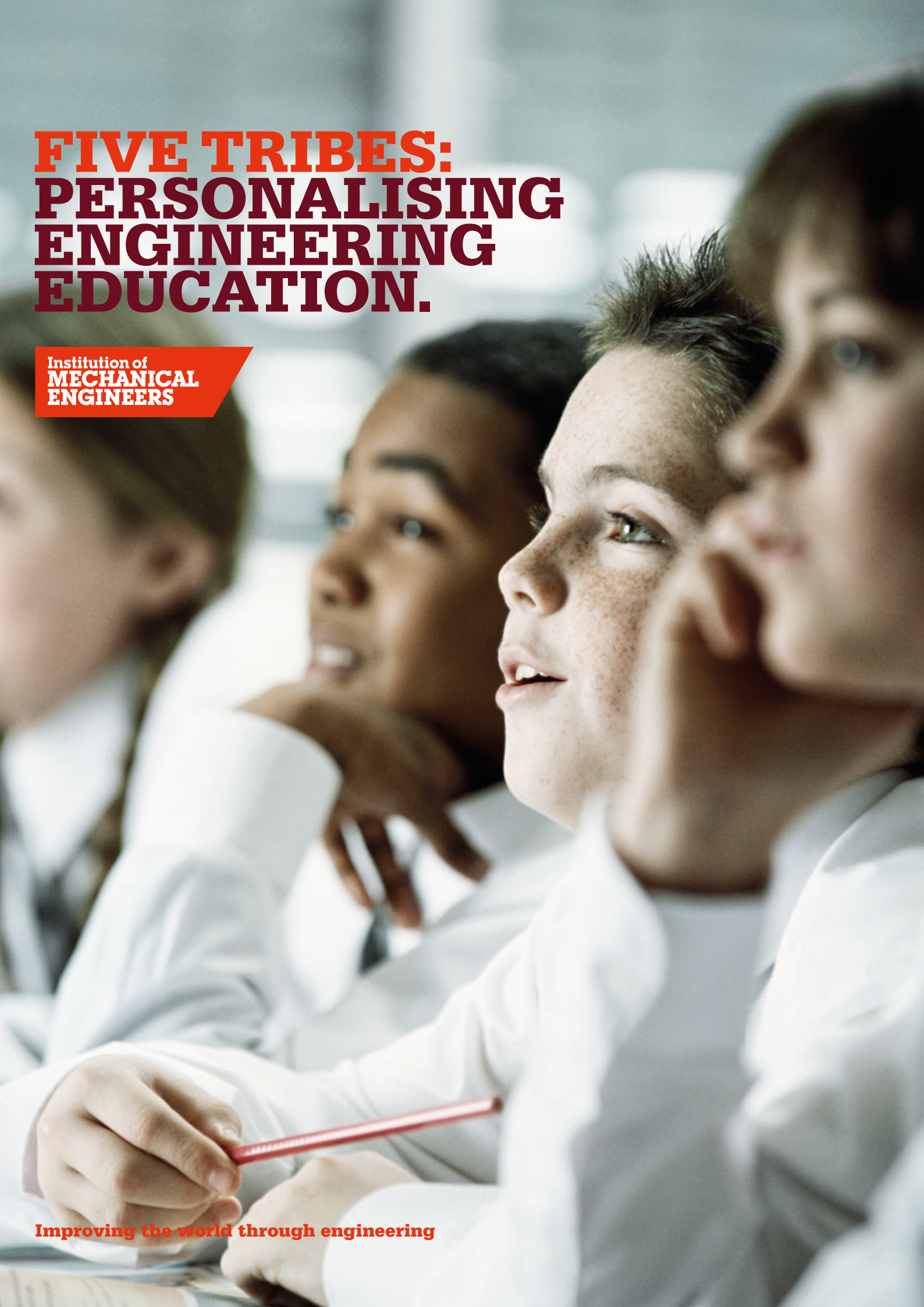
FIVE TRIBES: PERSONALISING ENGINEERING EDUCATION.

Institution of MECHANICAL ENGINEERS



Improving the world through engineering

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SAYING: ‘I’M AN ENGINEER… BE LIKE ME!’ MAY NOT BE SUFFICIENT TO PERSUADE THOSE WHO SIMPLY ARE NOT ‘LIKE ME’ TO BECOME ENGINEERS.

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MECHANICAL ENGINEERS

This report has been produced in the context of the Institution’s strategic themes of Energy, Environment, Education, Manufacturing and Transport and its vision of ‘Improving the world through engineering’.

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EXECUTIVE SUMMARY

Engineers create the world we see around us. From the earliest cave dwellers with their simple tools to today's sophisticated transport, energy and communications technology, humans have relied on engineers to improve the world. Engineers, "…make 'things' work or make 'things' work better"[1] – our prosperity and security are increasingly dependent on both nurturing engineering talent and fostering an environment in which the skills of the engineer are valued. At the same time, the processes that collectively constitute engineering remain among the most creative and fulfilling experiences that human beings can have.

And yet despite this, the number of people employed in engineering and manufacturing in the UK has halved in the last 30 years.[2] At a meagre 10%, we now have the smallest proportion of manufacturing in our economy of any G8 country[3], a feature occurring alongside low levels of interest in engineering among young people and an ageing workforce.[4] This means that at a time when we need to produce and sell more goods to restore the nation's finances, we face a severe skills crisis in this key sector.[5] The UK economy is strongly reliant on identifying and unleashing untapped talent among a wider number of school students. We need them all to fulfil their engineering potential rather than just have us rely on a reducing minority of die-hard enthusiasts. As we stand our current system is producing little more than one half of the engineers and technicians we need to sustain our economy.

Evidently, more needs to be done to encourage young people to see the value of pursuing STEM (Science, Technology, Engineering and Mathematics) studies, since these form the foundations of engineering. Much effort is made to attract tomorrow's engineers, often outside mainstream formal education, including after-school clubs and talks by practising engineers. Such approaches have not been without their successes, and there are encouraging signs in the increase in A-level achievement in England in 2014.[6] But the underlying message underpinning these activities is: "I'm an engineer… be like me!" which may not be sufficient to persuade those who simply are not "like me".

"The messages focusing on what pure scientists and engineers 'do' are NOT sufficient to persuade the under-represented groups...Careers from STEM need to be described in terms of the personal characteristics required."[7]
Professor Averil Macdonald.

In its commercial activity, industry makes good use of sophisticated market research to target products to its audience, by understanding how to characterise potential buyers by their attitudes, values and beliefs. But when it comes to promoting engineering and industry to young people in schools and colleges, less is known about the customer. In particular, by focusing on reaching large numbers, we seldom take into consideration the relationship between young people's self-perception, developing values and world views, and how these influence the career paths they choose to take.

This report describes a survey of values and beliefs, attitudes and preferences of a representative sample of 1,500 UK citizens aged 11 to 19. The results show that adolescents divide themselves broadly into five categories, determined by their values as well as their reactions to engineering as a subject and as a potential career.

The research raises questions about whether we should replace the current 'be like me' approach with programmes that take difference into account. It compels us to explore how it might be possible to retain the creative talents and innovative abilities of many young people who do not fit the obvious engineering archetype.

How might this knowledge inform how best to spend the limited amount of resource on encouraging young people to choose a STEM career path? It is plausible that a more directed approach to STEM engagement could be undertaken, focussing on each of the five categories (Tribes) where the likelihood of conversion is greatest. A common strategy would be to concentrate resources on Tribes who have the skills and interest but may need a small push in the direction to heighten their confidence and staying power. Meanwhile, we still need to maintain the interest of the already committed, and help keep engineering in mind.

KEY FINDINGS

- There are five broad categories (‘Tribes’) of adolescent attitudes to STEM within the nations of the UK; with each Tribe internally demonstrating shared values and beliefs, as well as similar attitudes to school, family and work.
- Two of the Tribes, ‘STEM Devotees’ and ‘Social Artists’, are present in similar proportions across all ages. These Tribes express very different attitudes and ambitions, yet both appear more focused in their goals than other Tribes.
- The three remaining (smaller) Tribes are found across different age groups, although the size of each Tribe is variable at different age stages.
- The ‘Enthused Unfocused’ Tribe emerge as a potentially valuable source of engineering talent. They are passionate about STEM but lack confidence to achieve success in the subjects.
- Social Artists’ are a large, female-dominated and creative section of the population who seemingly have relatively little affinity with STEM. Their rejection of STEM is mainly driven by absence of interest rather than lack of confidence. ‘Social Artists’ are the second largest and a potentially influential Tribe.
- The ‘Individualists’ are independent innovators and future entrepreneurs. Though they value creativity and consider it evident in engineering, they do not see engineering as being for them.
- The ‘Less Engaged’ Tribe reflect a section of the school-age population who are relatively less connected to school and appear to have lower interest in wider social values, in comparison to the other Tribes.
- Technology appeals overall to some Tribes more than others. Though there are clear differences in the profile of the technologies that appeal to individual Tribes, greater disparity is evident between the interests expressed by young women and men within the same Tribe (girls in all Tribes find most technology less appealing than boys).

RECOMMENDATIONS

Recommendation 1

There is no single best practice in teaching students or inspiring their interest. For engineering, different approaches are needed for five distinct audiences. Government, teachers, industry and STEM organisations must take into account young people’s diverse values and attitudes, when developing programmes, courses and activities, if we are to significantly increase numbers to desired levels.

Recommendation 2

A significant minority of school students is enthusiastic about engineering but lacks confidence to pursue the subject. Schools and outreach providers should actively identify and support these young people to build up their resilience and maintain their passion.

Recommendation 3

We should select a broad range of modern technologies and contexts to illustrate the diverse nature of engineering. Young women, for example, tend to have greater affinity with engineering connected to design, medicine, sports, information, environment, agriculture and construction. This should be reflected in how engineering is presented to them.

Recommendation 4

Adolescents currently have little exposure to engineering within schools so have few opportunities to look beyond outdated archetypes of the subject. UK Government Education Departments should ensure that engineering features prominently and explicitly in the curriculum to allow each young person to see the connection between their individual capabilities, interests and values; and future career opportunities.

Recommendation 5

This work offers a national snapshot of attitudes to engineering and technology within a specific age group. The study should be repeated every 3-4 years to gauge how the combination of initiatives and interventions has changed perceptions of STEM and engineering and hence the supply of skilled people needed to grow the UK economy.

INTRODUCTION

Engineering is what humans do. It is an intrinsic part of how we engage with the world, and has enabled us to survive and thrive. Just like our desire to make music, there is seemingly an insuppressible urge for members of our species to express themselves – in this case, through intelligent manipulation of the physical environment. In common with musicianship, some of the species are born with outstanding natural ability, while others become good or better as they develop and learn.

The current and projected shortage of engineers is well-documented[8] as is the widely accepted view that a highly technological future requires a technologically literate, highly-skilled and adaptable workforce.

Valiant attempts have been made by the engineering community to encourage greater interest in future careers among young people in the discipline. There have been successes, yet there is evidently still more to do since employers continue to raise concerns that shortages of skilled professionals threaten recovery and growth.

Five Tribes explores whether existing approaches to engineering education meet the needs of the wider population of young people, or they are simply reaching the naturally gifted or already converted. It also attempts to understand the potential for attracting people, not normally associated with engineering into the sector

These insights may prove vital as the UK works to increase both the number and diversity of young people choosing to pursue a career in engineering and in other STEM (Science, Technology, Engineering and Mathematics) subjects. In common with most technologically advanced nations, our future economic success and prosperity depends on these skilled innovators and technical experts. The level of demand means that we cannot simply rely on those with obvious natural talent, and we need to reach out more widely. At the same time, the world of work is changing rapidly, with technological developments forcing society to challenge long-established notions surrounding education, jobs, careers, study and training. Even within engineering, traditional disciplines are giving way to new cross-sector projects and ways of working. Meeting this challenge means acquiring a better understanding of the varied nature of the audience and potential pool of future talent – and acting on this knowledge.

What motivates and engages people varies from individual to individual. Our core values determine our beliefs, shape our attitudes and lead us to be more receptive to some ideas and less to others. Identifying groups of people within a population, who share a set of common values, is recognised as powerful knowledge in helping us to understand what is important to that group. *Five Tribes* sets out to establish and understand identifiable groups of young people aged 11–19 and explores how best to engage with them.

Few organisations have unlimited funds to engage fully with all Tribes. At the same time, government, industry and charities have differing aims despite often operating within the same field. *Five Tribes* suggests that there are a number of roles for different players, including challenging the most committed, building confidence in the less secure and providing basic skills.

> **“EFFECTIVE ENGAGEMENT IS INSPIRED BY THE EMPATHY THAT DEVELOPS SIMPLY BY BEING HUMAN.”**
> BRIAN SOLIS
> ALTIMETER GROUP

BACKGROUND

When democratic government seeks to modify the behaviour of its citizens, the options at its disposal are often limited. For generations, UK governments of all complexions have acknowledged the increasing importance of fostering conditions to bring about a highly skilled technologically literate workforce to deliver economic growth and stability. However, while politicians may have the power to influence, for example, in which part of the country to site a major manufacturing facility or where to lay tracks for a new railway, they have far less sway over the career choices of young people.

There are good reasons for this. Talent comes from many sources, and it is widely believed that young people should be free to pursue interests and make their own choices, independent of the needs of the state. These principles are seemingly enshrined in our culture, and in mainstream education, largely limiting scope for addressing fluctuations in the demand for skills.

What then are the options available to attract more young people into STEM? The Royal Society, in its *Vision for Science and Mathematics Report*[9], proposes modernising post-16 academic qualifications. Its authors cite the views of an independent group, chaired by Professor Sir Roy Anderson, in which a strong case was proposed for a baccalaureate system.[10] The report states how examination systems in England, Scotland and the rest of the UK:

"…may have largely benefited the minority of the population destined for academic study, but they have failed to meet the needs of the vast majority of young people and not necessarily best served those of employers."

The national shortage of engineers is evident at both technician and graduate levels, yet currently the majority of pupils have little exposure to engineering within mainstream school, and remain largely unaware of alternatives to academic study. Government and industry therefore rely on meeting demand through a combination of informal outreach activity and faith that the market will influence supply.

The success of a minority within the existing system may also conceal an unpalatable truth that current communications activity, educational initiatives and outreach, may only appeal to a small section of the population of young people.

Meanwhile, critics argue that the UK education system(s) forces too many pupils to make choices before they are at the right level of maturity or before they are sufficiently knowledgeable about their options.[11] For STEM subjects, school qualifications are seen as a compulsory foundation for further study, meaning that making the wrong decision at age 13 or 16 cannot easily be put right later.

Engineering has a low profile within many UK schools, which compounds the issue raised. How then might we ensure that school pupils are sufficiently well informed about subjects that may not feature in mainstream education until after key career decisions have been made? This holds special significance where the subject both falls outside of the standard school offering and has a strong perceived gender bias. The school inspectorate in England, Ofsted has noted that girls hold conventionally stereotypical views about jobs for men and women, and retain these views throughout their schooling.[12]

The answer seems obvious. In addition to greater visibility of engineering in the school curriculum, high quality careers information, advice and guidance should be at the core of this process. Yet this is not the case. In England the schools inspectorate, Ofsted has stated how arrangements for careers guidance in schools are not working well enough,[13] which may account for the statistic published by business leaders that 93% of young people are not getting the careers information they need.[14]

In 2014 the Gatsby Charitable Foundation published a report of research it carried out to establish benchmarks of good career guidance, based on best practice within the UK and across nations in which educational results and career support were both highly rated. *Good Career Guidance*[13] highlights the importance of meeting individual needs, including acknowledging:

"…Pupils have different career guidance needs at different stages. Opportunities for advice and support need to be tailored to the needs of each pupil. A school's careers programme should embed equality and diversity considerations throughout."

The findings from Five Tribes suggest that a more nuanced stratified approach should be adopted when attracting young people into engineering. Many believe the best mechanism for engaging young people with STEM involves 'lighting the touch paper' through experiences that are enjoyable and inspiring. Others focus on exposure to authentic engineering applications and employment as the most effective method. In truth the efforts made are often predicated on a 'will to believe', rather than robust evidence demonstrating real and sustained change in attitude in the target audience. The Institution of Mechanical Engineers believes that real change requires systemic, cultural and attitudinal change among policymakers, industry and educationalists. That is why its education strategy attempts to address the issue at a number of levels:

- Inspiring the next generation through exposure to high quality learning experiences
- Informing young people, teachers and parents in a timely and professional manner about the broad range of paths into modern engineering careers
- Transforming the educational infrastructure through increasing the professional skills of key practitioners, including teachers and careers experts
- Understanding the nature of the audience, its receptiveness to key messages and the effectiveness of different interventions through research
- Influencing policymakers, industry and practitioners to adopt and support proven programmes and approaches

THE RESEARCH

OUTLINE

Five Tribes is an applied research study that employed market segmentation techniques to understand more about the values of young people aged 11–19 by identifying distinct groups. The study also examined the level of appeal expressed by members of each tribe for a range of technologies that broadly equate to traditional engineering disciplines. Our intention was to understand how young people's attitudes towards engineering and technology were influenced by their values, beliefs and experience, and how these insights might inform practice and policy.

The research instruments were designed by members of the Institution of Mechanical Engineers and ICM Unlimited. ICM created a three-stage project of offline and online methods to explore these themes, as well as asking questions about educational achievement and career aspiration. Initially, secondary school pupils were recruited to attend focus groups to inform a quantitative survey. The second stage consisted of an online survey to a much larger sample of young people to yield statistical data and create the foundation for the third stage, involving cluster analysis. Five segments of young people emerged from the quantitative survey that built a profile of young people in terms of attitudes towards STEM subjects, technologies and engineering.

DESIGN

An extensive online survey included quotas set according to UK representative data on age, gender, government region and social economic grade. This is population data sourced from ONS 2007, 2009 and 2011. Quotas were not interlocked and the final data set has been weighted to this information and therefore this study is considered broadly representative of those aged 11–19 living in the UK. Research was conducted in February 2014 over a three-week period.

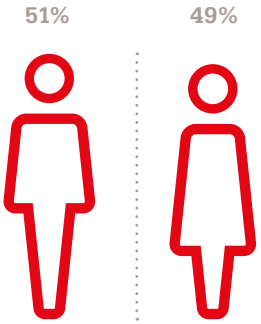
ICM convened focus groups with three schools to help inform the quantitative survey, testing how young people would respond to questions on attitudes, values and beliefs. The qualitative findings informed the survey through:

- Determining the scope of relevant questions that would produce the breadth and discrimination of response
- Ensuring that the questions asked were coherent to all participating age ranges and both genders
- To test out some proposed innovative data gathering techniques

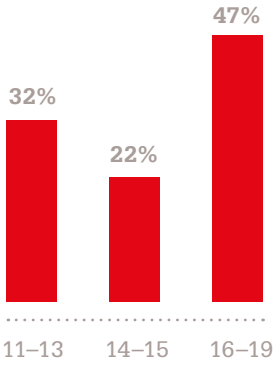
SAMPLE

Participants aged 11–19 were interviewed through an online survey with 1,504 interviews collected. All respondents originated from an online panel where adults, mainly parents, have signed up and given explicit permission to be contacted in relation to carrying out market research surveys. The parents and other responsible adults have disclosed permission for their child aged 15 or under to also participate in relevant surveys. All respondents were currently residents of the UK and were randomly chosen within the child age criteria, to take part.

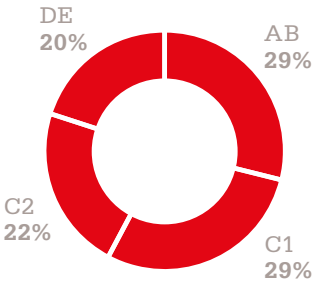
The online panel consists of approximately 37,000 young people aged 11–24 years old in the UK and has been in operation for just over a decade. The panel has been designed specifically for encouraging young respondents to take part in research surveys. Each time they participate respondents receive incentive points that can be redeemed once their account reaches £15. Young people have been recruited from various offline and online sources to reflect the diversity within the UK. The data were weighted to match Office of National Statistics data on age, gender and region for those aged 11–19 in the UK.



Gender profile



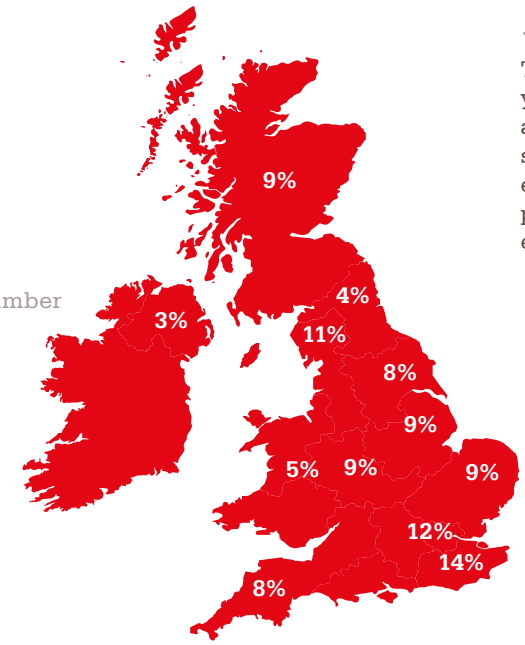
Age profile
Average age is 15 years old



Social grade profile

Region profile

14% South East
12% London
11% North West
9% East Midlands
9% East of England
9% West Midlands
9% Scotland
8% South West
8% Yorkshire and the Humber
5% Wales
4% North East
3% Northern Ireland



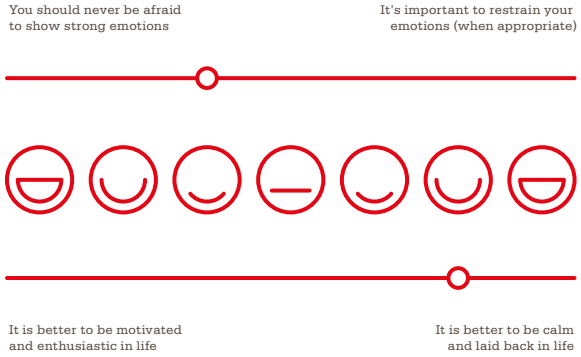
There is an even distribution of young people in the sample according to their academic school year. According the the ethnic profile, 14% of the young people in this study are of an ethnic minority background.

QUESTION STYLES

The survey employed a range of interactive question styles to maximise engagement throughout the questionnaire. Significant attention was given to producing stimuli that were uniquely designed to measure alignment with values in a neutral way; thereby minimising respondent bias. The research team designed the questions to maximise data quality. Steps were taken to ensure all stimuli were engaging, accessible and unambiguous so that respondents fully understood tasks, completed the survey and provided responses that could be easily analysed.

Examples of two of the question styles are shown here.

See appendix for the full set of questions and survey stimulus questions



Q3 Determining young persons alignment to a range of values.

Respondants were asked to read statements on both sides of the scake and then move a pointer towards one end or the other indicating their level of agreement. A polarised seven point scale was used.

Q24 Determining the appeal of different technologies.

This question was asked in two parts:

The first required respondents to say how important technologies are to the world and how important the people behind the technology as well. Respondents were shown 12 images of technology, each with a short description. Through a drag and drop system, respondents could actively grab the first card from the pile and place it in a category of importance. This question gave the survey an interactive edge but also allowed the respondent to visualise a technology they may not know about.

THE ANALYSIS

FACTOR ANALYSIS

The segmentation process comprised the following:

1. Determining which questions to use for segmentation (questions 3, 4, 8, 10, 20, 23, 25 and 26 selected)
2. Checking and cleaning the data.
3. Assessing the completeness and accuracy of responses to the values and attitudinal statements, suitable for analysis. Respondents who did not show any variance across questions were removed, and questions with less than 80% completion were deemed unsuitable for use in the segmentation. Missing values for those questions remaining were replaced with the mean across all respondents for that question. To remove any respondent bias associated with using scale questions, the data were centred so all attributes were expressed in terms of deviation from the respondent mean.

The factor analysis was then carried out to group the standardised attitudinal statements into common themes, which would then be used as inputs to segment respondents in the clustering process. To generate clear segments these inputs should be truly orthogonal, so a varimax rotation method was applied with Kaiser Normalisation to produce 18 factors initially with an eigenvalue above 1. An iterative process was then applied to refine the factor analysis, each time removing any individual attribute which had a negative loading into a factor. The end result was a final solution of 12 clear factors which accounted for 56% of variance in the attributes used.

CLUSTERING

The final stage of segmenting respondents made use of two different clustering methods called Two Step and K means. Using each method, solutions were run from three up to eight segments. Each segment was then profiled by the factors, individual attributes and demographics. After assessing the size of the segments in each solution and how they break down when the number of segments increased, it became apparent that the Two Step similarity measure gave the most differentiating clusters. Of the Two Step solutions, the five-segment profile gave the optimum number of segments, in terms of being targetable and reachable so this solution was then carried forwards for further profiling.

THE RESULTS

Our research has shown five clearly defined tribes of young people in the UK, aged 11–19. Through detailed analysis of shared characteristics, we have defined the following headings:

1. Stem Devotees
2. Social Artists
3. Enthused Unfocussed
4. Individualists
5. Less Engaged

STEM DEVOTEES

The tribe with the largest membership was *STEM Devotees (N=435 and overall 29%)*. This group was predominantly male (58%), with 69% growing up in ABC1 households. They were also more likely to be affluent or have parents who were professional. *STEM Devotees* aligned themselves with strong values around reliability, commitment and education. They saw themselves as completers and were organised. They also appeared to have strong STEM capital, with 87% citing ties to STEM within the family – who were identified as strong influencers on them through well formed networks of extended family.

This tribe expressed very high levels of enjoyment of STEM subjects (85%), especially mathematics – scoring more highly than others on their positive experiences of studying mathematics, further mathematics and statistics. This group saw STEM related careers as prestigious, clever and were least likely amongst all the tribes to feel excluded from them. *STEM Devotees* expressed a clear affinity with most technologies but specifically identified space, chemical technology and materials science as particular areas of interest. Strikingly, there were, however, big differences in the appeal of different technologies among male and female members of this tribe.

SOCIAL ARTISTS

Social Artists were the second largest tribe (N=390, 26%). This group was predominantly female (55%), an identical gender split to *Enthused Unfocussed* described later. Some 93% of this group classified themselves as white – the highest proportion of any group. Their survey responses suggest that *Social Artists* were the most socially conscious of the groups; however they placed very little importance on religion. Of all tribes, *Social Artists* seem to be the natural 'networkers', and judging by the subjects they enjoy most in school, they were by far the most creative tribe. They tended to enjoy STEM subjects less than other tribes but were more likely to be positive about art, English language, drama and dance as school subjects. Consistent with this, they displayed little connection with technologies presented, with the exception of engineering related to art and design. Along with the *Less Engaged* (also described later), *Social Artists* expressed the least interest in engineering as a career or the five tribes (30%). Otherwise, this group is highly engaged in school, with a large network of support and developed views on the wider world. Their connection with what traditionally have been considered 'creative' subjects makes them less likely candidates for a future in STEM – academically or as a career. Yet this tribe comprises many potential engineers who would be more inclined to contemplate what is on offer if the engineering community were better able to promote its creative side.[16]

INDIVIDUALISTS

The third tribe (N=255, 17%) was, in some ways, the least tribe-like, with its members being highly independent and choosing to work on their own. *Individualists* are most likely to have a small inner circle of friends and value courage, humour and innovation. They saw themselves as 'action takers' and generators of new ideas. Once more, there was a higher proportion of females in this group (55%), but unlike the *Enthused Unfocused*, they tended to be older (56% were 16–19). *Individualists* were fairly unengaged with STEM (55% claimed to enjoy it) suggesting they felt the subjects were for clever people but not for them. In this regard, *Individualists* are similar to the *Enthused Unfocused* tribe, and resemble the young people characterised as having low family science capital in the Aspires Report produced by King's College London. These ideas appeared to deepen among older member of the tribe. They were more likely to study academic subjects linked to specific vocations, such as law, psychology and business. Levels of affinity with technology seemed to decrease at each increasing age stage, though interest in civil engineering and construction went up. As a group they have little interest in engineering as a career, a view that is even more pronounced among girls (28% of girls within this tribe compared to 54% of boys) – yet they do see engineering as a creative career with an important set of skills.

ENTHUSED UNFOCUSED

The smallest of the tribes (N=150, 10%) comprised more girls (55%) than boys and tended to be younger, with 41% aged 13 or under. A large minority (16%) described themselves as coming from Asian backgrounds (mainly Pakistani, Indian, Chinese and Bangladeshi). They had a broad sense of values, including honesty, courage, optimism, passion and humour. This tribe values athleticism while placing emphasis on competitiveness and aspiration. Family ties with STEM were relatively low, with just 27% identifying that they were aware of someone within their network of family and friends, working in a related area. Despite a fairly high degree of confidence in their own abilities and an acknowledged enjoyment and interest in STEM subjects, it was unclear whether they would give STEM priority. They held STEM careers in high regard in almost all respects, and would like to use STEM in a career (84%). However, more strongly than any other segment, and somewhat paradoxically, they believed that STEM careers were not for people like them (61%). The *Enthused Unfocused* appeared to have a high affinity with most technologies presented. Though this segment was the most interested in a career in engineering, they were less aware of the entry requirements for the routes into a career.

LESS ENGAGED

Members of this tribe (N=255, 18%) were more likely to be male (57%) and less likely to come from a professional background, with 34% and 25% of the group identified as C1 and C2. As their name suggests, this tribe is less engaged with STEM and all other school subjects. The group is the most insular with regard to values and views, appearing to hold fewer strong world views, and is not strongly aligned to any values. They are the least adventurous tribe too. The *Less Engaged* are also characterised by a lack of confidence in their own abilities and the perceived absence of a wider support networks. We see a greater focus on close blood family and step parents. Since they are largely only influenced by close family they may have a narrower set of views.

When questioned about the appeal of different types of engineering, this tribe had the lowest affinity of any tribe with the choices presented.

TRIBES OVERVIEW

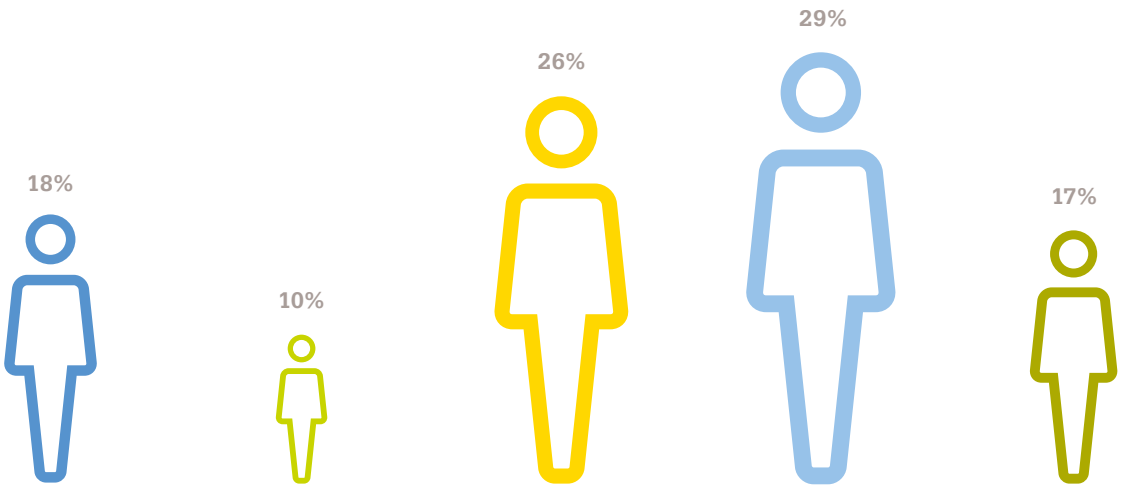
Less Engaged
Lower levels of engagement with subject

Enthused Unfocused
Lots of interests but lacking clear alignment

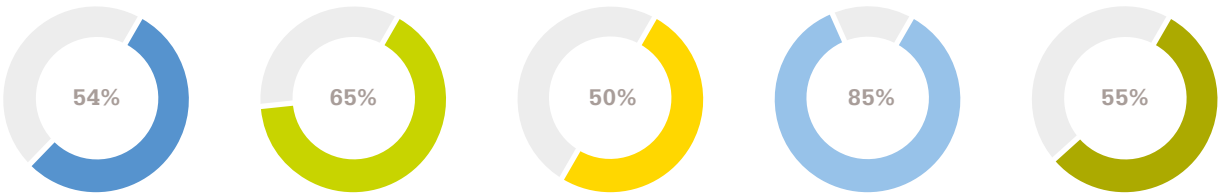
Social Artists
Socially conscious and creative

STEM Devotees
Focused achievers, likely to continue with STEM

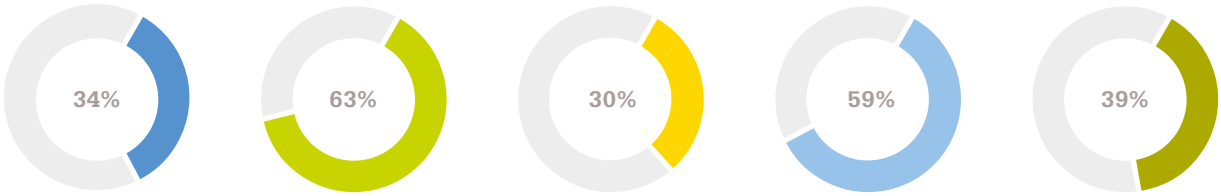
Individualists
Courageous innovators who want to get things done



Enjoyed STEM



Interested in Engineering



WHAT DO WE KNOW ABOUT THE TRIBES?

Since the tribes are derived from a segmentation study, care should be taken that over- and under-indexing simply means that the group has scored significantly differently on a question or trait from all groups or other tribes. Therefore comments are based on relative rather than absolute measures of values, interests etc.

1. Changes with age

We were keen to understand how these differences in might influence how the engineering community engages with them.

How we can tailor communications about STEM in a different way to speak to broad groups and tribes of young people?

There has been much discussion about when is the best time to talk to young people about engineering. In its report: '*When STEM? A question of age*', the Institution of Mechanical Engineers concluded that outreach interventions were best targeted at the 11–14 age group, since:

"This is a key period during which children's interest in STEM often falls away; this influences their future decisions about whether to study STEM subjects and pursue STEM careers"[17]

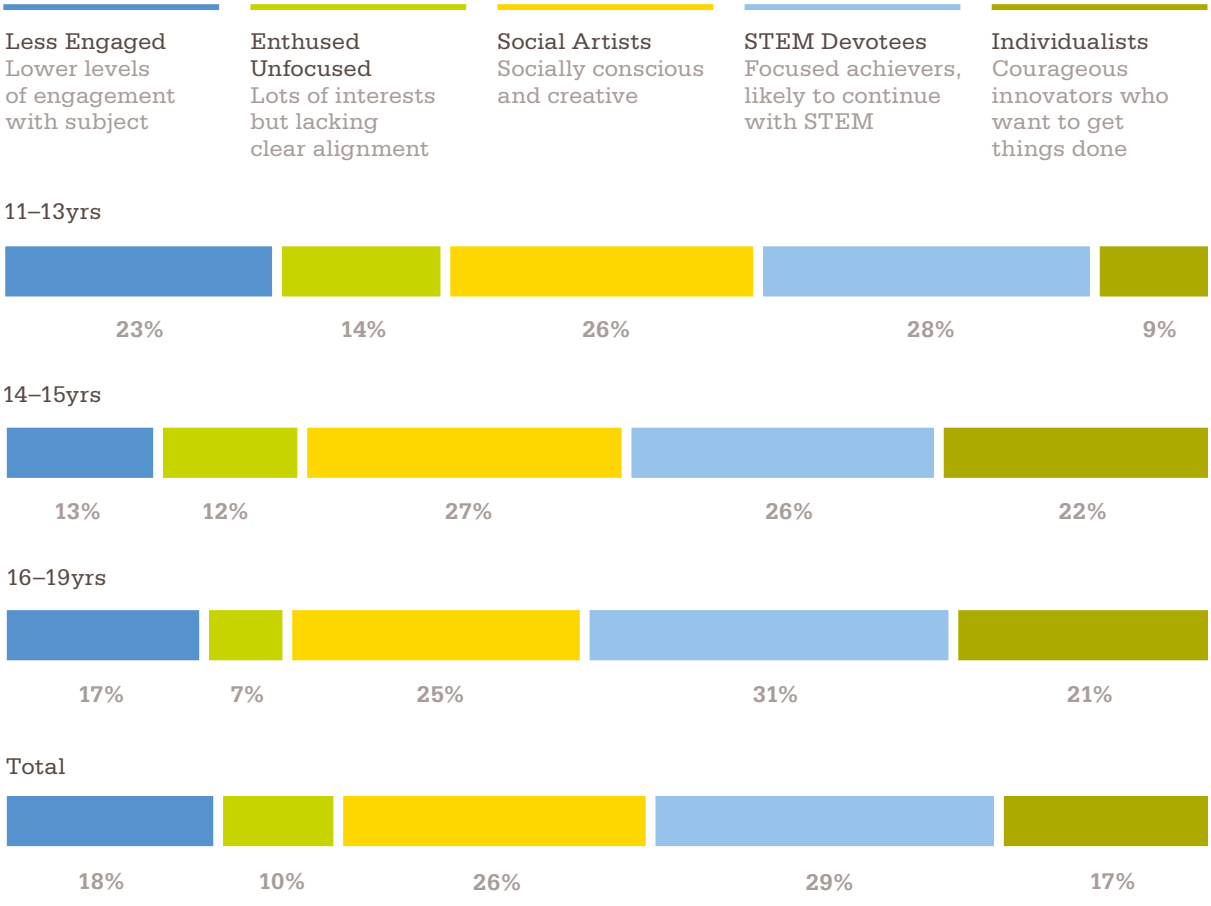
However, many argue that signalling and inspiration about STEM needs to happen sooner – at primary school or even earlier – often citing figures that show how a gap appears between interest in the subjects and perception that a future in the subject is not for them. According to research led by the University of Derby, International Centre for Guidance Studies[18] on young people's attitudes, 'feelings' about STEM determined subject choice, compounded by the fact that these attitudes are thought to: "*…harden at a very early age*"[19]. Industry and others express concern that despite a plethora of interventions targeted at promoting engineering to specific age groups, there was only limited evident of a shift in levels of interest, especially among girls and young women.

The scope of this study did not extend down to primary aged pupils – it may not be valid to identify 'tribes' in younger children, since stable values, beliefs and attitudes may well not be established at this age. Equally, the methodology employed would not have been appropriate. *Five Tribes* does not propose specific interventions, but in attempting to characterise the teenage audience in this way, our research findings suggest that we need to go beyond simply tailoring activity to particular age groups, and no longer assume that all young people have latent interest ready to be switched on. STEM ambassadors, outreach providers and teachers may need to consider other factors besides age, intellectual ability, behaviour and attainment. In particular, what are these young people's values and how to make better use of group differences to capture their interest.

By exploring three educational stages corresponding to key points in secondary and post-16 schooling throughout the UK, we were able to compare the relative population size of the five tribes at 11–13, 14–15 and 16–19. The population of the two largest segments, *Social Artists* and *STEM Devotees*, appeared to be the most unchanging over the three phases, with mean populations of 26% and 29% respectively. *Social Artists* in particular showed almost no change throughout the entire secondary education phase (26% > 27% >25%), while STEM *Devotees* exhibited a marginally greater, though still fairly minimal change (28% > 26% > 31%). For other tribes, there appeared to be greater movement between the age stages.

This leads us to suggest that there may be two broad categories of tribe – *resilient* and *transitional*. The resilient tribes – *Social Artists* and *STEM Devotees* – are familiar inasmuch as they strongly resemble intellectual types identified by C.P. Snow in his 1959 Rede Lecture: 'The Two Cultures'.[20]

The two larger groups have similar age profiles, towards the older age range, both are likely to be white, although *STEM Devotees* come from more privileged backgrounds.



2. Gender, social class, and ethnic background

Two tribes comprised significantly higher proportions of males – *Less Engaged* and *STEM Devotees* (57% and 58%). Interestingly these are the groups that were respectively least likely and most likely to pursue STEM. *Less Engaged* members have the lowest representation from amongst the AB social grade. By contrast, *STEM Devotees* are more likely to be privileged, with almost 70% coming from professional and managerial backgrounds (AB and C1) – 39% from the most socially advantaged (AB) grades. The *STEM Devotees* have the fewest members from grades C2 and DE, which also reflects the Aspires data on who aspires to science. The three other tribes share identical gender splits, each with 55% female. Social class is more evenly shared out between and amongst these groups.

The tribes with the greatest ethnic diversity were the *Enthused Unfocused* and *Individualists*. One quarter of the *Enthused Unfocused* tribe identified themselves as minority-ethnic, with 16% described as Asian (Pakistani: 5%, Indian: 4%, Chinese: 2%, Bangladeshi: 1% Other Asian: 3%) which is higher than for other tribes. Some 6% of this group are black. The same proportion of minority ethnic members was found amongst the *Individualists*, though more identified as black (10%) and fewer as Asian (12%). The *Social Artists* were predominantly white (93%).

3. Values, world-view and self-perceptions

Among other factors, the tribes were established through inquiry about values, world views and how participants perceived themselves. The 'values' questions presented two extreme perspectives and asked respondents to move a slider to indicate their relative position along a continuum. For example, for 'optimism', respondents had to show their position between the extremes:

- It's important to be positive whatever the situation
- It's important to express doubt or concern

We then asked participants to indicate their levels of agreement with a set of statements on 'world-views' – essentially, philosophical, political and ideological perspectives. For example, the importance of religious faith was determined through the level of agreement on a seven-point Likert scale response to the statement:

- "Believing in religion is more important than anything else".

To gain greater insight into how abstract values might translate into individual intentions or actions, participants were invited to state the extent to which they agreed with a further range of statements, such as:

- It is important to focus on how people feel as well as what they do
- I like to be organised and structured
- I sometimes find it hard to keep going if there are obstacles

These statements challenged young people a little more to consider what they might do about the values they hold, while providing the researchers with a mechanism for checking reliability of responses.

Overall, the top four values rated positively by young people were:

1. **Caring:** Being caring is a strength (87% agree)
2. **Loyalty:** Loyalty is the most important thing in friendship (77%)
3. **Open-mindedness:** We should always be open to others' new ideas and different opinions (77%)
4. **Innovative:** It's good to think of new ways of doing things (76%)

Nearly all respondents valued human rights, fairness and equality. There was also broad consensus that the world should be a more caring place. However, clear support for most of these political and ideological world-views tended to decrease as their age increased (16–19).

Within the tribes themselves, there were clear differences in the values and philosophies. *Enthused Unfocused* are good team players. They value honesty, optimism and reliability, as well as favouring passion, commitment, humour and courage. They are also more likely to see religion as important. Along with *Social Artists*, tribe members demonstrate greater empathy, whilst supporting a range of political causes, yet they are ambitious and self-interested. *Social Artists* are the most caring, most passionate and fun-loving, but no more ambitious than any other group. *STEM Devotees* are no less caring than the population overall, but are more inclined to value education, reliability and commitment than others. Though they only marginally miss out on over-indexing on fairness and equality, they are not an obviously political tribe. Meanwhile, *Individualists* are even less affected by these broader political perspectives, and value family less than most. However, they do rate innovation, adventurousness and courage more highly than most, and think that humour is important too. These are qualities that seem synonymous with entrepreneurship.

The *Less Engaged* tribe might appear to lack values and political interest. We need to be careful in how these data are interpreted. Though they under-index on all but five values and on all 'world-views', this may reflect that this tribe tends to comprise younger teenagers, and that scoring lower on, say, 'caring' relative to the other groups does not mean that they are uncaring.

INFLUENCING THE TRIBES

One of the factors used to build up a profile for each tribe was who were their key influencers and the degree of sway they had. The 'importance of family' was rated highest overall (37%), scoring more than three times as highly as 'fairness and equality' (12%) and four times as the 'importance of addressing poverty' (9%). Family was considered as more important for 11–13s (49%) but much less so for 16–19s (26%) unsurprisingly reflecting greater independence. Responses to this question did generate a significant social class effect too, with some 43% from C2DE social grades ranking family as 'most important' compared to 33% for those from ABC1 backgrounds.

Parents and carers were considered close and trusted by most young people, followed by siblings and then friends. Parents and carers influenced how young people 'saw themselves', though this figure almost halved from 64% to 34% from the youngest to oldest ages. In terms of shaping how they saw the wider world, just over half of younger respondents (53% of those aged 11–15) acknowledged parental influence, falling to two-fifths (40%) among their older peers (16–19).

STEM CAPITAL AND VALUE

We asked young people three questions to help determine their STEM capital. Was anyone in their household or among wider family/friends interested in science, technology, mathematics or engineering? Did these same people have qualifications (past secondary school level) in science, mathematics, technology or engineering? Were they or their network employed in a job where knowledge of science, mathematics, technology or engineering was important?

The term '*STEM capital*' draws on a feature of the Aspires education research project carried out by King's College London. This study highlighted the significance of family science capital[17] which it described within the five-year longitudinal research, as…"*a key factor affecting the likelihood of a student aspiring to a science-related career by the age of 14 is the amount of 'science capital' a family has*". According to the report's author, Professor Louise Archer, Science capital:

"*…Refers to science-related qualifications, understanding, knowledge (about science and 'how it works'), interest and social contacts (eg knowing someone who works in a science-related job). Science capital is unevenly spread across societal groups. Those with higher levels of science capital tend to be middle-class – although this is not always the case, and not all middle-class families possess much science capital.*"

The significance of science capital is clearly spelled out:

"*Students from families with medium or high science capital are more likely to aspire to science and STEM-related careers and are more likely to plan to study science post-16. Longitudinal tracking showed that students with low science capital who do not express STEM related aspirations at age 10 are unlikely to develop STEM aspirations by the age of 14.*"[21]

Five Tribes did not employ the more rigorous mechanism employed by the Aspires team for science capital, but was able to make use of data surrounding parental profession, interest and qualifications to offer relative and more descriptive levels of STEM capital.

The Less Engaged and Social Artists had the relatively low STEM capital with 36% not having a close family member with either an interest in STEM, a STEM qualification or a STEM-based career. These two tribes also shared relatively low levels of agreement with statements such as, 'STEM leads to the best-paid jobs' and "People with STEM-based jobs do valuable work". Individualists felt that only the cleverest students did well in STEM. Their STEM capital was fairly high, though they were less inclined to feel that the subjects helped them learn interesting things and only 43% said that they would want a career that used STEM. In comparison, *Enthused Unfocused* members had an intermediate relative STEM capital, but considered STEM as valuable, highly regarded and routes to a good future – though at the same time, they still considered the subjects difficult and 'not for them'.

The highest STEM capital was found among *STEM Devotees*. Some 67% had parents or close relatives with an interest in STEM, 55% had a qualification in the subjects, whilst 47% identified their family members as having a STEM career. Only half of *STEM Devotees* felt that the subjects were difficult and for the cleverest students. This is a similar percentage to the *Social Artists* but far lower than *Enthused Unfocussed*. At the same time, the *Social Artists*' negative responses about the value of STEM suggests that this tribe rejected STEM through lack of interest rather than because they found the subject intrinsically difficult. By contrast, the *Enthused Unfocussed* rejected it largely because they felt it to be too hard.

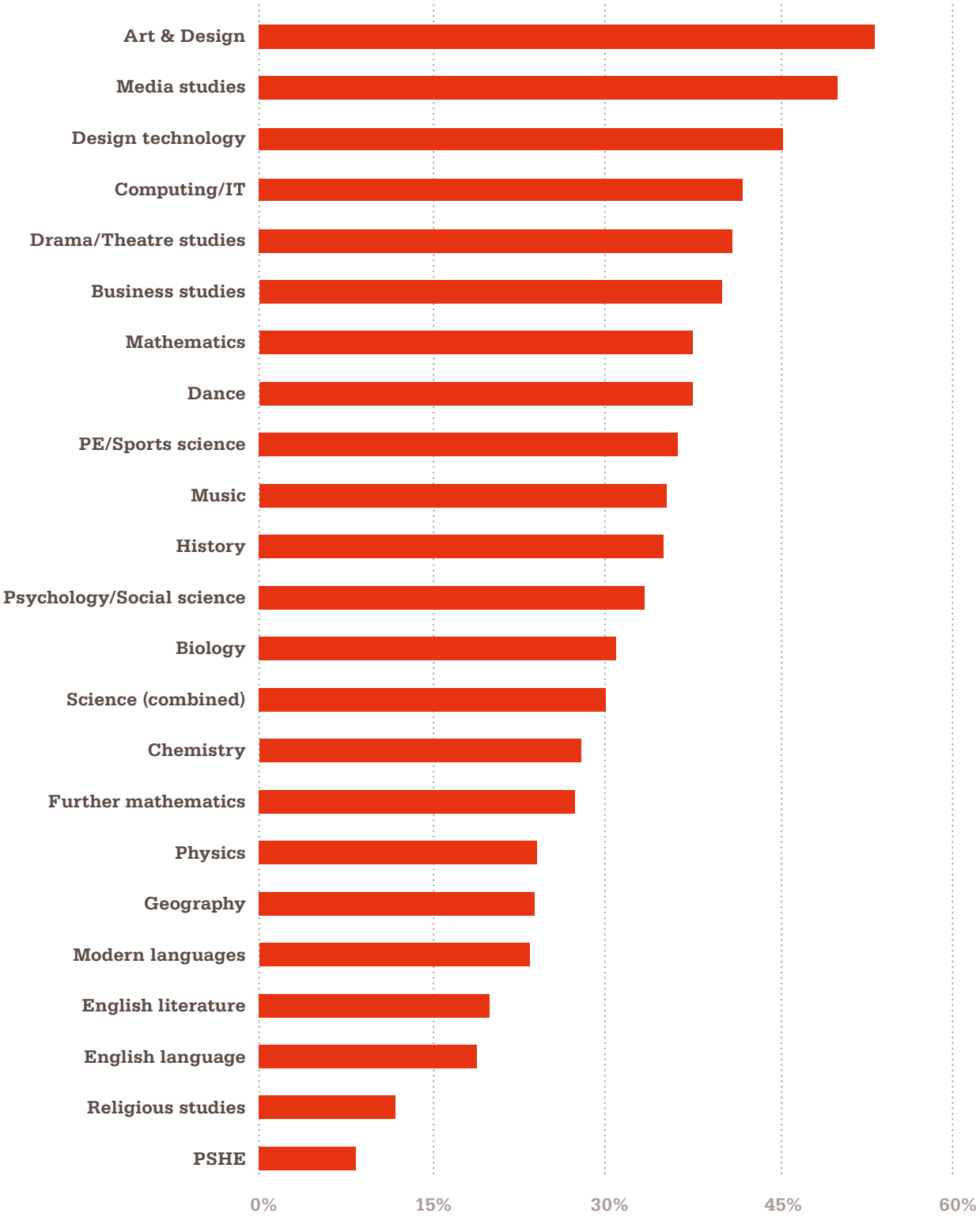
ENJOYMENT OF STEM STUDY

Students were asked which subjects they studied at school and to indicate which their favourite was. By dividing the number who selected the subject as their favourite by the total number who have or had studied each, we were able to produce a percentage which indicated the proportion of young people who found the subject most enjoyable (see **Figure 1**). Most students studied the compulsory subjects: mathematics, science and English up to the age of 16.

When asked whether they 'enjoyed subjects' sometimes, mostly or all of the time, nearly three quarters gave a positive answer for science, 70% enjoyed design & technology, while mathematics scored lower at 61%. Science was also considered to be an interesting subject by seven in ten young people and especially so by those aged 16–19. Half agree that studying the subject was fun. Four in ten aged 11–16 said that they were considering going on to study science post-16, with some 44% of 14–15s considering this option. One third of this age group would be interested in using science in their job one day, compared with 41% of 16–19s. Of this older group 30% would like to study science at degree level, while some 19% were sure they did not want to take the subject any further.

Some 56% of 17–19s surveyed were actually studying science. Two-thirds of this subset came from the more affluent backgrounds. Almost six in ten of those who have made a decision not to study science, were happy with this decision, leaving 43% who expressed some level of disappointment that they had not continued with the subject. This contrasted with seven in ten young people who were happy to have given up design and technology (DT) and 30% who were not pleased to have done so. Many young people who were interested in engineering but who had given up DT voiced how they wished they had continued with the subject. Three in ten would like to use DT in their job one day, while 23% felt that they might go on to study the subject post-16.

Figure 1: Enjoyment of subjects studied.



TRIBES AND TECHNOLOGIES

The research set out to investigate any relationship between the members of each tribe and their affinity with various types of engineering. Participants were asked to arrange 12 technologies according to personal appeal, sense of global importance, value they ascribed to people working in each field and the extent to which they would want to work with the technology or in a related area.

Overall, engineering linked to electronics, information technology and robotics was seen as appealing, important and valued. Young people also held medical and environmental technologies in high regard, both in their value for society as well as for future careers. Manufacturing, chemical, marine and railway engineering were relatively less popular – though these sectors were still seen as important.

Social background had a small effect on choice. Some 54% of students from higher social groups had a preference for aerospace compared with 46% from less affluent homes.

A more marked difference occurred across gender. The table in **Figure 2** illustrates relative appeal of each of the 12 technologies for males and females. Girls found most technologies less appealing than boys – emphasised by the percentage values for each technology. The blue lines indicate where boys ranked a technology higher in their list than girls, and the dark red lines show where girls placed the option higher than their male counterparts in the equivalent list. The yellow line shows where both boys and girls ascribe equivalent relative appeal.

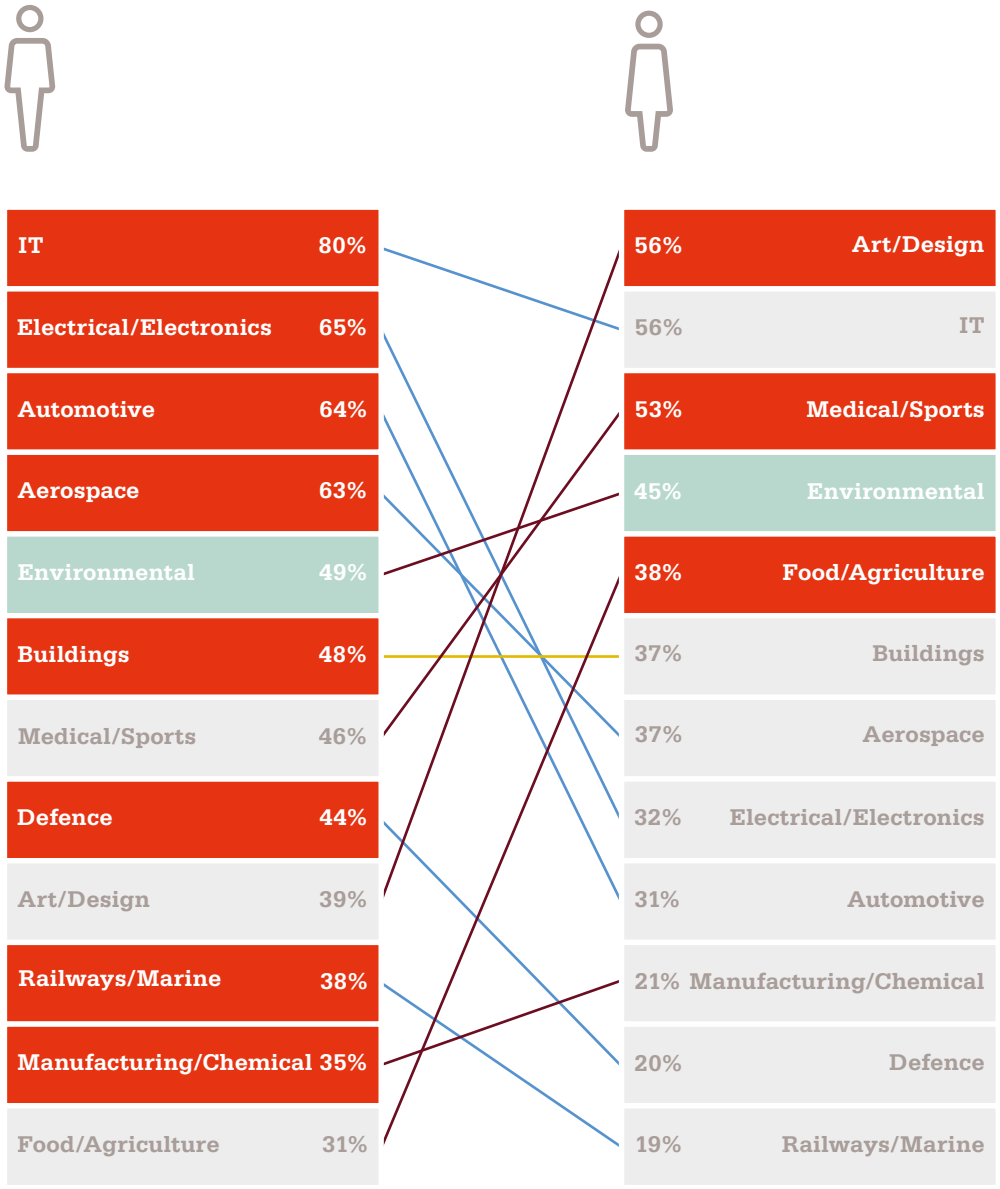
We note that although boys find most technologies more appealing than girls, the steeply descending lines indicate clear gender difference in ranked order preference. For example, girls favoured engineering linked to art, medical and sports technology and food/agricultural engineering, whilst boys placed power, electrical and energy, automotive engineering and aerospace far much higher in their list than girls. Of the 12 technologies. across all tribes, only environmental engineering showed no significant difference in its appeal for both genders.

Some 63% of boys found aerospace appealing, compared with 37% for girls. Over half of young women (56%) were interested in technologies linked to art & design, compared with just 39% of boys, whereas two-thirds of the male respondents found power, electricity & electronics appealing, double the percentage for girls.

In terms of world importance, research participants placed power, electricity & electronics (56%) as the most important for followed by IT & robotics (51%), then medical and sports technologies (49%). Manufacturing, chemicals & materials were ranked as fifth important on 83%, with 43% classifying these disciplines as ‘most important’.

People working in the electrical and electronics sector were most highly valued (56%), while those involved in Buildings were most important to 11–13s (37%) – though this figure fell by one fifth to 29% at age 14–15. Girls saw more value in people involved in environmental technology (42%) than boys (36%).

Figure 2: Percentage and ranking by gender for expressions of net appeal for response to statement: *For each type of technology say how much it appeals to you.*



Technologies with significant difference in net appeal between genders at 5% risk level

Technologies with no significant difference in net appeal between genders at 5% risk level

Boys ranked a technology higher than girls

Girls ranked a technology higher than boys

Boys and girls ascribe equivalent relative value

STEM DEVOTEES

- Overall, 59% of *STEM Devotees* were interested in engineering. Some 68% were male and 47% female.
- Three-quarters of *STEM Devotees* identified IT and robotics as their most highly favoured type of technology, followed by aerospace (66%), and power, electricity & electronics (61%).
- Interest in technology linked to environmental matters scored highly for this group (55%) – significantly higher than most other tribes.
- Some 53% were seen to have an affinity with medical and sports technology, though, in common with most tribes there was a marked difference between male and female devotees, both for this technology and more widely.
- For male *STEM Devotees*, the most popular was aerospace, then electricity, automotive, followed by buildings technology.
- For females, medical and sports at the top of their list, next IT, then technology associated with art & design.
- At 61%, over twice as many male *STEM Devotees* were interested in automotive technology than their female counterparts (30%). Although half of female *STEM Devotees* found aerospace appealing, one third stated that this engineering discipline did not appeal – this contrasts with 77% of male tribe members who liked automotive and 12% who did not.
- The tribe also rated power, electricity & electronics as the technologies of greatest world importance, followed by IT and robotics.
- Though both choices were consistent with their rankings in terms of appeal, the third ranked technology was food and agriculture – an engineering discipline that they had placed close to the bottom of their list of personal interest.
- There was a high degree of consistency in rankings between world importance and value ascribed to people who worked in each sector. The exception was aerospace, which they rated eighth out of twelve in its importance, while those working in the industry were jointly ranked as third.
- Along with other groups, *STEM Devotees* placed manufacturing and chemical engineering low down in their interests, while considering its importance in the top half and positioning people working in the field as highly important.

ENTHUSED UNFOCUSSED

- The greatest interest in engineering was expressed by the *Enthused Unfocused* tribe, with 63% finding the subject appealing.
- Levels of interest differed between males at 74% and females at 54%.
- 70% of the tribe's members under-16 were interested in engineering; 48% of over 16s.
- The level of enthusiasm for engineering was reflected in the broad range of technologies that they found appealing – *Enthused Unfocussed* found half of the engineering contexts presented more appealing than the other tribes.
- *Enthused Unfocused* found IT and robotics most appealing (81%), then medical and sports (72%) and automotive (67%), with 81% of males finding this sector appealing, in contrast to 56% appeal among females.
- *Enthused Unfocussed* members demonstrated a link between how they ranked the global importance of the technologies presented and the value of people working in associated engineering activity.
- For a tribe defined both by their interest in STEM and their sense that the subjects were 'not for them', it was no surprise to find that there was a disparity between how they valued the technologies and their aspirations to work in a related field.
- To illustrate this, technology linked to art and design was fourth most popular, yet it was rated tenth in order of world importance, and 12th (and last) when considering the 'value' of those working in the field. By contrast, Manufacturing & Chemical Engineering ranked 11th in appeal, yet seen as third in importance – valuing practitioners at the same level.

INDIVIDUALISTS

- Despite average levels of STEM capital and with 51% having a close relative working in the subjects, *Individualists* were relatively unengaged with STEM subjects – with only 39% expressing some level of interest in engineering.
- This sub-group tended to be younger and male, with less than one-third of the tribe who were aged over 16 finding engineering appealing.
- Some 28% of females indicated an interest in engineering, compared with 54% of males.
- The four most appealing technology options were IT, aerospace, automotive and electricity/ electronics.
- Both males and females placed IT and robotics at the top of their list of appealing technologies – with a highly significant 85% of males registering its attraction, compared with 53% of females. However, 43% of males found IT very appealing, in comparison with only 13% of female tribe members.
- With the exception of civil engineering (Buildings), none of the technologies presented, stood out as being exceptionally more appealing to this group when compared with others.
- Female *Individualists* placed art & design related technology in second place while males relegated this type of technology to last place. Despite the marked difference in ranked positioning, and statistical significance in appeal, the percentage difference between the genders was only 13%. This reinforces the fact that males find technology more appealing overall, and may suggest that making use of 'female friendly' contexts is less alienating to boys than presenting engineering in a male focused way to girls.
- The prospect of some future role working with buildings or art & design scored more highly for this tribe than most others.
- Manufacturing and chemical engineering was ranked relatively highly in terms of their world importance for this group – as was the perceived value of people working in these fields – however it did not hold much personal appeal.
- Similarly, food and agricultural engineering featured as second most important in its global importance and fourth in terms of value ascribed to those working in the sector, but ranked third from bottom in appeal – and the least attractive for possible future work amongst tribe members.

SOCIAL ARTISTS

- *Social Artists* had little affinity with most technologies; the exception to this was art and design engineering, which had particular appeal for this tribe.
- Overall *Social Artists* demonstrated similarly lacklustre levels of enthusiasm for engineering as the *Individualists*, though slightly more than the *Lesser Engaged* tribe. Only 30% stated they had an interest in engineering – lower than any other tribe – with only 16% of females expressing an interest.
- More than any other group, the personal appeal of technology bore little relationship to their sense of its world importance, as did the value they ascribed to those working in the sectors. A vivid illustration was that despite their personal appeal for art related technology, they placed it bottom of the list for its importance and value.
- *Social Artists* acknowledged how power generation, electricity and electronics were the most important to humanity, but not for them – placing these technologies in the lowest third of the list.
- The *Enthused Unfocussed* rejected STEM despite having high interest, because they had low confidence and thought the subject hard. By contrasts *Social Artists* chose not to consider STEM because they have insufficient interest rather than being difficult to understand. *Social Artists* expressed around half of the level of interest of working in each of the different sectors as the *STEM Devotees*.
- There was a big gender split amongst *Social Artists*, in that art and design technology ranked highest for female tribe members, but was in the lower half for males. Interest among both genders was highly consistent with the overall pattern – medical/sports, environmental and food for young women; automotive, electrical and aerospace for males of the tribe.

LESS ENGAGED

- Some 34% of the *Less Engaged* tribe expressed an interest in engineering – 41% of males and 24% of females in the group. The age split was fairly even, with 35% under 16 and 32% over 16, stating they were interested in the subject.
- Along with *Social Artists*, the *Less Engaged* tribe has the lowest family STEM capital – which took into account the degree of family STEM interest, the extent of close family qualifications held and the frequency of careers held in STEM.
- The gender pattern for ranked order of interests for *Less Engaged* was fairly typical for all tribes with IT and robotics, equally most appealing for males and females.
- Large disparities were evident in terms of the level of appeal to females and males in automotive, electrical, aerospace and defence technology, with males ranking these sectors far more highly.
- Equally large differences were shown in the appeal of art & design and food & agriculture – this time favoured by females.
- Like other tribes who were hesitant about STEM, this group see the technology types presented as important, value the people who work in these sectors but do not see a role for themselves.

CONCLUSIONS

Five Tribes raises important questions about how we promote engineering careers. For young people, especially young women, context and self-imagining may matter just as much as earnings and job security when considering their future. For STEM and engineering educationalists, the research suggests that greater audience sensitivity would unleash latent talent in some, while boosting confidence in others.

If we are to double the number of engineers to meet demand, it is clear that we can no longer simply rely on recruiting committed engineering enthusiasts alone. At the same time, as technology becomes increasingly central to almost every aspect of our lives, we need to ensure that all of tomorrow's citizens are provided with meaningful opportunities to understand and appreciate engineering's role in our society.

RECOMMENDATIONS

Recommendation 1

There is no single best practice in teaching students or inspiring their interest. For engineering, different approaches are needed for five distinct audiences. Government, teachers, industry and STEM organisations must take into account young people's diverse values and attitudes, when developing programmes, courses and activities, if we are to significantly increase numbers to desired levels.

Recommendation 2

A significant minority of school students is enthusiastic about engineering but lacks confidence to pursue the subject. Schools and outreach providers should actively identify and support these young people to build up their resilience and maintain their passion.

Recommendation 3

We should select a broad range of modern technologies and contexts to illustrate the diverse nature of engineering. Young women for example tend to have greater affinity with engineering connected to design, medicine, sports, information, environment, agriculture and construction. This should be reflected in how engineering is presented to them.

Recommendation 4

Adolescents currently have little exposure to engineering within schools so have few opportunities to look beyond outdated archetypes of the subject. UK Government Education Departments should ensure that engineering features prominently and explicitly in the curriculum to allow each young person to see the connection between their individual capabilities, interests and values; and future career opportunities.

Recommendation 5

This work offers a national snapshot of attitudes to engineering and technology within a specific age group. The study should be repeated every 3-4 years to gauge how the combination of initiatives and interventions has changed perceptions of STEM and engineering and hence the supply of skilled people needed to grow the UK economy.

APPENDIX

SURVEY QUESTIONS

- Sample: 1,500 interviews with 11–19 year olds in the UK (includes Northern Ireland)
- Nationally represenative quotas on age: 11–13 years old (31.7%), 14–15 year olds (21.6%) and 16–19 year olds (46.7%)
- Gender 51% Males, 48.7% females
- SEG: AB 29%, C1 29%, C2 22%, DE 20%
- 12 Regions:
  North East 4%
  North West 11%
  Yorkshire and the Humber 8%
  East Midlands 8.6%
  West Midlands 8.8%
  East of England 9%
  London 12%
  South East 13.6%
  South West 8%
  Wales 5%
  Scotland 8.5%
  Northern Ireland 3%

Questions D1–5 asked to parents if child is under 16 years old.

D1 Just so that we can direct you to relevant parts of the survey, please tell us if you are the parent or if you are aged 16–19 years old?

- I am the parent
- I am aged 16–19 years old

D2 How old are your children (is your child)/ are you?

- 10 years old or younger (CLOSE)
- 11 years old
- 12 years old
- 13 years old
- 14 years old
- 15 years old
- 16 years old
- 17 years old
- 18 years old
- 19 years old
- Over 20 years or older (CLOSE)

D2 **A.** Please select the age of the available child.

D2 **B.** Is your child/ Are you…

- Female
- Male

D3 Which region do you live in?

- North East
- North West
- Yorkshire and the Humber
- East Midlands
- West Midlands
- East of England
- London
- South East
- South West
- Wales

- Scotland
- Northern Ireland

D4 Which of the following groups' best describes the occupation of the Chief Income Earner in your household? The Chief Income Earner is the person with the highest income in the household. If incomes are equal, the oldest person should be considered as the Chief Income Earner.

D4 **A.** Do you personally, or anyone in your household or wider family/ friends network fit any of the following?

- Interested in science, technology, mathematics or engineering
- Have qualifications (past secondary school level) in science, mathematics, technology or engineering
- Work in a job where knowledge or science, mathematics, technology or engineering is important
- None of these

D5 How would you describe your ethnic group?

White

- English/Welsh/Scottish/ Northern Irish/British
- Irish
- Gypsy or Irish Traveller
- Any other White background

Mixed/Multiple Ethnic Groups

- White and Black Caribbean
- White and Black African
- White and Asian
- Any other Mixed / multiple ethnic background

Asian/Asian British

- Indian
- Pakistani
- Bangladeshi
- Chinese
- Any other Asian Background

Black/African/Caribbean/Black British

- African
- Caribbean
- Any other Black/Asian/Caribbean background

Other ethnic group

- Arab
- Any other ethnic group

D6 **A.** Which of the following best describes the type of school or college your <insert child age> attends/you attend?

D6 **B.** Which school did your child/you attend previously?

- State School or High School eg community, foundation & trust, voluntary aided/controlled
- State grammar school
- Private or independent school
- Academy
- Sixth form college
- College
- University
- Free School or Studio School
- No longer in education (show at Q6a only)
- Other

D7 Just to confirm, could you again please type in the job title of the chief income earner in your household/your job title here.

Allow child to answer survey from here onwards.

D8 Which academic year are you in? (Pre-coded list for respective country)

ALL ABOUT ME

Section Overview

To understand what drives these young people as individuals. Focus on exploring their interests, values, attitudes and family influence.

All those in year 11 (or equivalent) or below.

Q1 **A.** Which of the following subjects do you currently study?

- All those in year 12 (or equivalent) or above

Q1 **B.** Which of the following subjects did you study up to the age of 16?

- Art & design
- Biology
- Business Studies
- Chemistry
- Classics
- Dance
- Design & Technology
- Drama/Theatre Studies
- Economics
- English Language
- English Literature
- Film Studies
- Further Mathematics
- Geography
- Geology
- History
- ICT/ Computer Studies
- Law
- Mathematics
- Media Studies
- Modern languages
- Music
- Personal and Social Education/Citizenship
- Physical education (P.E.)
- Physics
- Politics
- Psychology/social science
- Religious Studies
- Science (general)
- Sociology
- Statistics
- Travel and tourism
- None of these
- Don't know
- All those at university

Q1 **C.** And which subject are you currently studying?

- Enter course title

Q2 **A/B.** And which subjects do you enjoy the most? Please pick up to 5 subjects.

- (Ask only subjects selected at Q1A)

Q2 **C.** What are your interests or hobbies? Please tick all that apply.

- Music – playing/ producing/listening
- Celebrities
- Watching television
- Playing video Games
- Films/Movies
- History
- Science
- Role Play/ drama/ acting
- Reading fiction
- Reading non-fiction
- Building/ making things
- Creative arts and crafts
- Fashion Design
- Fixing things/ DIY
- Cars/ Motorbikes/ Engines etc.
- Cycling/ outdoor pursuits
- Computers or other technology gadgets
- Dancing
- Playing or watching sports
- Other
- Don't Know

Q3 The next few screens show values on a sliding scale. For each one we would like you to read the statements on BOTH sides and then move the slider towards the one that you agree with most. If you are unsure, you can leave the cursor in the middle.

Reliable	It is important to keep your word and get things done	Sometimes you can't please everyone
Loyal	Loyalty is the most important thing for friendship	Loyalty is just a small part of friendship
Committed	People should see things through when they take something on	Sometimes it is not always possible to see things through
Open-Minded	We should always be open to other peoples new ideas and different opinions	We should trust our own ideas and opinions rather than other people's
Honest	You should be honest no matter what	Protecting friends, family and yourself is more important than being honest
Innovative	It's good to think of new ways of doing things	If something already works then there is no reason to change it
Humorous	It is important to see the funny side of any situation	There are many situations where it would be wrong to laugh
Fun-loving	Life is about enjoyment first and achievement/ hard work second	Life is about achievement/ hard work first and enjoyment second
Adventurous	It is important to break rules and try new things	It is better to stick to the rules and do things as done before
Motivated	It is better to be motivated and enthusiastic in life	It is better to be calm and laid back in life
Optimistic	It's important to be positive whatever the situation.	It's important to express doubt or concern
Passionate	You should never be afraid to show strong emotion	It's important to restrain your emotions (when appropriate)
Respectful	Everyone should be treated with respect	Respect belongs to those who earn it
Athletic	Doing well at sports or physical activity is more important than academic achievement	Academic achievement is more important than doing well at sports or physical activity
Courageous	When faced with danger or fear we should just face it and fight it	We should remove ourselves from dangerous situations; staying to fight is reckless
Educated	It is important to get a good academic education to be succesful	You do not need a good academic education to be succesful
Caring	To be caring is a strength	To be caring is a weaknesses
Liberal	It's right to be open minded to all types of people and beliefs	Some things are right or wrong no matter what
Practical	Problems are best solved by looking at the facts	Facts only tell you part of the story.

Q3 **A.** Place the following statements in order of importance to you. With the most important statement first and the least important last.

(Ask only those values rated at 5–7 at Q3)

Q4 We have collected ideas about the world, given by other young people, but we are interested in your personal opinion.

For each statement, please say how much you agree. 7 = agree completely and 1 = disagree completely

- Fairness and equality – everyone should have the opportunity to contribute to the world and be treated fairly
- Looking after the environment – We should be concerned about the environment and want to help find new ways to protect it
- Rights of animals – Animals should be respected and not abused and we should do all we can to protect them
- Competition/being the best – more people should think about the taking part rather than the winning
- Family – Family is most important
- Religion – Believing in religion is more important than anything else
- Poverty – it is ridiculous that the world is defined by those who have too much when millions are living in poverty
- Laughing at ourselves – we take ourselves too seriously, being able to laugh at ourselves is important
- Empathy – the world should be a more caring place
- Aspiration – we live in a world where anything is possible

Q4 **A.** And please place the following statements in order of importance to you. With the most important statement first and the least important last.

(Ask only those options rated at 5–7 at Q3)

Q5 Which of the following are you closest to, do you trust and care about?

- Parents and carers
- Step mum or step dad, or parent's parter
- Grandparents
- Brother or sister
- Cousin
- Aunt or uncle
- Niece or nephew
- Teacher/lecturer/tutor
- Friend (under 18)
- Friend (over 18)
- Parents of friends
- Girlfriend/boyfriend
- Someone else (do not specify)
- No one (GO TO Q7)

Q6 Who from this list influences the way you A. see and B. see the world?

(Ask only those options selected at Q5)

Q7 We would like you to play a short game.

You have been given 100 points which you can spend on three things: fame, money, happiness. You have to decide how important each of these things is for your future. Once you decide, enter the amount you wish to give for each.

The most important thing should gain the highest points and the least important the fewest eg 50, 30, 20.

It is completely up to you to decide. All we ask is that all 100 points are spent.

Fame **Money** **Happiness**

Enter number

Total

WHERE DO I FIT?

Section Overview

To understand their perception of their own strengths and capabilities and measure closeness to STEM. With some focus on rejection, barriers and impact of perceived family capital.

Q8 Please read the list of statements below and for each one, please say by how much they reflect how you see yourself. Please use the scale shown below where 1 = Not at all like me and 7 = exactly like me.

- I am confident in my own thoughts and abilities
- I like to communicate with others
- I like to put ideas into action rather – make things happen
- I like to ensure that things are finished and completed properly
- It is important to focus on how people feel as well as what they do
- I like to think of new ways to do things
- I sometimes find it hard to keep going if there are obstacles
- I am always thinking of ways to make things better
- I like to ask a lot of questions
- I like to think about things quietly by myself before talking to others
- I like things to be organized and structured
- I prefer to work alone, teams distract me

Q10 **A/B.** For each of the subjects below, please say how much you enjoy/ enjoyed each one. Use the scale below where 7 = enjoy all of the time and 1 = do not enjoy at all.

- Design and technology
- Mathematics (including Further Mathematics)
- Science (generally as a subject, or biology, chemistry or physics)

Q11 **A/B.** If it was up to your family, friends and others close to you, which subjects would they want/have wanted you to focus on? Please select the top FIVE subjects they would choose.

- Art & design
- Biology
- Business Studies
- Chemistry
- Design & Technology
- Economics
- English Language
- English Literature
- Further Mathematics
- Geography
- History
- ICT/ Computer Studies
- Law
- Mathematics
- Music
- Drama/Theatre Studies
- Physics
- Religious Studies
- Science (general)
- Statistics
- Modern languages
- Physical education (P.E.)
- They do not have any influence on my preferred subjects
- Don't know

Ask those who enjoy mathematics

M16 **A.** Which of the following reasons describe why you like mathematics

- I'm good at it
- It's challenging
- It's easy
- It's satisfying
- It's fun
- I can see how it might be useful in the real world
- I find it very logical
- I like the practical aspect
- Someone I like or look up to is good at it
- I have a good teacher/I like my teacher
- My friends are in the same lessons for this subject
- My school/college has good resources for this subject
- It's a change from other subjects
- It's interesting
- There is a definite right or wrong answer
- I'm better at it than other people
- I feel confident in this subject
- Some other reason (do not specify)
- Ask those who do not enjoy mathematics

M16 **B.** Which of the following reasons describe why you do not like mathematics?

- It's hard
- It doesn't make sense
- It's boring
- I'm not good at it
- I don't have a good teacher/I don't like my teacher
- There is no room for creativity
- I don't have any friends in those lessons
- I'm no good with my hands
- It's repetitive
- Other people are better at it than I am
- I can't see how it might be useful in the real world
- I don't feel confident at this subject
- My school/college doesn't have good resources
- Some other reason (do not specify)
- Did not take this subject (show if did not select subject at all at Q10)
- Ask those who enjoy mathematics

M17 To what level are you likely to take mathematics forward, into future studies?

- To A level
- To degree
- I would like to use mathematics in my job one day
- I don't want to take mathematics any further (SP)
- Don't know (SP)
- Ask those who enjoy mathematics

M18 Do you currently study anything that includes mathematics?

- Yes – please specify the course
- No

Ask those not currently studying mathematics

M19 Do you wish that you had taken mathematics further?

- Yes
- No

Ask those who enjoy science

S16 **A.** Which of the following reasons describe why you like science?

- (Use list at M16A)

Ask those who do not enjoy science

S16 **B.** Which of the following reasons describe why you do not like science?

- (Use list at M16B)

Ask those who enjoy science

S17 To what level are you likely to take science forward, into future studies?

- (Use list at M17)

Ask those who enjoy science

S18 Do you currently study anything that includes science?

- Yes – please specify the course
- No

Ask those not currently studying science

S19 Do you wish that you had taken science further?

- Yes
- No

Ask those who enjoy design & technology

D16 **A.** Which of the following reasons describe why you like design & technology?

- (Use list at M16A)

Ask those who do not enjoy design & technology

D16 **B.** Which of the following reasons describe why you do not like design & technology?

- (Use list at M16B)

Ask those who enjoy design & technology

D17 To what level are you likely are you to take design & technology forward into future studies?

- (Use list at M17)

Ask those who enjoy design & technology

D18 Do you currently study anything that includes design & technology?

- Yes – please specify the course
- No

Ask those not currently studying science

D19 Do you wish that you had taken design & technology further?

- Yes
- No

Q20 Please say how strongly you agree or disagree with each of the following statements. Use the scale where 1 = disagree completely and 7 = Agree completely.

- Mathematics, science and design & technology lead to good future careers
- Only the cleverest students do well at mathematics, science and design & technology
- Mathematics, science and design & technology lead to the best paid jobs
- Mathematics, science and design & technology are highly valued and respected
- Mathematics, science and design & technology help you learn interesting things
- People with jobs involving mathematics, science and design & technology do valuable work that changes the way we live
- I would like to have a career that allows me to use mathematics, science or design & technology one day
- Mathematics, science and design & technology are really difficult subjects
- Mathematics, science and design & technology are not for people like me

AFFINITY WITH TECHNOLOGY

Section Overview

To explore which technologies young people gravitate too and why.

Q23 You will now see pictures of types of technology. You can hover over a picture with your mouse to find out more about each one.

For each type of tehnology say how much it appeals to you. If it was very interesting to you, your score may be 7 = Appeals a lot. If you're not interested in that type of technology you may decide to give it a score of 1= Does not appeal at all.

(Each option accompanied by a picture and a description)

- Food & Agriculture
- Buildings
- Trains & Boats
- Aerospace & Space
- Environmental
- Cars
- Medical
- Manufacturing Chemicals and Materials
- Sports
- Information Technology and Robotics
- Art & Design
- Defence & Arms
- Electricity & Electronics

Q24 **A.** You'll now see images and descriptions of types of technologies. Please say how important this technology is for our world by dragging it one of the boxes below. You can say whether it is very important, fairly important or not very important.

You can put more than one picture in each box and all pictures should be placed in one of the three boxes.

Q24 **B.** Now repeat this for the pictures below. For each one, tell us how important you think the people are who design this technology.

Ask those who find at least one technology appealing

Q25 For each type of technology please state how much you would be interested to have some work connection with it in the future. Use a scale given where 7 = I would definitely want to be involved and 1= I would definitely not want to be involved.

(Each option accompanied by a picture and a description)

- Food & Agriculture
- Buildings
- Trains & Boats
- Aerospace & Space
- Environmental
- Cars
- Medical
- Manfacturing Chemicals and Materials
- Sports
- Information Technology and Robotics
- Art & Design
- Defence & Arms
- Electricity & Electronics

ENGINEERING SECTION

A final measure on closeness to engineering

Q26 How interested are you in a potential career in engineering?

- Extremely uninterested
- Very uninterested
- Quite uninterested
- Neither interested nor uninterested
- Quite interested
- Very interested
- Extremely interested

Q28 What do you think you need to go into a career in Engineering?

- To study Mathematics past the age of 16
- To study Physics past the age of 16
- To study Design and technology past the age of 16
- To study Art past the age of 16
- Be creative
- Be innovative and original
- Have some work experience in the field first
- Be fully trained or qualified first
- Be clever
- Be focussed and determined
- Be very organised and level-headed
- Have problem solving skills
- Have no work experience just educational qualifications
- Like building things/making things/fixing things
- Be able to draw, use graphic designs to draw ideas on paper or computer
- Be prepared to study for many years
- Have the money to pay for university or higher eduction
- Like a challenge
- Enjoy working in teams
- Enjoy working on your own
- Other

THE APPEAL AND VALUE OF DIFFERENT CATEGORIES OF TECHNOLOGY

Respondents were presented with a series of illustrative photographs of technology to represent a range of engineering. Each photograph was accompanied by a brief description of the scope and application of the technology. The research participants were invited to assign a rank to these images and to assign them to three categories (low, medium, high importance). The themes represented the broad range of engineering activity, though in order to streamline the online survey, some were amalgamations of engineering disciplines.

Defence Technology

The most sophisticated equipement, vehicles and communication systems used to protect lives in conflict zones the world over. Democratic governments try to deter attacks from other nations by having the latest technology.

Information Technology and Robotics

The amazing developments of computers have produced systems for storing, retrieving, and sending information that continues to change the way we live our lives. The design of robots that will do the work and take on many of the difficult jobs that people currently have to do.

Environmental (Green) Technology

An increase in the planet's population size and the growth in industry have changed the Earth's sensitive atmosphere and habitats. Engineers are developing new ways of meeting our needs without polluting our environment.

Electricity Generation and Electronics Technology

The world is run on electricity. Power generation is how we convert energy from other sources into the electricity that powers our lives. Electronics is the design of circuits using transistors and microchips that control most other technologies in our world.

Medical & Sports Engineering

Engineering ideas and methods are used for healthcare and in the treatment of disease and illness. Examples include surgery, monitoring equipment and scanners. Modern athletes make use of science to develop more advanced technology that improves their performance and fitness, and reduces injury.

Automotive (cars, vans, lorries, buses and coaches)

Improving people's driving experience through more affordable, comfortable and practical cars, lorries and other forms of road transport. Making greener and more efficient vehicles, to limit the impact on the world we travel.

Trains and Boats

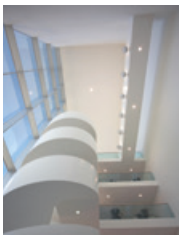
In our busy and crowded world, we need to move products (and people) from place to place. Railway and marine (ships and boats) engineers design faster, safer and more efficient ways of moving large loads cheaply, quickly and safely.

Agricultural Engineering

Designing new machinery and methods to grow food in even the harshest conditions. Ensuring there is a consistent supply of food for a growing population, whilst limiting damage to the planet.

Aeronautical and space technology

Faster, safer and greener aircraft, 'shrink' our world and allow people to connect with others in different places. Helping to explore our solar system and discover more about our Earth and the Universe.



Building (Civil Engineering)

Developing modern houses, offices, factories and public buildings, that are comfortable, energy efficient and durable. Building roads, bridges and tunnels that bring communities together.

Engineered Art & Design

Using engineering to produce sculptures and other artworks that impress and improve the quality of our lives. Making our cities and the countryside more pleasant places to live through design with people in mind.

Manufacturing chemicals and materials

Almost everything we own and use is made from materials which began as natural resources and which engineers maufactured into new materials. This includes everything from clothes and sports equipement to technology and kitchen utensils.

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