**The STEM engagement landscape and *This is Engineering***

**Introduction**

This document includes information about research that has been undertaken by several organisations looking at perceptions of engineering and engineers, why students aren’t taking up STEM courses and careers, strategies for reaching underserved audiences, and the Academy’s response to some of these issues

**Summary of research into people’s perceptions of engineering**

Over the last 15 years extensive research has been conducted into the public’s perceptions of engineers and engineering. These studies have provided valuable insights into how to influence people’s perceptions of engineering.

**What is engineering?**

A major barrier to young people taking up engineering courses are deep-rooted misconceptions about the profession. Although there has been a marked improvement in teachers’ understanding of engineering in recent years, many misconceptions persist among parents and pupils.

Engineering is a well-regarded profession that is perceived to be worthwhile, rewarding and well paid; but there is very limited understanding of what engineers actually do. Engineering is predominantly associated with the construction, automobile and transport industries. Its vital role in other areas of society – healthcare, music, games, sport, food production etc - is largely unknown.

Although people have a vague idea that engineers make things there is very little awareness of the role of creativity, problem-solving, team-working or the use of cutting-edge technology in engineering.

The strongest associations with engineering are:

* Building sites, railway tracks and car workshops
* Dirty hands, oil, fumes, overalls
* Routine maintenance and fixing broken things
* Long unsociable hours
* Working in isolation from others
* Work that involves little variety
* Potentially dangerous work

“I wouldn’t like to be an engineer because I would not like to get my hands dirty all the time”

“Engineering is about cars. It’s a bloke’s job”

“An engineer, he’s a man who likes to fix things & he’s wearing overalls”

**Attitudes towards STEM subjects**

Another barrier to young people going into engineering are the attitudes about science courses at school, college and university.

Although school pupils enjoy science lessons, they perceive science subjects to be difficult, involve a lot of work and are only suitable for the most ‘brainy’ students. This is especially the case with physics. Pupils also perceive the science they learn in school as having little relevance to their lives, interests and future careers.

“Science is for the clever pupils mostly … clever people like science because it’s tricky”

“You have to be really clever to study science ... ‘I’m not clever enough to be good at science”

Whereas STEM subjects are perceived as geeky and inaccessible, arts subjects are seen as accessible, creative and human-focused. Such views are often reinforced by parents, peers and even some teachers.

By secondary school most pupils have defined themselves as either STEM or Arts focused. Very few perceive that there is any middle ground between these subject areas. As a result, all things to do with ‘the other’ become irrelevant. Anything strongly associated with STEM is ignored by those who are ‘Arts focused. Engineering is felt to have no relevance for those pupils who perceive themselves as artistic and creative.

Compounding these problems is the misconception that studying science and maths narrows one’s career options. Many parents and pupils believe that the only careers open to science graduates are research scientists, science teacher, doctor or pharmacist.

**Girls & STEM**

The UK has the lowest proportion of women in engineering among the European Union countries. In part this is related to the very low take-up of physics and maths A level courses among girls as well as the male-dominated image of engineering.

Girls exhibit lower confidence in their ability in science subjects than boys, which has been shown to be a significant barrier to them taking STEM courses after GCSEs.

“I don’t like science lessons. They’re tough & nerdy & there are some really geeky boys who are all into maths & science. I’m not that kind of clever. I prefer English & PE”

Girls are less likely than boys to aspire to STEM careers, even though a higher percentage of them rate science as their favourite subject. Instead they are more likely aim for arts-related careers that they perceive to be creative and aligned to a feminine identity.

Girls’ misconceptions about STEM courses and careers are often reinforced, intentionally or unintentionally, by their parents and teachers.

**Careers education – too little, too late**

Despite recent improvements the provision of careers education is still patchy and sometimes of poor quality. Many schools lack teachers with adequate training in careers guidance. Those who need it the most – girls, working class, black and minority ethnic pupils, and those planning to leave school at 16 – are among the most poorly served.

Parents have a huge influence on their children’s choice of courses and careers, yet their understanding of career paths and the future job market is often very limited – based largely on their own experiences.

STEM qualifications are often wrongly perceived by parents and pupils to narrow career options to a handful occupations – scientist, doctor, pharmacist, science teacher.

“There’s no point doing science & then getting a job that doesn’t use science”

“English & Maths are used more widely but Science, like unless you want to be a scientist, isn’t as relevant to you”

Less than a third of secondary science, maths and secondary teachers and parents of secondary school pupils, have a high level of understanding of engineering. The majority express a lack of confidence in giving their pupil/ children advice on the profession.

Pupils do have high aspirations for their future careers, seeking jobs that will provide them with:

* Sense of achievement
* Opportunities to make a positive contribution to society and to individuals (especially among girls)
* Variety with plenty of opportunities for creativity, problem-solving and team-working
* Different working environments (i.e. not just stuck in front of a computer all day) and opportunities for international travel
* A diverse workforce
* Good salary, job security and progression

However, most do not associate engineering with these characteristics, in part because engineering is almost invisible in the school curriculum and in their daily lives.

Even among pupils who are interested in STEM careers there is little understanding of how to become an engineer. It’s not that pupils and parents outright reject the idea of an engineering career. It is more that it doesn’t spontaneously occur to them, unlike other professions such as medicine, pharmacy or the law.

When engineering is considered, it is predominantly perceived as a university degree course. Understanding of apprenticeship routes into engineering is very low, even among teachers.

**Messages that work**

The most successful STEM engagement activities are those that illustrate how engineering overlaps with the interests and identities of children and young people. Initiatives that illustrate ‘we’re like you’ are far more effective than those that try to persuade people to ‘be like us’.

Research has shown that children and young people respond very positively when shown:

* That engineers design products they value – mobile phones, clothes, sports equipment, computer games
* Engineers work in a vast range of industries - aerospace, computer gaming, energy production, environmental protection, fashion, film and TV, medicine, music, robotics, sports technology, telecommunications etc
* Engineering is a highly creative process where you use your imagination to solve problems
* Engineering involves team-work and interacting with a wide range of people
* Engineers use the latest cutting-edge technology
* Engineers are shaping the future and have a positive impact on society and on individuals
* Many types of people choose engineering as a career from a wide range of background
* Engineering is a secure, well paid profession with many opportunities to travel and work abroad

It is vital that these messages reach teachers, career advisors and parents as well as pupils to have maximum impact.

**Further reading**

If you would like to find out more about public perceptions of engineering, and about how to influence their opinions about engineers we recommend the following publications.

**Public perceptions of engineering**

Engineering UK 2020: The state of engineering; available at <https://www.engineeringuk.com/research/engineering-uk-report/>

Engineering UK research briefings on: women in engineering, STEM careers provision in schools, social mobility in engineer; available at <https://www.engineeringuk.com/research/briefings/>

Changing perceptions of Engineering: campaign pre-testing; *Voodoo* on behalf of the Royal Academy of Engineering (2018)

“We think it’s important but don’t quite know what it is”: the culture of engineering in schools; Institute of Mechanical Engineers (2017)

Engineering Talent Project Research Qualitative Research; *Define Research & Insight Ltd* on behalf of Royal Academy of Engineering (2016)

Department for Transport Engineering research; *the Nursery Research & Planning* on behalf of Department for Transport (2016)

Engineering Talent Project front-end qualitative research; *Define Research & Insight* on behalf of the Royal Academy of Engineering (2016)

Five Tribes: personalising engineering education; *ICM Unlimited* on behalf of the Institute of Mechanical Engineers (2014)

An investigation into why the UK has the lowest proportion of female engineers in the EU; Kiwana L, Kumar A & Randerson N on behalf of EngineeringUK (2011)

Changing the Conversation: Messages for Improving Public Understanding of Engineering; *Committee on Public Understanding of Engineering Messages* published by the National Academy of Engineering (2008)

Engineering our future: inspiring & attracting tomorrow’s engineers; *Brunswick Research* on behalf of National Grid (2008)

Influence of high school students’ perceptions on their preparation for Engineering; Reyer J, Proceedings of the 37th ASEE/IEEE Frontiers in Education Conference, Milwaukee, WI (2007)

What brings women to the table? Female and male students' perceptions of ways of thinking in engineering study and practice; Kilgore D, Yasuhara K, Saleem J & Atman C, Proceedings of the 36th ASEE/IEEE Frontiers in Education Conference San Diego, CA (2006)

**Attitudes towards STEM courses & careers**

The most recent and extensive programme of research into pupil’s attitudes towards STEM subjects and careers is the ASPIRES project led by Professor Louise Archer at University College, London.

You can access reports summarising their research findings and a full list their published academic papers at <http://www.ucl.ac.uk/ioe/departments-centres/departments/education-practice-and-society/aspires>

We also recommend reading the Wellcome Trust’s Science Education Tracker report that provides an up-to-date overview of the state of science education. The report is available at <https://wellcome.ac.uk/reports/science-education-tracker-2019>

**Working with under-served audience**

One of the main aims of the Ingenious scheme is to broaden the reach of engineering public engagement. We want Ingenious projects to involve people who are currently under-represented in STEM engagement activities and who are under-represented in the engineering profession.

Underserved audiences can include:

* Women and girls
* Black, Asian and Minority Ethnic communities
* People experiencing economic & social disadvantage e.g. living in areas of high indices of multiple deprivation; pupils receiving Pupil Premium funding (or the equivalent in Northern Ireland, Scotland and Wales
* People aged 16-24 who are not in education, employment, or training (NEETS)
* Children in care
* People with a disability or long-term illness

**Recommendations**

The following recommendations come from various research studies into engaging under-served audiences, as well as evaluations of previous Ingenious projects.

* Clearly define the under-served audience you intended to reach at the beginning of you project. On your planning template you should define which underserved audiences you will target and your strategy for reaching them. We recommend focusing on one or two underserved audiences to avoid spreading your resources too thinly
* As you plan and develop your activities research your audience’s specific needs and wants, and the potential barriers to their involvement in your project. This will involve reviewing the published research literature and evaluation studies related to public engagement; talking to members of the audience, community leaders and teachers at local schools.
* Try to involve members of the audience in planning, developing and delivering your activities to ensure that the content is appealing and relevant, that it is delivered in venues that they can reach and marketed through channels that they use and trust
* If you are running a co-creation project be clear and honest with the community members what role they will be playing, how much of their time you will be asking for, what you are aiming to deliver and what constraints you will be working under. Carefully consider how the community members will help you deliver a project that is more accessible, appealing and impactful for your whole target audience.
* Develop content that demonstrates the relevance of engineering to their cultural heritage, daily lives, interests and local area.
* Provide plenty of shared, hands-on activities that are appealing and accessible for children and adults alike. Many people who avoid visiting museums and science centres do so because they assume the experience will be unappealing to their children
* Encourage parents and grandparents to take part in these activities. Help them to support their children’s learning, for example by providing questions to ask during the activities, hints on what to do, background information that links these activities to their everyday lives, ideas for things to do at home.
* Provide support for parents and grandparents for whom English is not their first language
* Ensure that the engineers and science engagement professionals running the activities represent a range of age, ethnicity and gender.
* Run activities in locations that the audience can easily reach, and where they feel comfortable and welcome. NB museums and universities can feel very intimidating to those who are not used to visiting them and are often located in parts of town that your audience isn’t used to visiting
* A very effective way to engage parents is to showcase materials that have been developed by their children in class or in after-school activities.
* Ensure the language and imagery in your marketing clearly illustrates what the activities will be like – adults and children from your target audience, working together on enjoyable, rewarding hands-on experiences; content that’s relevant to their interests, lives and culture. Ensure the terminology you use is familiar to your audience. For example, words like ‘interactive’ or ‘tinkering’ may not be familiar to people who rarely visit museums or science centres
* Address financial barriers to participation (e.g. provide discount tickets, subsidised transport, free or subsidised food and drink)
* Promote your activities through trusted sources of information e.g. local papers, blogs, community newsletters, local places of worship, schools etc
* Work in partnership with trusted ambassadors from the community - youth workers, coaches, club leaders, places of worship, community groups. Work in partnership with schools to reach families via their children
* Provide, or commission, training for your engineers on how to work with these communities.

We have selected three projects that we have previously funded that demonstrate best practice in engaging underserved audiences.

SMASHfest UK [insert link to film]

SpaceFund [insert link to film]

Fixperts [insert link to film]

**Further reading**

To find out more about strategies to reach underserved audiences through STEM engagement we recommend the following publications

[ASPIRES 2: Longitudinal research project studying young people's science and career aspirations](http://www.ucl.ac.uk/ioe/departments-centres/departments/education-practice-and-society/aspires) – this web-page provides access to a summary of the research findings, longer reports from the various studies and a list of the peer reviewed papers that the team have published since 2010

[Culture On Demand - ways to engage a broader audience](http://www.culturehive.co.uk/wp-content/uploads/2013/04/Culture-On-Demand-full-report1.pdf); Fresh Minds on behalf of the Department for Culture Media & Sport (2007)

[Experiments in Engagement: Review of literature around engagement with young people from disadvantaged background](https://www.sciencecentres.org.uk/national-impact/other-reports-science-centres/experiments-engagement-review-literature-around-engagement-young-people-disadvantaged-backgrounds); Platypus Research on behalf of the Wellcome Trust (April 2014)