroom to support cross-curricular learning. By taking part in this programme, teachers develop a better understanding of the diversity challenges facing Engineering in the UK and the important influence school staff can wield in encouraging future engineers.

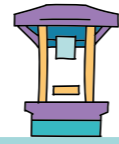
Pupils are also found to benefit greatly during the *Primary Engineer Rail Programme*. Young pupils develop a greater understanding of Engineering and the rail sector, as well as the importance of both to society. Pupils also develop skills and knowledge in other subject areas, supporting the value of this programme to wider school objectives. Analyses find that the programme leaves pupils curious to learn more about Engineering and with a greater interest in Engineering careers. By taking on the role of engineers, young pupils are reported to practice the ‘ways of thinking and doing’ Engineering that are central to Engineering roles, highlighting the validity of this school-based programme. Overall, this suggests that pupils experience a fun, informative and educational Rail Engineering experience that can provide a positive first impression of the world of Engineering.

These findings overwhelmingly support that the *Primary Engineer Rail Programme* is successful in its objectives. **Young people are inspired by Engineering, develop richer understandings and interests in Rail Engineering, and express a desire to learn more about Engineering following their experience with the *Primary Engineer Rail Programme*.**

Future development of this programme would see it grow with more partners and offer this beneficial experience to even more young pupils. Greater understanding of the impacts of this programme might be developed through the use of case studies and focus groups to explore the experience of young pupils and the lasting benefit to schools who engage with this programme. The positive impacts offered by this programme are worth exploring further, perhaps through novel educational research to better understand diversity and skill supply development in Engineering. A successful programme such as this is likely providing young pupils with ‘engineering capital’⁸. The valuable resources that individuals carry forward to support their future participation in Engineering should also be further investigated. The *Primary Engineer Rail Programme* offers the opportunity to not only introduce Engineering to school experiences but to develop best practices that can benefit many pupils across the UK.

⁸McDonald, 2022: Engineering capital: a theoretical and empirical model of engineering learning, diversity and participation.

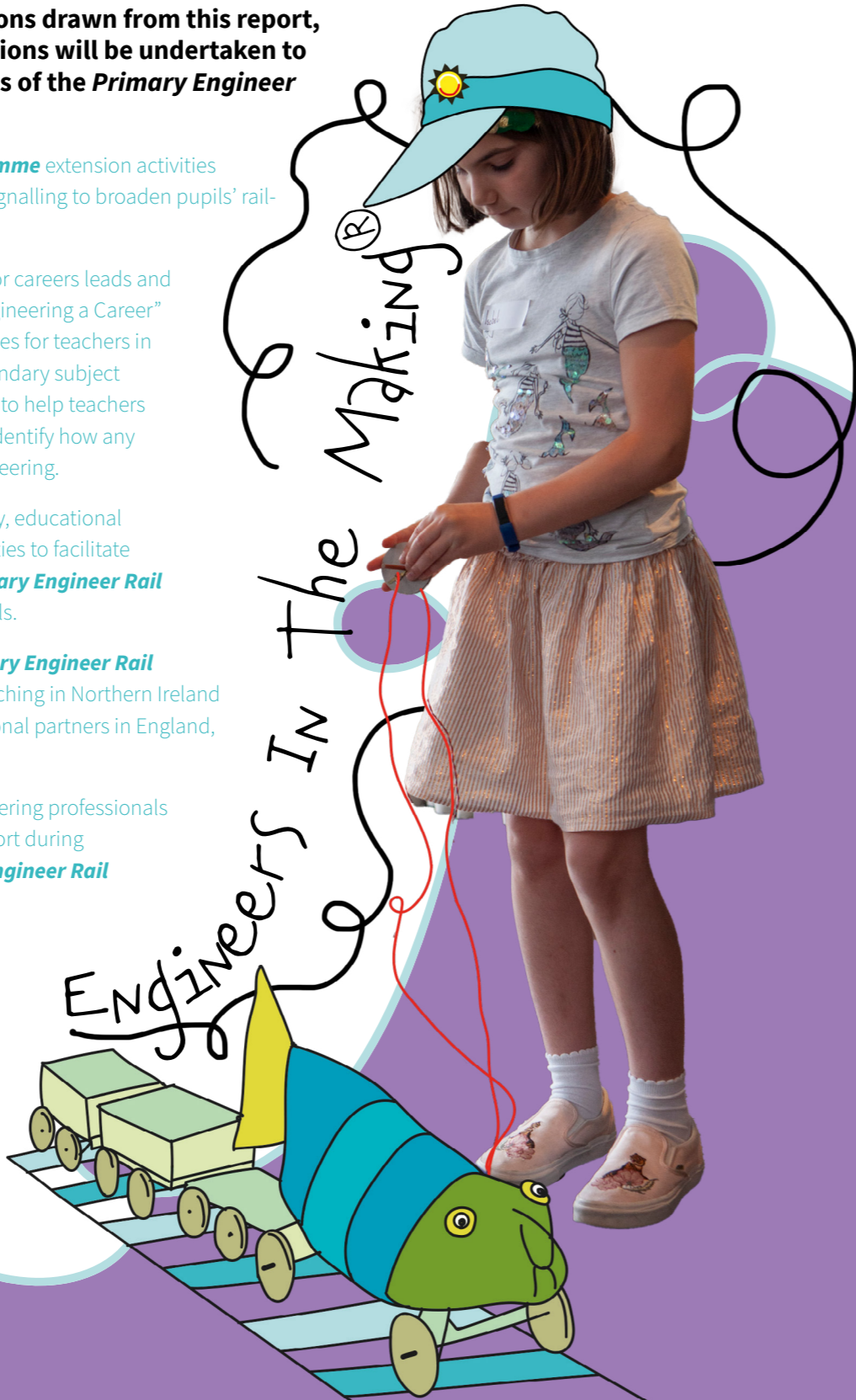




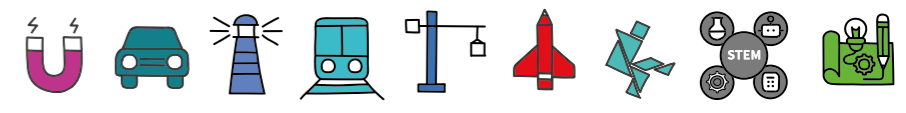
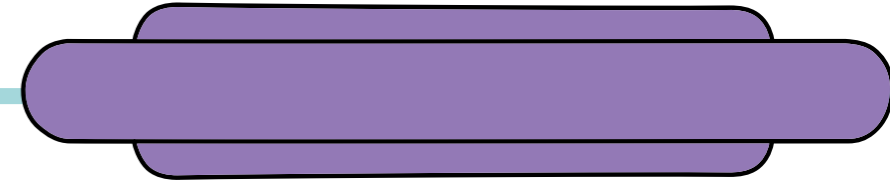
NEXT STEPS ON THE JOURNEY

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**:

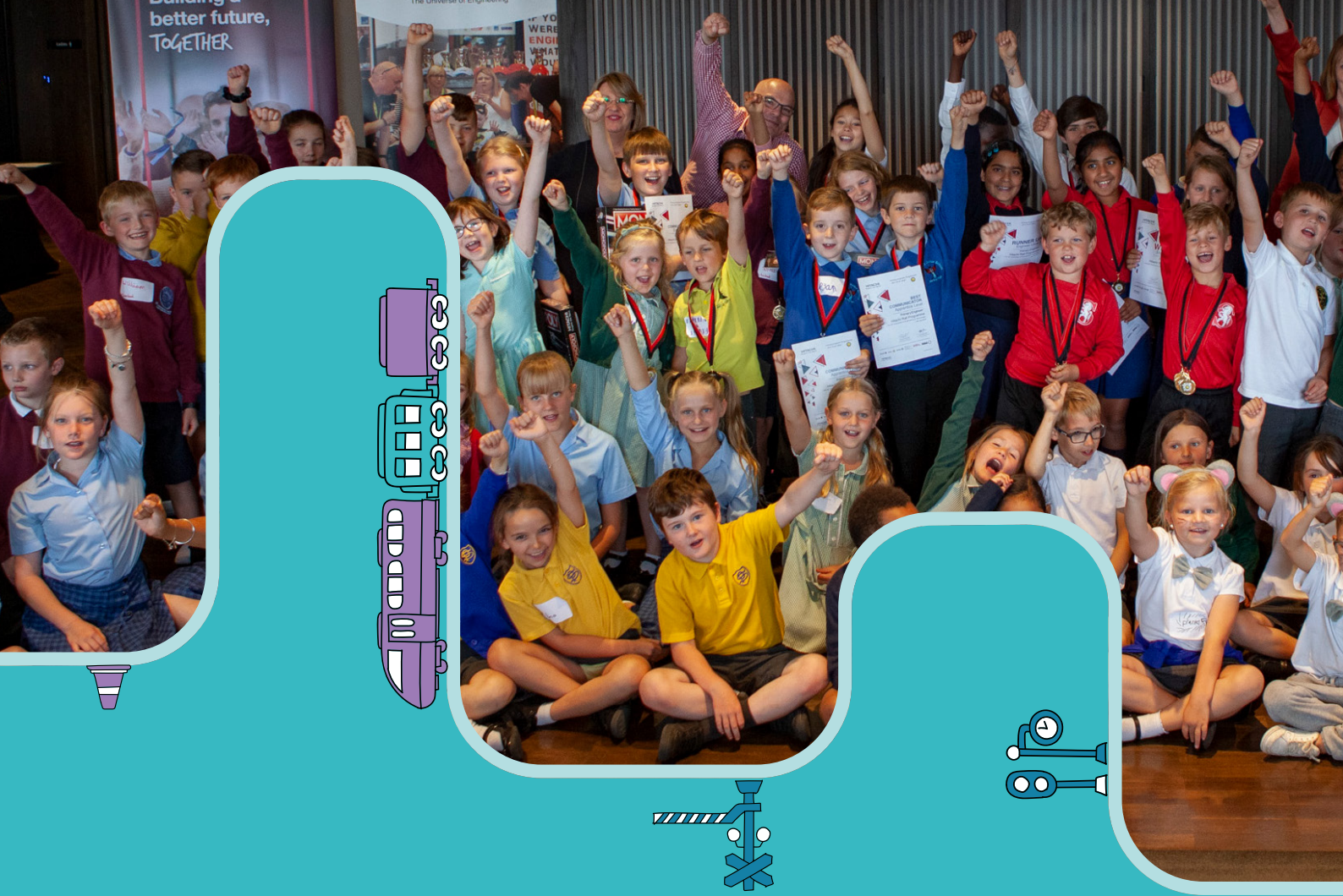
- 1 Launch two new **Rail Programme** extension activities focusing on Tunnelling and Signalling to broaden pupils' rail-related experiences.
- 2 Launch a brand-new course for careers leads and guidance teachers called "Engineering a Career" to offer training and experiences for teachers in linking engineering 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**.



Thanks to our partners for the past 5 years

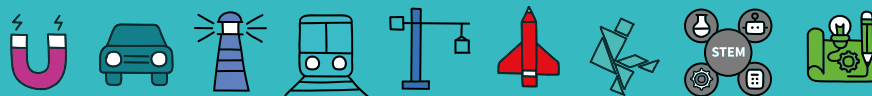


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