

## Robots vs Animals: Learning from the Ingenuity of Nature



Final Summary Report August 2015



*“Thank you for coming to our school and showing us your wonderful robots. When I grow up I want to be one of you!” (Child, aged 7).*

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**ROBOTS  
VS  
ANIMALS**



<http://robotsvsanimals.net>



## Contents

1. Executive Summary.....	2
2. Project Objectives .....	4
3. Project Activities .....	5
4. Evaluation.....	6
4.1. Methods .....	6
4.2. Outcomes .....	6
5. Project Highlights .....	8
5.1. Workshops and Festivals.....	8
5.2. National Competition.....	9
5.3. Website and Social Media .....	10
5.4. Media.....	11

## 1. Executive Summary

'Robots vs Animals' was a creative collaboration between engineers and zoologists, exploring the ingenuity of both nature and humankind. The project was organised and managed by the Science Communication Unit at the University of the West of England, Bristol (UWE), and funded by the Royal Academy of Engineering Ingenious Awards. The project communicated the stories of the engineering design process taken by Bristol Robotics Laboratory (BRL) engineers to create biologically inspired robots. Interactive sessions at Bristol Zoo Gardens and other public venues and events featured engineers and zoologists explaining and demonstrating the skills and processes of their respective charges.



*Permissions were obtained for all photos shown in this report.*

All project objectives for activities were surpassed, with a total of 29 engineers involved in the project (ten of whom were women). Ten Early Career Researchers (ECRs) received tailored bespoke public engagement training and presented their research as part of interactive sessions for 11-14 year olds at Bristol Zoo Gardens, along with opportunities at other public events and media. Five Principal Investigator (PI) senior researchers presented at major public events, as well as mentoring the ECRs throughout the project. The project also facilitated a further 14 ECRs to receive STEM Ambassador training, and eight of these participated in public events under the Robots vs Animals theme.

Collaboration with external visitor attractions and festivals was a hallmark of the project and indeed is one of the most successful resulting legacies. Four central themes (narratives) were developed and featured swarm robotics, communication, sensing, and Microbial Fuel Cells. Face-to-face live science events formed the backbone of the project, and in total 31 events were organised across the South West region, reaching around 1010 children and 180 adults in interactive presentations, along with thousands more through festival exhibits. These narratives have been developed further through a website (<http://robotsvsanimals.net>), social media (@robotsvsanimals), written materials, online videos, activity guidelines for public events, and worksheets or case studies for schools.

Qualitative data from the project evaluation indicated that the engineers enjoyed being part of the project and thought it was well organised. Quantitative data indicated that the ECRs felt more able to “demonstrate engineering activities in outreach sessions effectively” and significantly improved their perceived self-efficacy to conduct engineering outreach following the project. Quantitative audience data indicated that most participants surveyed thought the interactive sessions were ‘excellent’ or ‘above average’. Qualitative audience data indicated that they thought engineering was ‘exciting’, ‘creative’, and ‘relevant to the real world’.

The project has greatly strengthened a culture of public engagement at the BRL with increased institutional recognition of activities and their value. The value of collaborating with other organisations to provide innovative and supported public engagement activities has been recognised and there is also strong support for a dedicated project coordinator to promote and highlight public engagement within the organisation and externally.

## 2. Project Objectives

- Stimulate 10 junior engineers and five senior engineers to develop creative stories and demonstrations about their research and the wider field.
  - The project will develop at least three overarching narratives along with training on the public engagement and storytelling skills needed to communicate these in different formats to different audiences.
- Provide opportunities for Bristol Robotics Laboratory (BRL) engineers to experience the challenges and opportunities of public engagement.
  - The project will operate at least nineteen face-to-face encounters as well as developing digital media outlet opportunities. The project caters for different career level engineers, and will foster relationships with community attractions and festivals so that these opportunities will continue.
- Provide audiences with visual, interactive encounters that will encourage awareness of both robotic design and the niche skills of the animals featured.
  - While the project name engenders conflict, it is designed to generate discussion and raise awareness of engineering robotics, biomimetics and its potential, through at least nineteen face to face encounters, media coverage and digital media outlets.
- Reach audiences interested in biology and ecology who may not normally be interested in engineering, and stimulate dialogue between the two fields.
  - The project will work with audiences interested in biology and the environment, in collaboration with Bristol Zoo and the Festival of Nature. Overall the project will reach around 450 children and 160 adults in interactive presentations, along with the potential to reach hundreds of people nationally through the website and competition.
- Enable follow-up of these encounters and discussions for both engineers and audiences.
  - The project will develop a website, written materials, and social media discussion for the general public, along with biomimetic design story case studies for teachers, schools and science centres.

### 3. Project Activities

Target	Actual
Fifteen engineers recruited	29 engineers involved; 10 core ECRs, 5 PIs and 14 additional ECRs
Fifteen school interactive workshops (Key Stage 3 - 11-14 year olds)	13 interactive workshops with KS3 reached approximately 250 KS3 students. Seven interactive workshops with KS2 reaching 560 students. One teacher CPD event Four school/community open day stalls reaching approximately 300 students and families.
Two general public events	Three general public events (City of Bristol Day; Pint of Science 2015; Café Scientifique 2015)
Two festival events; Bristol Festival of Nature 2014 and Bristol Green City 2015	Four festival events (Festival of Nature 2014, 2015; Bristol Bright Night 2014; Harbour Festival 2015)
Schools competition for Green City 2015 with award ceremony at Bristol Festival of Nature 2015	Nationally announced schools competition for 6-18 year olds. Certificates given at Festival of Nature 2015. Approximately 70 entrants.
Website with learning materials, along with social media discussion.	The website <a href="http://robotsvsanimals.net">http://robotsvsanimals.net</a> received 3,300 visitors June 2014-June 2015, of whom approx. 70% were UK based. The highest viewed @robotsvsanimals tweet (referring to a female robot engineer as a role model) received 15,500 views. Professionally produced short film collaboration: At Bristol <a href="https://www.youtube.com/user/atbristol">https://www.youtube.com/user/atbristol</a>

## 4. Evaluation

### 4.1. Methods

Questionnaires were designed using valid and reliable methods of questioning to evaluate responses to the public events (audiences) and project participation (engineers). A pre-participation written questionnaire and self-efficacy test were completed by the ten core ECR engineers at the start of the project. The self-efficacy test was repeated at the end of the project, and descriptive and analytical statistics were completed. All ECRs and senior engineers were also interviewed at the end of the project by a science communication academic. Interviews were transcribed in full and analysed using the general inductive technique.

Written questionnaires were completed by audiences where possible, or event evaluation data was shared by external organisers. Schoolchildren were not surveyed due to ethics consenting, but teachers provided feedback on behalf of their classes. Descriptive statistics were completed. Audience numbers were gathered through observation and event organiser statistics.

### 4.2. Outcomes

All project objectives for activities were surpassed, with a total of 29 engineers from the Bristol Robotics Laboratory (BRL) involved in the project (ten of whom were women). Of these, ten core ECRs (five female) were recruited to the project. Eight had bespoke public engagement training, and two accessed alternative training opportunities as a result of the project. Eight ECR presented their research as part of interactive sessions for 11-14 year olds at Bristol Zoo Gardens, and two were involved in preparing materials for the Zoo sessions or presenting to media and other public events. Five of the core ECRs were PhD students, two were lecturers, two were post-doctoral fellows and one was a research associate. Five PI senior researchers presented at major public events, as well as mentoring the ECRs throughout the project. The project also facilitated a further 14 ECRs to receive STEM Ambassador training. 12 of these were PhD students, one was a research associate, and one was a start-up entrepreneur. Eight of these additional ECRs participated in public events under the Robots vs Animals theme.

The collaboration between Bristol Zoo Gardens and the BRL, facilitated by a project coordinator, enabled the development of in depth stories about biologically inspired robots. Four main themes were developed, creating narratives for public events and online materials featuring; swarm robotics, communication, sensing (whiskers), and Microbial Fuel Cells. Face to face live events formed the backbone of the project, and in total 31 events were organised across the South West region. Overall the

project reached around 1010 children and 180 adults in interactive presentations, along with thousands more through festival exhibits.

The Robots vs Animals narratives have been developed further through written materials, online videos, activity guidelines for public events, worksheets for schools, and social media engagement. Worksheets for school use have also been shared on the Times Educational Supplement and other learning resources websites. Case studies describing the career routes of the female and the Black and Minority Ethnic engineers in the project have been disseminated on the Women's Engineering Society and the Ethnic Minority and Traveller Achievement Service websites.

Qualitative data from the project evaluation indicated that the engineers enjoyed being part of the project, thought it was well organised, and were interested in the project goals for future public engagement. Quantitative data indicated that most of the ECR participants (9/10) felt more able to “demonstrate engineering activities in outreach sessions effectively” and “communicate engineering concepts effectively to students during outreach activities” after participating in Robots vs Animals. The core ten ECRs significantly improved their perceived self-efficacy to conduct engineering outreach following the project. Quantitative audience data indicated that most participants surveyed thought the interactive sessions were ‘excellent’ or ‘above average’. Qualitative audience data indicated that they thought engineering was ‘exciting’, ‘creative’, and ‘relevant to the real world’.

Perhaps most importantly, the project has greatly strengthened a culture of public engagement at the BRL with increased institutional recognition of activities and their value. Public demonstration kits have been created as a pooled resource in the BRL for public events, to reduce damage to research robotics. This was a key barrier for academic engineers to take part in public engagement, so the use of ‘show robots’ has enabled greater commitment to activities. Future PhD students will all receive STEM Ambassador training as part of the FARSCOPE Doctoral programme, and there is now recognition of public engagement on the external BRL website <http://www.brl.ac.uk/publicengagement.aspx>. Institutionally, the value of collaborating with other organisations to provide innovative and supported public engagement activities has been recognised. There is also strong support for a dedicated project coordinator to promote and highlight public engagement within the organisation and externally.



## 5. Project Highlights

### 5.1. Workshops and Festivals

Photos from Key Stage 3 Events



## 5.2. National Competition

‘What amazing animal ability would you use to design a useful robot?’

<http://robotsvsanimals.net/competition/>

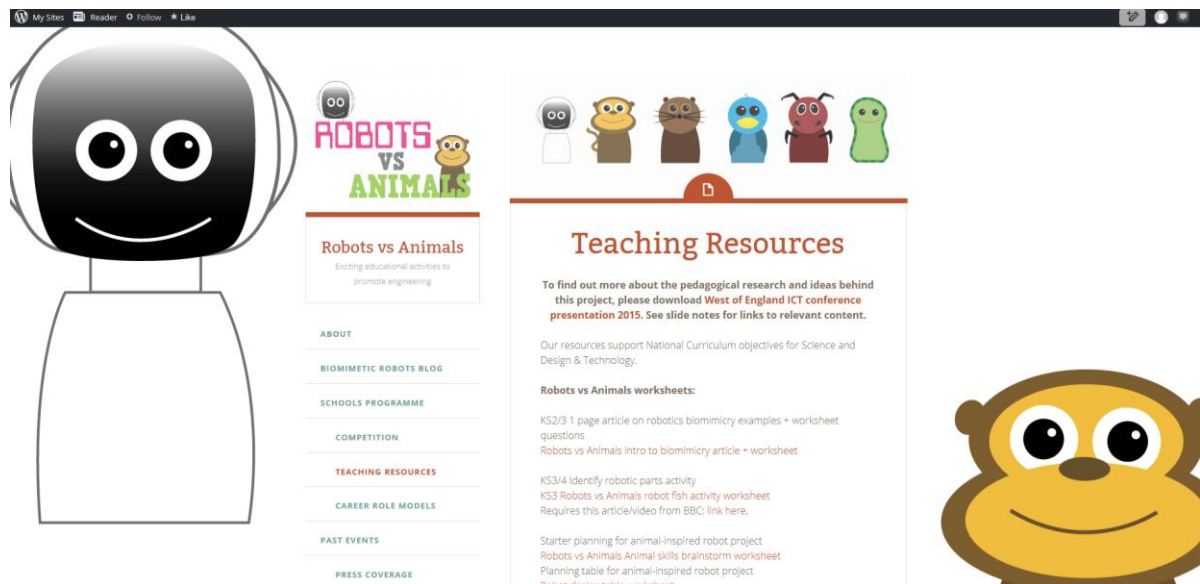


Here are the guiding questions to help students (5-18 years) “think like a robot engineer.”

- 1) *What problem does your robot solve?*  
A useful robot is one that solves a problem, for example  
How can robotics help us become more sustainable?  
How might robots support our health and wellbeing?  
How can robots help us to explore dangerous or difficult to reach places?
- 2) *What animal or animals have you been inspired by?*  
How has biomimicry influenced your design?  
How does biomimicry improve your design?
- 3) *What would your robot be made of? Why?*  
How will it be powered?  
How will it work?
- 4) *What problems might you need to overcome?*  
What have you done to improve the design?  
What alternatives did you consider and reject?

### 5.3. Website and Social Media


<http://robotsvsanimals.net>



The screenshot shows the website interface for 'Robots vs Animals'. On the left is a large illustration of a white robot head with large eyes. The main content area features a navigation menu with links: ABOUT, BIOMIMETIC ROBOTS BLOG, SCHOOLS PROGRAMME, COMPETITION, TEACHING RESOURCES (highlighted), CAREER ROLE MODELS, PAST EVENTS, and PRESS COVERAGE. To the right, under the heading 'Teaching Resources', there is a list of resources including a 1-page article on robotics biomimicry, a worksheet, and a planning table for an animal-inspired robot project. A small illustration of a yellow monkey is visible in the bottom right corner of the website view.


## Most popular tweets @robotsvsanimals

Tweet activity ×




**Robots vs Animals** @RobotsvsAnimals  
Just sent the 1st "robotics" engineer profile into @WES1919 Gloria shows #robots = #notjustforboys @wiset @smrtgrls pic.twitter.com/52MboHjn0G

Impressions	15,667
<b>Total engagements</b>	<b>264</b>
Photo or video clicks	187
Detail expands	31
Link clicks	16
Favorites	12
Profile clicks	9
Retweets	6
Replies	1
Follows	1
Hashtag clicks	1

 **Reach a bigger audience**  
Signing up for Twitter Ads will take you away from this page. Come back here after to promote this Tweet!


Sign up for Twitter Ads

Tweet activity ×



**Robots vs Animals** @RobotsvsAnimals  
Scientists from Bristol Robotics Lab, UK doing fab outreach #sciencewoman @smrtgrls #biomimicry @Stemettes @WES1919 pic.twitter.com/OE6hhQu1K7

Impressions	15,106
<b>Total engagements</b>	<b>199</b>
Photo or video clicks	122
Detail expands	31
Link clicks	16
Profile clicks	11
Favorites	8
Retweets	7
Follows	3
Hashtag clicks	1

 **Reach a bigger audience**  
Signing up for Twitter Ads will take you away from this page. Come back here after to promote this Tweet!

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## 5.4. Media

### 5.4.1. Press releases and internal coverage

Robots vs Animals: The Bristol Robotics Laboratory learning from the ingenuity of nature <http://info.uwe.ac.uk/news/uweneews/news.aspx?id=2819>

Design an animal-inspired robot competition <http://info.uwe.ac.uk/news/uweneews/news.aspx?id=2960>

UWE Bristol bring Robots vs Animals to Bristol Zoo <http://info.uwe.ac.uk/news/uweneews/news.aspx?id=2988>

UWE Bristol Department of Engineering, Design and Mathematics Newsletter

Zoo Internal Staff and Volunteers newsletter

## 5.4.2. Newspaper and magazine coverage

Clifton Life Magazine 'Bristol Bright Night' listing

The Engineer Magazine, 'Honouring yesterday's engineers and the creativity of tomorrow's engineers'

<http://www.theengineer.co.uk/blog/honouring-yesterdays-engineers-and-the-creativity-of-tomorrows-engineers/1019437.article>



### Honouring yesterday's engineers and the creativity of tomorrow's engineers

3 November 2014 | By Jason Ford

It seems fitting at the start of **Tomorrow's Engineers Week** to bring news of an engineer who is to be commemorated with a statue.

Tomorrow's Engineers Week aims to 'challenge the perceptions of engineering among young people, their parents and teachers' and encourage young people to investigate the profession and be inspired 'by celebrating the everyday engineering heroes that design, create and innovate to improve our lives.'

It is, of course, all too easy to overlook or take for granted the myriad of contributions engineers have made to our daily lives, one of whom was **Sir Nigel Gresley**, the mechanical engineer who designed locomotives, carriages and wagons for the London & North Eastern Railway (LNER) from 1923 until his death in April 1941.

To recap, Sir Nigel's achievements include designing the *Mallard*, the fastest steam locomotive in the world, *Flying Scotsman*, and streamlined high-speed trains such as *Silver Jubilee* in 1935 and *Coronation* in 1937. He also invented vehicle articulation, which is still used by railway and tramway engineers.

Sir Nigel is to be remembered at London's Kings Cross railway station with a 7'6" bronze statue sculpted by Hazel Reeves SWA, FRSA.

According to the Trust, the statue will be placed in the Western Concourse, beside the entrance to the Ticket Office, by the wall to West Offices where Sir Nigel and his principal assistants worked until the outbreak of war.

Network Rail, Camden Borough Council, and English Heritage have cleared the erection of the statue, which needs donations from interested parties to fund the project. The Gresley Society Trust is hoping to raise £95,000 and donations can be made via its website here.

There is some method in linking these Tomorrow's Engineers Week and Sir Nigel Gresley, the first of which is remembering that we still live with his principles of articulation.

The second is to remind ourselves of a word that some young people might not always associate with engineering, and that word is 'creativity'.

Without creativity and logic engineers would not have evolved the myriad of platforms and systems that simplify many aspects of our lives, and our young friends will be required to dig deeply into theirs as they face the sort of challenges, such as climate change, that weren't even considered in Sir Nigel's lifetime.

One stimulating initiative from Tomorrow's Engineers Week - Robots vs Animals competition from the Science Communication Unit at the University of the West of England (UWE), Bristol Robotics Laboratory and Bristol Zoo Gardens - is asking 11 to 18 year olds: What amazing animal ability would you use to design a useful robot?

Funded by the Royal Academy of Engineering, the national competition taps directly into biomimicry, a relatively new field that takes the most efficient elements from animal evolution and puts them into a robot.

According to project leader Laura Fogg-Rogers, this could include a robot with the flight of a bird, the sensing power of shrews' whiskers, or the gentle strength of a monkey's hand.

In a statement she said: 'Working with Bristol Zoo Gardens, we are developing workshops which demonstrate how engineering can solve real-world problems by taking inspiration from other realms, such as animals in nature.'

'We hope the young people who take part are really inspired by the competition to continue and develop their skills as engineers.'

UWE add: 'The aim of the project overall is to demonstrate engineering as a creative, exciting and innovative field, and encourage a wider range of young people, both boys and girls, to consider it as a career possibility.'

'Competition entrants will need to consider how their robot could be useful by solving real-world problems. It might be a robot that helps us to become more sustainable or supports our health and wellbeing. The robot also needs to take its inspiration from an animal, with careful consideration of the materials that it will be built with and the engineering design process used to make it work.'

Winning entries will be exhibited as part of Bristol's Festival of Nature 2015.

#### ***5.4.3. TV, podcast and radio coverage***

BCFM local radio 'Love and Science' programme

<https://www.youtube.com/watch?v=y7tAhUJSo7s> (3<sup>rd</sup> November 2014)

The Cosmic Shed podcast Episode 6 (March 2015)

<http://www.thecosmicshed.com/>

'Made in Bristol TV' news item (6<sup>th</sup> Nov 2014)

<https://www.youtube.com/watch?v=y7tAhUJSo7s>

BBC Radio Bristol interview (17<sup>th</sup> July 2015)

<http://www.bbc.co.uk/programmes/p02vm8ck#auto>

#### ***5.4.4. School websites reporting on their Robots vs Animals activities***

Bristol Grammar School "Behaving like Animals"

<http://www.bristolgrammarschool.co.uk/News/Behaving-like-animals.aspx>

St. Julian's School, Newport

<http://www.stjuliansschool.co.uk/robots-vs-animals-bristol-zoo/>

Mangotsfield School, Bristol

<http://www.mangotsfieldschool.org.uk/c/asset/2014-15%20Newsletter/Newsletter%208%20-27th%20March%202015-FINAL.pdf>

#### ***5.4.5. Promotion on educational/teacher-facing websites***

STEMNet South West School newsletter Autumn 2014

STEM in Wales website promotion of Zoo sessions

STEM in Wales website promotion of competition

Science Oxford Website promotion of competition

STEM Wilts and Dorset promotion of competition

Make Things Do Stuff website

Derbyshire Education Business Partnership website