

Round 3 (2009): *Ingenious* Final project summaries

SHARON BISHOP, Cheltenham Festivals

Finding the answers: contemporary issues in engineering and technology

With sponsorship from a grant by The Royal Academy of Engineering, *The Times* Cheltenham Science Festival 2009 created a series of five events exploring the world of engineering to foster greater engagement in the subjects by the public and also for engineers participating or attending.

The five events were:

Can We solve the Climate Change Conundrum (Wednesday June 3rd – 12.15 to 1.15pm): This debate involved Lord Drayson (Science Minister) amongst a stellar panel discussing real technologies that can tackle climate change.

Flood Defence (Friday June 5th – 10.15 to 11.30 am): This focused on if clever engineering and design can safeguard our homes and livelihoods.

Synthetic Biology (Friday June 5th - 4.30 to 5.30pm): Explored the emerging world of engineered cells with the panel and audience sharing excitement and concerns about artificial life.

Pleasure of Cars (Saturday June 6th - 9 to 10pm): An innovative cross disciplinary event involving design, engineering and psychology to engage the audience in why car design and performance has such an impact on us.

Bloodhound (Sunday June 7th - 12.15 to 1.15pm): Bloodhound covered the cutting edge engineering and design required to develop the world's first 1,000 mph car.

DR SUE CAVELL, Techniquest Science Centre, Cardiff

Public engagement and evaluation training for engineers

This project will develop and deliver a two-day workshop in public engagement training for 10-12 engineers, new to public engagement. It will provide them with the appropriate skills for engagement/communication with a range of audiences of different backgrounds and ages. It will also introduce them to the Generic Learning Outcomes and show how they can be used to plan public engagement activities and to evaluate their impact. Participants will be given 'hands-on' experience during the workshop, as it is intended to be practical rather than simply theoretical, and will develop an activity that they will present to visitors to Techniquest during National Science and Engineering Week, March 2010.

From this workshop, 10-12 engineers, currently working in academia, industry or the public sector will:

- have a raised awareness of the need for public engagement;
- possess the skills and confidence to present engineering activities to a range of different audiences;

- possess the skills and ideas to develop presentations appropriate to their audience;
- be able to use the Generic Learning Outcomes to plan public engagement activities and to evaluate the impact of their activities on their audiences;
- have developed and presented an activity to public audiences at Techniquest during National Science and Engineering Week, 2010, during which Techniquest has approximately 5,000 visitors;
- have become a Science and Engineering Ambassador.

The intended impact on the engineers is that they will have:

- increased awareness of the importance of public engagement;
- increased confidence and skills to engage with the public, and knowledge of how to assess the impact of their activities;
- worked with experienced Techniquest staff and gained an understanding of how to develop appropriate ideas and activities for a range of audiences; Projects
- tried out their new public engagement skills on audiences at Techniquest; and
- have become a Science and Engineering Ambassador.

The intended impact on the public) is that they will have:

- increased interest in engineering, and a raised awareness of the relevance of engineering to them and of its role in society.

The special feature of this training workshop, the need for which was highlighted by The Royal Society, is that participating engineers will have the opportunity to hone their new skills by engaging with the public at Techniquest during National Science and Engineering Week. A novel aspect of this training workshop is the application of the Generic Learning Outcomes methodology to evaluate the impact of engineering public engagement activities

PROFESSOR WILLIAM GALE, University of Leeds

Risky business? Public engagement on protection versus practicality and the acceptability of risk in engineering

The project involved the collaboration of a reasonably representative cross section of the general public (variable sized cohort, but typically 10–15) with a group of engineers (typically 5 with experience in a range of engineering disciplines). Staff with professional experience of public engagement (1–2) provided light touch moderation. The public cohort ranged from those with no prior exposure to engineering to a retired engineer. The public cohort worked with the engineer participants to co-develop a strategy for public engagement, based around the opportunities provided by collaboration with the Royal Armouries in Leeds, as an important and well visited public space:

- Engagement started with a session focusing on a general discussion of the public perception of engineering.
- Collaboration with the public cohort then moved on to specific concerns that the public cohort had, related to engineering.
- In the light of the initial discussions between the engineers and the public cohort, possible features of a public engagement interactive on risk in

engineering, to be located at the Royal Armouries and to take advantage of the unique character of this venue were then discussed.

The engineer participants then proceeded, with the assistance of a series of discussions with the curatorial and educational staff at the Royal Armouries to develop ideas for a public engagement interactive that compared the risk-related decisions that engineers need to make in formulating major projects, with those facing a military commander planning a major operation. The interactive computes a measure of relative risk, based on the options and controls chosen by the visitor. The underlying algorithm was intentionally based on very simple arithmetic, allowing this to be discussed with the public (at the price of a rather rough and ready output). This interactive also encourages visitors to consider the impact on risk of not just technical decisions, but also societal value judgments on the relative importance of human life, the environment, finance etc.

The public cohort was then invited to comment on design, along with extensive input from the Royal Armouries. After several iterations, the interactive was fabricated by Paragon (a specialist manufacturer of interactives for public display). The interactive now forms part of the Royal Armouries collection, collocated with a display on the war in Afghanistan (based around a full-scale model of a Hesco bastion, as used for force protection), with a theme of force protection that offers synergy with the risk theme.

The original intent was to use the interactive to spark a series of dialogue events with the general public visiting the Armouries, but unfortunately this did not prove possible to complete within the duration of the project, owing to the long lead time needed to agree a design with the Armouries, gain approval to incorporate the interactive into the Armouries' collection and to satisfy their installation and use requirements.

TUDOR GWYNN, The National Children's Museum, Halifax
Robots explore the universe

Over the school summer holidays of 2009 recent graduate engineers and more established engineers from academia and industry had the opportunity to engage with families visiting Eureka! A variety of robots that can be controlled on a highly realistic planetary landscape were used as a catalyst to encourage discussion between families, engineers and Eureka! staff about the practicalities of space exploration as well as broader questions relating to the need for and reasoning behind our determination to explore other planets.

JUDITH HARVEY, WhoWhatWhereWhenWhy (W5), Belfast
Engineering challenges of the future

Engineers from Queen's University and Bombardier Aerospace worked with W5 to develop and deliver a series of school and public events. The programme included three challenges, each related to the theme of climate change. There were two aspects to each challenge:

- An introductory talk by a guest speaker outlining the real engineering challenge

- Followed by a related practical problem solving exercise were pupils/public had the opportunity to work with the engineers to complete a challenge.

Challenge One: Reducing the carbon footprint of aeroplanes (Schools Only)

An introductory talk by Professor Mark Price from QUB explored how industry is currently tackling the problem of the environmental impact of aeroplanes and what the futures holds for air travel. Working in teams supported by an engineer, pupils were then challenged to design and test a model aeroplane bearing in mind the issues previously outlined during the lecture.

Challenge Two: Renewable energy - TRANSPORT (schools and public)

An introductory talk by Dr Robert Kee from QUB explored how to reduce our dependency on fossil based fuels within transportation, examining how efficient the current alternatives are and what the future holds. Pupils and the public, with the support of our engineers, then had to make and test a model car using a choice of renewable power solutions such as solar panels.

Challenge Three: Renewable energy – SOCIAL SOLUTIONS (schools and public)

The third challenge related to our dependency on fossil based fuels within a social context and speakers Adrian McLaughlin from Action Renewables and Dr Brendan Fox from QUB began by looking at how this dependency can be reduced and how efficient are the current alternatives. Pupils and members of the public were then challenged to create the city of the future using a simulation game and also to design a windmill for optimal power output with the help of our engineers.

DR JOAN HEGGIE, University of Teeside

Engineering new partnerships in public engagement: bridging the past and the present through school projects

The British Steel Archive Project (BSAP) is a three year project to catalogue, conserve and engage the community with the British Steel Collection (BSC). The BSC is a business archive relating to the iron and steel industry on Teesside. It includes business records, maps, plans and photographs dating from about 1840 to 1970.

In 2009, the BSAP worked with a primary and secondary school in Middlesbrough on a collaborative project to celebrate the 75th anniversary of the Newport Bridge. The project was so successful we wanted to roll out the model to other schools in the region. Ingenious funding enabled us to improve upon the pilot by involving engineers in the projects who gained public engagement skills enabling them to effectively share their expertise with schoolchildren and their teachers.

After an intense recruitment campaign we recruited and trained 16 engineers from across Teesside and allocated them to a pair of schools (one secondary and one primary) to work on a project inspired by the BSC. Each engineer was invited to a half day course to improve their public engagement skills and then they were given the opportunity to put them into practice.

We successfully ran five collaborative projects across three boroughs of Teesside, where two or more engineers worked with secondary school students

to develop and deliver an activity to a primary school. The teachers had the greatest input in choosing the project topics which ensured they fitted the curriculum and needs of the teachers. Three of the projects were based on bridges. The other topics were cars, cranes and raising the Titanic.

The feedback we received from participating students, teachers and engineers was overwhelmingly positive. All of the teachers said they would like to take part in a similar project in the future. The engineers all enjoyed working on the project and most of them are planning to continue with some public engagement work. The students all enjoyed taking part and the majority would like to do it again.

Some of the engineers did not complete the projects they were working on. This was mainly due to the closure of a Corus plant early in 2010 and its knock-on effects. However all the schools (except one primary school) had engineers working closely with them throughout the project.

We recruited engineers from the following organisations: Teesside University, Durham University, Cleveland Institute for Engineers, Corus, AMEC, and two retired engineers. The engineers ranged in age from 23 to 70 years old, one of the engineers from Corus was female, the rest were male.

In total we held 54 meetings and workshops, 31 of these were attended by engineers who contributed a total of 82.5 hours to the project. The project reached 27 teachers, 455 primary school students and 73 secondary school students.

SUE HORDIJENKO, British Association for the Advancement of Science
A series of engineering events at the British Science Festival

The project was made up of eight events in the British Science Festival programme. These included talks, debates, workshops and science shows for both the main and Schools programme. The events included in the engineering strand were varied and diverse thus attracting a range of audiences and allowing them to be engaged and reached. It has also allowed us the opportunity to take the Isambard Kingdom Brunel Award Lecture to Newcastle Science Festival in March 2010 for the first time, engaging with new audiences in the Northeast of England.

BEN JOHNSON, Graphic Science Ltd
Ambassadors for the Engineering Diploma

A bespoke training course, along with a set of specially devised classroom activities and resources, for engineers who wish to support the delivery of the 14-19 Engineering Diplomas in schools. The engineers were primarily STEM Ambassadors based in the South West and were recruited and trained by STEM contract holders across the region.

DR VINAY KATHOTIA, Royal Institution of Great Britain
Royal Institution engineering in the community

The Ri's Engineering in the Community project followed on from the success of the Ri's Engineering Masterclass programme piloted in 2008/2009. The current project aimed to consolidate the confidence and ability of the team of engineers to develop and deliver a variety of high quality, engaging and educative engineering outreach events targeting a range of audiences.

The engineers, some of whom had no public engagement experience, were provided with guidance and support throughout their sessions, which were to a variety of ages from years 3 to 12, teachers, undergraduates and families. Sessions varied from hour-long demonstration-talks, to 2½-hour Year-9 masterclasses to full-day sessions in laboratories or in schools.

All the sessions contained hands-on activities, led by the engineers, with both practical and theoretical ideas from the work they do within their daily jobs. Most of their presentations included details about the personal career path of the engineer, discussions about other engineering disciplines and included debates about the diversity, nature and impact of engineering.

The audiences were inspired to fully participate in the hands-on activities and could appreciate the specific engineering topic covered in a class and its societal and ethical impacts. The project presented new opportunities to engage audiences with modern and relevant engineering. The engineers, from industry, were in the areas of civil, mechanical, structural, chemical, renewable energy and space engineering, and, from academia, structural with bio-medical, mechanical/artificial intelligence/oceanography and civil engineering. Two PhD students studying medicine are preparing their first activity having enjoyed helping at engineering events.

The preparation of each session was built around preparing and delivering a 2½-hour, Year-9 student masterclass. The engineers came to meetings at the Ri to discuss their ideas for a suitable topic and activity and then built the lesson plan with theoretical ideas around the activity.

The engineers had practice sessions in schools, during normal lessons or in after-school clubs where they could try out the activities with students, prior to delivering the full masterclass. Once confidence of delivery and presentation of this session was complete, it was a straightforward task to expand or shorten the activity and adapt it for younger or older students.

It was found that the preparation and delivery of the masterclass was crucial to the development of the engineer's ability to adapt to a different session. The confidence and ability of the engineer to take a session further once they had delivered the masterclass was very noticeable and the Ri and engineering teams all agree that this is the way to move forward.

The engineering team has worked with a number of teachers across a variety of departments including mathematics, science, design and technology. These teachers gained new technical knowledge, teaching resources and a better understanding of engineering to take back to the rest of their students.

Although the Ingenious project is coming to a close, we have booked further events during the summer holidays and in the new Autumn term. With the four

newly-mentored engineers joining the seven continuing from last year, four new engineers preparing masterclasses, and prospective new recruits, the Ri's Engineering Team is going from strength to strength.

PROFESSOR NIGEL LINGE, University of Salford

So what do engineers actually do?

This project allowed engineers working within the digital industries to carry out both public and schools engagement activities. We achieved this through three main channels of engagement; public exhibitions, schools activities and a website. The aim was for the engineers to showcase what their jobs entail and the type of work they do. In so doing this would help raise the profile of engineering and overcome some common misconceptions. Our public exhibitions were held at the Museum of Science and Industry in Manchester and provided engineers with an opportunity to create an exhibit. Training was provided to the engineers by the project team and 8 engineers participated across two exhibitions held as part of the Manchester Science Festival 2009 and National Science and Engineering Week 2010. These exhibitions attracted a combined general public audience of 4,606.

For the schools activities we worked with our partner, the Centre for Science Education, and used a very effective engagement technique which they have developed called the "Active Visitor Technique". Using this technique, small groups of students work closely with an engineer to develop a questioning framework through which they can discover more about what the engineer does. At the end of the session each group of students delivers a short presentation to the whole class. Three of these events were held within local schools and a fourth was hosted at the University of Salford as part of a Royal Academy of Engineering Dragonfly event. A total of 11 engineers participated in these events with 5 of them contributing to two events. The feedback obtained from these sessions shows very clearly how the perceptions of the students were changed positively towards engineering.

Finally, we created a website for the project and decided to build this around a blog. This website has been populated with a profile of each engineer, their blog entries, 10 films made throughout the project showing the engineers carrying out their engagement activities and general information about engineering. The site can be viewed at: www.sowhatdoengineersactuallydo.com

All engineers were encouraged to register as STEM Ambassadors which not only ensured that the CRB checking process could be completed easily but also provides sustainability in the sense that these engineers are now engaged in the much broader range of STEM activities on offer within the region.

All of the engineers participating in this project have done so enthusiastically and with the full support of their companies. However, it is essential to provide good support, not only in terms of training but also by ensuring that the events in which they participated were well planned and structured so that they could understand their role and levels of commitment required in advance. Advance notice of events is also essential to ensure good levels of participation. Indeed, recruitment of the engineers took far longer than anticipated and even though we were able to recruit 21 engineers to the project, only 14 of these were able

to participate in our events. We were also only able to recruit one female engineer which was disappointment. All participating engineers were asked to complete a reflective diary.

PROFESSOR JON OBERLANDER, University of Edinburgh
Robotics @ InSpace

What could a robot do by 2030? Will they move like humans, feel and show emotions, or talk like you and me? These are just some of the questions posed by University of Edinburgh robotics engineers in the Royal Academy of Engineering funded project, Robotics @ Inspace.

During 2009-10, we held 13 public events at Inspace, sharing research into robot action, perception and behaviour; artificial intelligence; human-computer interaction and social and cultural aspects of robotics.

Our programme included two Doors Open Days, seven events for adults at the Edinburgh International Science Festival and three "Robotics in Space" events featuring NASA astronaut and engineer, Bill McArthur.

The events were attended by 2539 people. Over 90% of respondents to our questionnaire found the events enjoyable, interesting, informative and well organized. We have seen relatively modest on-line engagement (173 views/downloads of related content), but this continues to grow as more people engage with Inspace on-line.

52 individual robotics and other engineers were involved in planning and delivery of the events. Most enjoyed learning about Inspace and found it is not just for talks, but for interactive, creative and hands-on discovery too. A key outcome was that the engineers involved now appreciate that although it takes time and effort to do engagement well, a professional approach reaps benefits for them and the audience.

The project enabled the Inspace team to develop how we work with engineers from different disciplines and the evaluations provided valuable feedback on our processes and facilities. Many new technologies were deployed during the events: multiple projectors, Pufferspheres (an interactive spherical display system developed by Edinburgh company Pufferfish), a steerable projector, infra-red motion capture equipment and various sound systems.

So, what was the impact of the project? We asked audiences what it would be useful for robots to do and what they thought it would be possible for a robot to do in 5, 10 or 20 years time. From their responses, a fairly typical day in the life of a future robot would look something like this:

- To do list for today, 30 September 2030:
- Tidy the flat and do the washing
 - Send good luck message to Robert on the battlefield (even though they've removed his empathy program).
 - Complete application form to acquire equal human rights. (Let's hope it works this time!)
 - Practice my winning smile

(still haven't quite got it, but almost there)

- Meet the gang for football practice

Although audience responses suggest most had a well-founded attitude to the immediate and longer term social issues around robotics, some were not aware of relatively well-developed robotics capability. We are therefore planning future Inspace programmes which showcase a mix of existing technology and research.

HELEN PENNY, At-Bristol

Engineering encounters

This project provided 20 early-career engineers with an opportunity to work intensively on developing their PE skills. Supported by recognised experts in the field, the project delivered:

- An intensive three-day workshop for 20 early-career engineers, including delivery of PE activities with At-Bristol visitors
- One-day development workshop for 12 early-career engineers
- Opportunities for participants to deliver PE with Engineering activities, supported by the project team

During an intensive 3-day residential workshop held in At-Bristol, participants explored the background to the current PE agenda, identifying audiences, fundraising and evaluating PE activities. The workshop offered taster sessions of four key types of engagement activities: debate and dialogue, presentations and shows, hands-on and new media. The workshop also involved participants delivering a range of activities for visitors to At-Bristol.

A 1-day (optional) creative workshop enabled participants to enhance their skills further and develop PE activities based on their own research.

Following both workshops, participants were provided with opportunities to put their newfound skills into practice by delivering their activities at key PE events including Science Cafés, university open days, science festivals and school visits.

MICHAEL RIDLER, By Design

Enterprising engineering and a greener future

The 'Enterprising Engineering and a Greener Future' (EEGF) Project was a pilot project delivered in four schools (originally intended to be three) which comprised of the following:

An initial presentation on climate change, current use of fossil fuels, renewable energy sources, the production of bio-fuel & its uses in more detail and a general overview of the project – (This was delivered by engineers at each of the schools involved).

There was then a workshop for students who wanted to champion the project within their schools, which covered bio-diesel production from waste cooking oil in more detail, trained the staff and students on the equipment used to do this, included several sessions on generic skills such as team work and communication and also specific sessions on enterprise skills. The day culminated with the students building their own solar powered car models. (This was also presented by the engineers with support from By Design staff).

The project was then run internally by the students and staff of each school where they each ran a mini enterprise, producing bio-diesel from used cooking oil.

The project then culminated with a celebration day where partners, engineers and some of the students gathered to share their experiences.

FELLOWSHIP AWARDS

DR DAVID JAMES, Sheffield Hallam University

"Is Engineering improving sport? Engaging the public in the ethics of advancing sports technology"

Dr James' work has mainly concentrated on communicating the science of his subject rather than engaging the public in a meaningful dialogue about the issues he presents. The fellowship allowed Dr James to explore the societal impact of his work in sports engineering, to examine the ethics of engineering athletic performance and to gauge public opinion. The fellowship also allowed the awardee to train in ethics and to enhance his skills in communicating the implications, as well as the applications of his work.