Royal Academy
of Engineering

Why do students choose engineering

Investigating what really influences students

Acknowledgements

Walnut Unlimited: The Human Understanding Agency

This research was conducted by Walnut Unlimited, the human understanding agency. Walnut blends neuroscience, behavioural science and data science approaches to peel back the layers of decision-making to deliver research that explores what society thinks, feels, and most importantly what drives the decision-making process.

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Executive summary

There are many studies surveying the perception and attitudes of young people in school towards engineering careers. These often show very positive responses and yet there seems to be little increase in the number of young people choosing engineering in higher education. This work surveyed undergraduates who had already made the decision to study engineering to understand the factors which led to their decision making.

The Royal Academy of Engineering commissioned Walnut Limited, an independent social research agency, to undertake a mixed method research study to identify the key decision-making factors for undergraduate students to choose engineering. As part of the study, we also surveyed students from sciences, technology and mathematics (STM) and from arts and humanities to identify specific differences between the cohorts.

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The study revealed five central findings:

1	Building awareness, understanding and knowledge, allows young people to make an informed decision when choosing to study engineering. Awareness of 'engineering' as a subject for formal study or learning remains significantly low, with less than half of sciences, technology and mathematics (STM) students (48%) and almost three quarters of arts and humanities students (71%) saying that they knew nothing about engineering during their early school years. Three in ten of those who actually took engineering courses (31%) also knew nothing about it.
2	Both school and home environments play crucial roles in nurturing interest in engineering and showcasing the breadth of careers on offer.
3	D&T remains a key conduit to engineering in the school curriculum and for many students it provides an early exposure to engineering as a subject.
4	As part of the decision-making journey to study engineering, many students initially focused on studying sciences more generally. With further exposure to engineering they discovered greater affinity with the subject.
5	While this study identified many of the factors that shape young people's consideration of engineering, there remains a wider range of social, economic and personal factors that inform and influence students' decision-making.

Introduction

Research aims

Attracting young people into engineering careers is a challenge that the engineering community has been tackling for decades. The Royal Academy of Engineering acknowledges that this is a well-researched area; however, the disconnect between what children and young people state their engagement in engineering is and the actual number of young people taking up engineering.

This research sought to examine this issue from a different perspective. It looked to better understand what has influenced those who have chosen to undertake an engineering course.

The aims of the research were to:

- Explore the factors that influenced young people to study on a higher education, vocational or technical course, or apprenticeship in engineering.
- Identify any additional characteristics or commonalities between young people who have decided to study engineering subjects.

Methodology

The Royal Academy of Engineering commissioned Walnut to undertake a mixed method research study to identify decision-making factors. A detailed methodology is provided in the appendix report. In summary this approach compromised of two parts:

- A **quantitative** survey of engineering students [306], alongside a control sample of students studying Science, Technology and Mathematics (not engineering) (STM) [500] and arts and humanities students [251] to identify key drivers.
- The role of the two control groups was to understand whether factors that influenced decision-making were similar across students studying different subjects, or if they were specific to engineering students. There was a particular focus on whether factors influencing the decision to study an engineering course were similar to why students chose to pursue STM subjects.
- A set of 20 **qualitative** interviews among engineering students were undertaken to explore emerging themes arising from the quantitative results. They also examined in greater detail how decision-making of engineering students played out over time.

The 10 factors influential in decision-making

When analysing both the quantitative and qualitative research, it was clear that 10 key factors influenced students' decision-making when choosing to progress with an engineering course.

These 10 factors have been grouped to follow a chronological path through their childhood and into early adulthood. This shows how influences on their decision-making happened throughout this journey. Most importantly, these factors serve to reinforce and compound one another.

Later sections will cover the factors in detail, but a short summary of each can be found overpage.

Early years [Ages 5-11]: Factors 1 and 2

These two factors both play a significant role in decision-making and are the first steps in getting young people on the engineering path.

1

A real interest in engineering

Active interest in activities and topics related to engineering can act as a bedrock to further engagement. Once these are coupled with a greater understanding of engineering; they can create a significant catalyst for decision-making.

2

A real interest in how things are made

Most students enjoyed building things in their early years. Importantly, those who went on to become engineers often maintained these interests, reflected in their media consumption, and served as a factor in the back of their mind when choosing a career pathway.

Secondary education [Ages 12-15]: Factors 3, 4, 5, 6 and 7

These factors are more likely to be influential during secondary school years. They include a mixture of school influences and an active understanding of engineering beyond what is provided through the school setting.

3 Awareness of ‘engineering’ the subject

There is evidence that the absence of engineering as a standalone subject in England’s national curriculum leads to generally low levels of awareness of ‘engineering’ among students in primary and secondary school. Without this awareness, young people struggle to connect any potential interest with engineering as a subject to study.

5 Engineering role models

Engineering-specific role models are a strong influencing factor on young people to choose engineering. This finding was particularly stronger in the quantitative survey of engineering students However, an important additional finding in the quantitative interviews, was that engineering students where less able to recall ‘famous’ role models in the media and, more likely to mention personal connections instead.

4 Enjoying engineering

Although enjoyment of a subject is important for all students, engineering students specifically describe engineering as being for those who are curious and enjoy solving challenges.

6 Liking their D&T teacher

All three student groups stated that one of their favourite teachers was likely to have taught the subject that they ended up studying later in higher education. For engineering students, they particularly favoured their D&T teacher.

7 Receiving engineering-specific careers advice

All three student groups recall receiving some careers advice when they were 12-15 years old. The quantitative research highlighted that engineering-specific careers advice for those that received it a key driver. However, in the qualitative research engineering students recalled receiving informal advice from a range of sources (such as family, friends and subject teachers) rather than more formal careers guidance in school.

Post-16 education [GCSEs, A levels, HE]: Factors 8, 9 and 10

These final set of factors are influential among engineering students towards the end of the decision-making journey. Overall, these factors feel less significant because they appear to be factors that influence decision-making when already on the path to engineering.

8

Choosing engineering over STM

Engineering students were likely to find maths and science subjects at school relatively easy at GCSE level. Many of the engineering students in the qualitative phase reported they considered doing a STM subject rather than engineering. However, their decision was swayed by several reasons, such as STM being deemed as less interesting to study.

9

Belief that engineering can make a difference in the world

Although the desire to make a difference in the world in their future career was not a key driver to choosing an engineering course, this was stated as being important to engineering students in the qualitative interviews. To engineering students, engineering allowed them to tackle worldwide issues such as climate change and waste reduction.

10

An ambitious mindset

In the qualitative phase, it emerged that there was a specific group of students who did not have an initial interest in activities related to engineering when they were younger but chose engineering as it challenged them. Engineering helped them fulfil wider career ambitions.

Breaking down the findings

Quantitative: The top Key Drivers

While the Key Drivers analysis was carried out amongst all students, the overall measure was whether the student took an engineering course. This allowed us to identify the factors that influenced young people to pursue post-compulsory education or training in an engineering subject specifically.

Table 1 below shows the top six attitudes, behaviours and demographics that were key in driving their decision to pursue engineering.

All the top drivers identified had a positive correlation. However, the number (correlation coefficient) is also important and shows the strength of the factor in terms of decision-making. Broadly, scores of:

- 0.1 – 0.29 indicate a low strength relationship
- 0.3 – 0.59 indicate a medium strength relationship
- 0.6+ indicate a high strength relationship

The correlations we found in this research were relatively weak even for the top drivers. This should be considered when interpreting the results, as they do not show a very strong relationship.

The relative importance percentage is a measure of how much more important one driver is versus another. Each statement has a score from 0 to 100 showing the relative importance of that driver compared to the others in the model. The scores sum to 100 and can be directly compared, for instance, a score of 10 is twice as important as a score of 5.

The R-squared for the model, (the goodness of fit of the model against the survey data) is low at 0.5 which suggests that there are other drivers not captured in the research.

There are various ways to interpret the low correlation levels:

1. Post-rationalisation

As the students who undertook this survey had already decided to study their subject at university, they may have post-rationalised some of their answers. This could be because something felt like it must have been an impact on them, regardless of whether it was or not, or they answered based on something that has a greater influence on them now (present bias) than the time period they were being asked about. For instance, respondents may

Table 1: Top six drivers for student decision-making towards engineering

#	Driver	Correlation	Relative Importance
1	Students recall being given **engineering careers advice** when aged 12-15	+0.39	8.8
2	Students recall having an **engineer role model(s)** when aged 12-15	+0.37	7.3
3	**Design and Technology (D&T) was engineering students' favourite teacher** at school when aged 12-15	+0.32	5.4
4	Student's media consumption about **how things are made or built** when aged 12-15	+0.29	4.5
5	**Designing things** when thinking about what is important to students in their future job/career when aged 12-15	+0.31	3.9
6	**D&T was engineering students' favourite subject** at school when aged 12-15	+0.29	3.6

have said they recall being given engineering careers advice because they think they must have received some at some point, because it's something that they are getting now. Their memory may have become blurred around whether they were given that type of advice when they were younger.

This bias is often found in survey data and can impact many people when they are asked to think back and reflect on past behaviours or decisions. In the survey we frequently asked participants to think back to when they were 12-15 years old. It can be very difficult for survey respondents to articulate childhood hobbies and bring these memories back to the forefront of their minds as such they can be over-exaggerated or overlooked.

2. The question codes didn't properly reflect student experiences

An example of this is occurred when the researchers asked about 'engineering careers advice' in a number of places, and this may have been interpreted by students as narrowly referring to formal careers advice. However, in the qualitative interviews, the researchers understood that engineering careers advice often came through various informal channels, such as teachers talking about their own personal interests or through guest speakers. Thus, the way the researchers designed the code lists in the questionnaire may have made it challenging for students to identify with and thus not select the code.

3. The quantitative model did not include all the attributes that impact decision-making

We built the questionnaire using the knowledge of colleagues from the Royal Academy of Engineering and Walnut, but the questionnaire may not have captured all factors that would influence young people in their subject decision making.

4. Deciding to undertake an engineering course is influenced by many diverse factors

Another consideration could be that these findings do reflect the decision-making landscape for young people around engineering, and that there are no strong factors that influence decision-making.

Qualitative: The top themes

Three decision-making influences

From the qualitative interviews we identified three broad drivers that influence decision-making to choose an engineering course.

It is worth noting that although we did find three distinct groups, there was some overlap, and many students did exhibit at least one decision-making driver in the course of their subject choices.

An 'early exposure' influence

Early exposure to activities related to engineering acted as a catalyst to decision-making. This often-included exposure to engineering-style activities or hobbies from a relatively young age, often at home. Much of this came through practical activities, such as building things or playing with Lego, and further drove exploration of why things are made, how they work and how to build them. However, it can also be exposure via family networks that help develop awareness of STEM at a young age.

A broader interest in STM, before deciding on engineering

Many of the engineering students we spoke to found maths and science subjects easy and were often on a pathway to a career in STM, such as medicine or maths, before they gained a greater understanding of engineering. This diverted their focus away from STM to engineering.

An ambitious mindset

These engineering students did not have the initial passion for, or interest in, engineering as the 'early exposure' group. What drives this group of students is their ambition; they are a set of hard-working students with a strong academic mindset who are often attracted to engineering because of the career opportunities and higher salaries that engineering careers bring.

Bringing the findings together

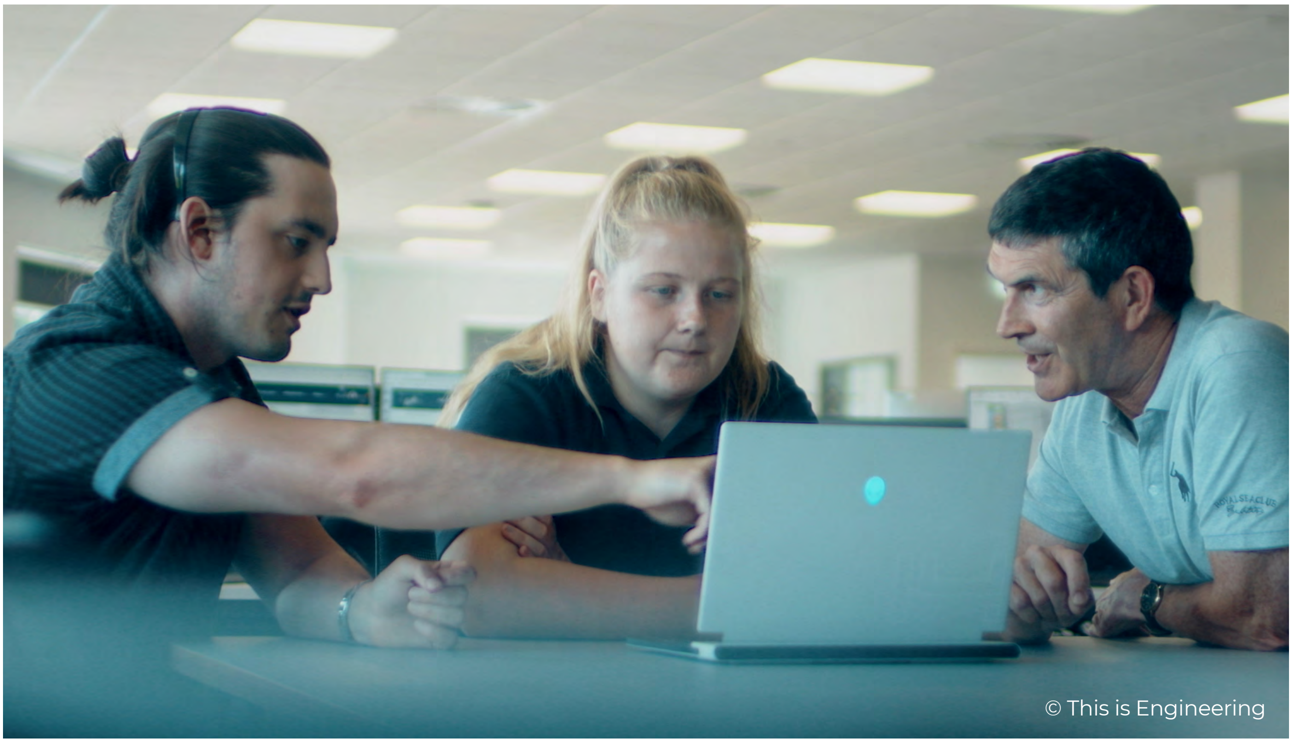
Similarities between the Key Drivers and qualitative themes

- The **early exposure** theme that arose from the qualitative interviews links to the drivers around **how things are built** and **designing things** (4.5% and 3.9% importance respectively) as it is often these types of activities that young people are introduced to at a young age and pique their interest. We would hypothesise that this forms the basis for an engagement with **D&T as a subject** (3.6%), as this is often the place in school where these types of activities happen.

Differences between the Key Drivers and qualitative themes

- Being given **engineering careers advice** came out as the top driver for decision-making from the quantitative study. In the qualitative interviews, we found that engineering-related careers advice often reinforced their decision to take engineering, rather than acting as the predominant driver. As detailed later on in the report, careers advice often did not come from an official 'careers advisor' but typically came from a teacher they found supportive, such as a D&T teacher (5.4%) or from a family member who had experience of the industry.
- Very few of the engineering students in the qualitative interviews mentioned having **role models** in general, let alone engineering ones, however it was the second highest ranking influence from the key drivers (7.3%). However, when probed, it appears this did not seem to influence their decision-making.

Given the relatively low correlation levels for the key drivers' analysis and some of the differences we found between the key drivers and qualitative themes, we have taken a decision to treat each phase of research equally. In the next section of the report, we outline the factors that influence decision-making, by combining qualitative and quantitative data where appropriate. Some factors may draw more heavily on either quantitative or qualitative data, but wherever possible we aim to incorporate findings from both.



In-depth look at the 10 factors

The following section will cover the factors in detail and provide evidence for each from both aspects of the research.

Factor 1:

A real interest in engineering

It is well documented in academia[1], news features[2], and frameworks such as Science Capital[3], that exposure to engineering via family connections contributes to a greater belief that engineering is 'for me'. Our findings added to this insight – with qualitative interviews linking an interest in engineering to early exposure to engineering-type activities, hobbies and interests.

Early exposure usually comes via a family member (usually male) and includes activities such as building and mending bicycles, helping with DIY, or playing with sets such as LEGO or Hot Wires. This early exposure begins to spark a genuine interest in engineering and engineering-style activities, although the respondents may not recognise it as 'engineering' in the way they understand it in their later years. The intensity of interest can vary across students. For a few, a topic like space can remain a strong constant throughout their early and later years when they start to think about GCSEs.

"Just basic things like that I was taught to do from when I was young, so like putting things together, building stuff was always part of my growing up. So, I think that sort of led me onto engineering."

Steve, 18, Civil engineering student

"My uncle owned a garage a long time ago. When I was a kid, he set up his own race team with my dad. So, I suppose seeing the inner workings of a team, albeit at a much smaller scale, was the stepping stone for wanting to learn more and taking it upon myself."

Muhammad, 24, Automotive engineering student

The case study overpage highlights the journey of an engineering student whose interests were facilitated by his parents from a very young age. Like several engineering students we interviewed, Rory (not real name) did not engage with formal careers advice at his school. This meant that his early engineering hobbies were pivotal in starting his journey towards an engineering course.

1 Mannon, S.E. and Schreuders, P.D., 2007. All in the (engineering) family? – The family occupational background of men and women engineering students. Journal of Women and Minorities in Science and Engineering, 13(4).

2 Young-Powell, A. 2019. Theory of relativity: parent-daughter duos with a shared love of engineering. The Guardian. Available at: www.theguardian.com/careers/2019/jun/25/theory-of-relativityparent-daughter-duos-with-a-shared-love-of-engineering

3 Science Museum Group. 2016. What is Science Capital? Available at: learning.sciencemuseumgroup.org.uk/blog/what-is-science-capital

Case study: 'Rory'

Age 7-8

Dad designed a treehouse and built it with Rory's help. He was shown how to use tools such as a sander and a drill.

Early interest in engineering starts here

Age 11+

Rory watched lots of YouTube videos and read magazines such as How It Works, which gave him ideas for his own projects Continues to build his interest in a broader set of engineering topics.

Age 11-16

At school, he saw posters about engineering careers

Makes connection between what he's interested in and 'engineering' as a topic

Age 11-12

Inspired by YouTube, Rory began his first solo project – modifying NERF guns to improve the range and speed of the bullets.

Age 12+

Regularly went cycling with his Dad and learned how to maintain and fix bikes in the workshop.

Age 14+

As a teenager, he began building his own bikes in his Dad's workshop.

Today, his ongoing project is to build a road-legal motorbike from scratch.

Age 16-17

Decision making: Rory had choice between natural sciences and engineering at university.

He consulted his parents, who knew he would enjoy "hands-on" engineering more.

> **"A lot of people might not have access to equipment that might allow them to do projects, for example in their own house.**
>
> **I think that is quite important – for giving people a flavour of what working (in engineering) might be like.**

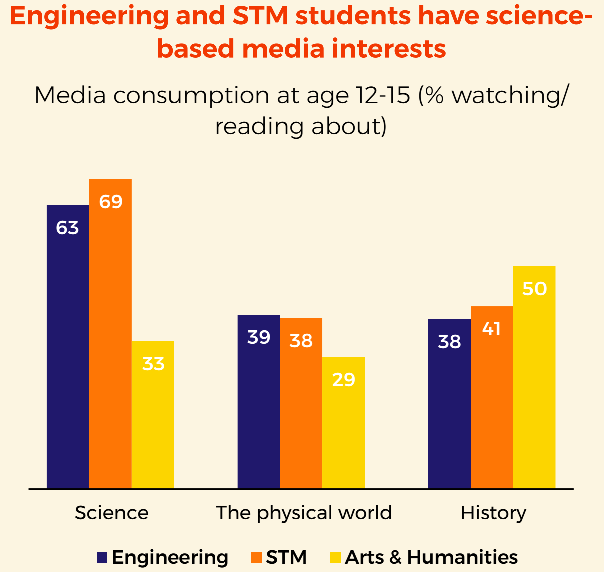
Our hypothesis would be that this early interest and exposure to engineering starts young people on a path to choose an engineering course. As the following quantitative data shows, interest in engineering-style activities at slightly later years (when aged 12-15 years old) also highlights a similar trend. As such, while students may not be conscious that this a factor in their decision-making, both phases of the research would suggest it plays a strong factor.

As such, while students may not be conscious that this is a factor in their decision making, both phases of the research would suggest that it is a strong influencer.

Unsurprisingly, what students are interested in reading and watching in their early years serves as another source of early exposure, and strongly links to the courses they later choose.

Interestingly, though, at age 12-15 there is little difference between engineering and STM students' interests in scientific media content, with roughly one in four of each group consuming media about the physical world (39%/38%, respectively) and two-thirds consuming science media (63%/ 69%, respectively). Comparatively, arts and humanities students are significantly less interested in either of these topics, preferring history-related media content as their top choice.

However, engineering students are significantly more likely to show an interest in space-related events, including the Mars landing (42%), CERN (40%), and private spaceflight (32%). In fact, interest in CERN specifically, is identified as a driver to deciding to take up an engineering course. This suggests that engagement with these types of events is a differentiating factor between engineering and STM (**Figures 1.1 and 1.2**).

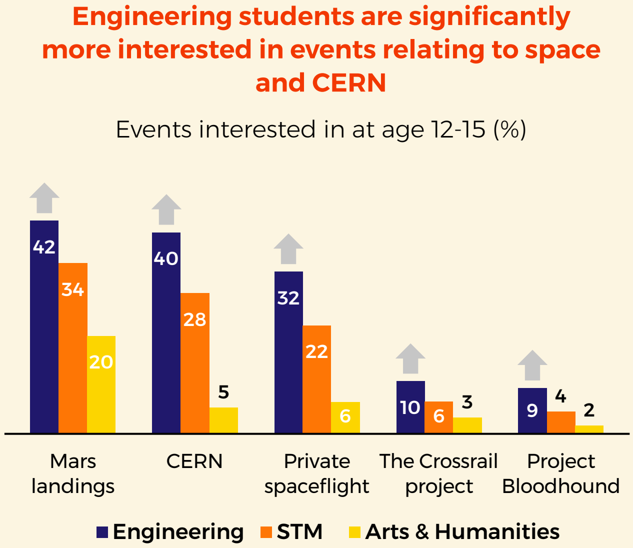


H6. Were you watching or reading about any of these, if any, when you were 12-15 years old? This could be watching on TV, YouTube, Instagram or TikTok, or it could be reading things online, in books or magazines.

Base: Engineering (306), STM (500), Arts & Humanities (251).

Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 1.1: Three of the top five media interests recalled by Engineering students at age 12-15. engineering and STM students have science-based media interests.



H8. And finally in this section, we'd like to know whether any of the following events interested you?

Base: Engineering (306), STM (500), Arts & Humanities (251).

Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 1.2: Events where engineering students recalled significantly greater interest at age 12-15 than students in STM or Arts & Humanities subjects.

Factor 2:

An interest in how things are made

Many of the students interviewed, discussed having a curiosity for how things are made and how they worked. This interest isn't borne from a consistent place; it can come from curiosity and thinking about how things work, or from consuming materials (videos, books, magazines) that demonstrate how things work.

"When I sat in either my parents' car or on a bus, I would watch the way the driver would change their gears and use their foot on the brakes. It got me thinking about how they were able to co-ordinate their feet and their hands to make the gear change or rev the engine up."

Noah, 24, Aerospace engineering student

"I had lots of books about World War II engineering, such as how the Spitfire worked. Also, I watched Hacksmith on YouTube."

Seamus, 18, Mechanical engineering student

Regardless of the source, hands-on learning seems to have served as an important mechanism to develop this interest into a decision-making factor. It allowed students to physically witness the process of dismantling and rebuilding things.

"I wanted to try and build stuff. I don't even know why I wanted to build, I just know I would like try and fiddle around with things or just make like little models or something."

Amelia, 20, Architectural engineering student

"I liked building something or taking it apart to see how things work inside. It's like a big puzzle, but you get to produce something useful at the end of it."

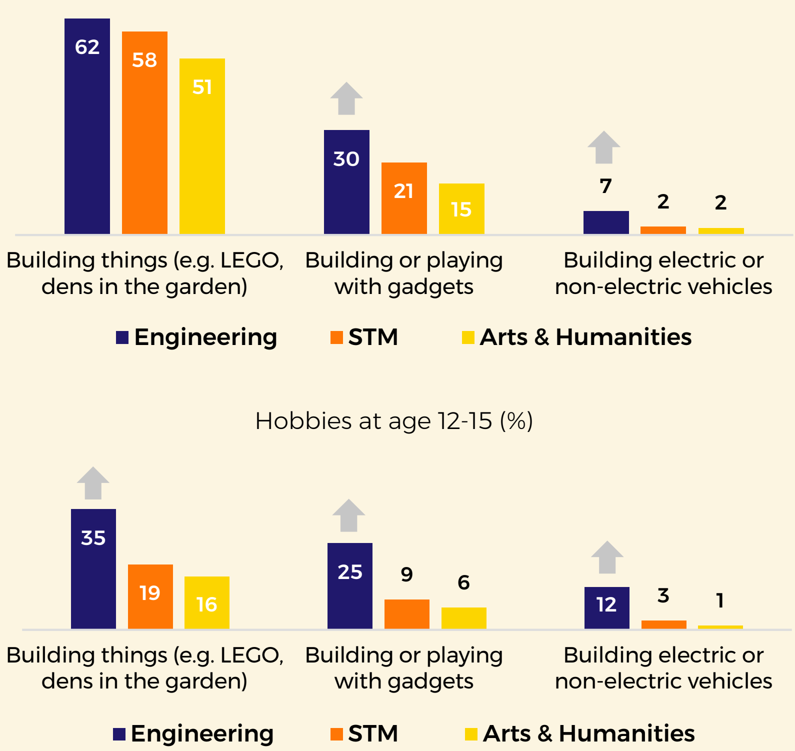
Mia, 22, Aerospace engineering student

This appears to be particularly important around the GCSE period. While this isn't always something that consciously factors into their decision-making about taking an engineering course, some students could reflect and see how this interest impacted them in the longer term.

> *"I've been hugely into cars and bikes and anything that moves with an engine since I was a kid. And playing with like Meccano sets and even things like Airfix kits, little plastic models and stuff, just having things going together was always an interest to me. It probably wasn't until a fair bit later on that I understood what that actually entailed in terms of engineering."*
>
> **Alex, 24, Automotive engineering student**

Engineering students were more likely than their peers to have, and maintain, hobbies related to building things, a difference that became stronger within the older age range (**Figure 2.1**).

As engineering students get older, they are more likely than their peers to maintain hobbies related to building



H2/H4. Which, if any, of these activities did you like to do when you had free time? These might have been on your own or with friends or family.

Base: Engineering (306), STM (500), Arts & Humanities (251). Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 2.1: Recall for hobbies and activities related to building, at age 5-11 and age 12-15.

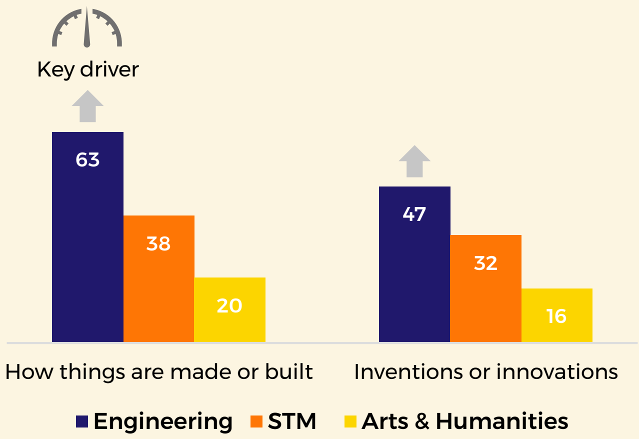
This data poses an interesting question as to whether subjects like space and hands-on practical activities for children, help to influence decision-making in later years. The survey evidence of engineering students placing more importance on designing and inventing things while consuming more media about how things are made, compared with STM and arts and humanities students suggests this to be the case. This correlates as a key driver for taking an engineering course (+0.31 correlation) (**Figures 2.2 and 2.3**).

Gender differences

Three in ten (30%) male engineering students said that wanting to invent something was important when thinking about a career when aged 12-15, significantly higher than two in ten women engineering students (20%). It is worth noting that more female engineering students stated this compared with those in STM or arts and humanities, whether comparing against men or women (**Figure 2.4**).

Inventions and interests in the built world differentiate engineering from STM students

Media consumption at age 12-15 (% watching/ reading about)



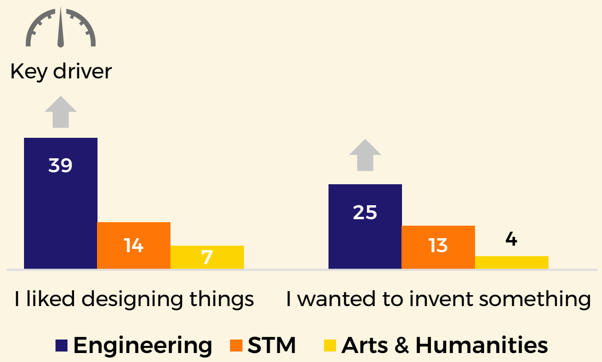
H6. Were you watching or reading about any of these, if any, when you were 12-15 years old? This could be watching on TV, YouTube, Instagram or TikTok, or it could be reading things online, in books or magazines.

Base: Engineering (306), STM (500), Arts & Humanities (251). Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 2.2: Three of the top five media interests recalled by Engineering students at age 12-15.

Engineering students were the most likely to want to design and/or invent things

Important job/career aspects when thinking at age 12-15



S7. Which of these reasons, if any, were important to you when thinking about what you wanted from a job/career?

Base: Engineering (306), STM (500), Arts & Humanities (251). Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 2.3: Two of the top three important job/ career attributes, thinking about when they were 12-15, recalled by engineering students.

Men engineers more likely to want to invent something, at age 12-15

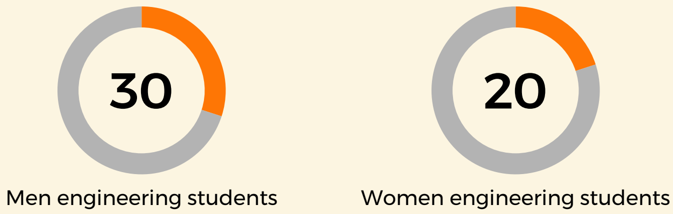


Figure 2.4: The proportion of engineering students who said they wanted to invent something when they were younger, split by men and women.

Factor 3:

Awareness of 'engineering' as a subject

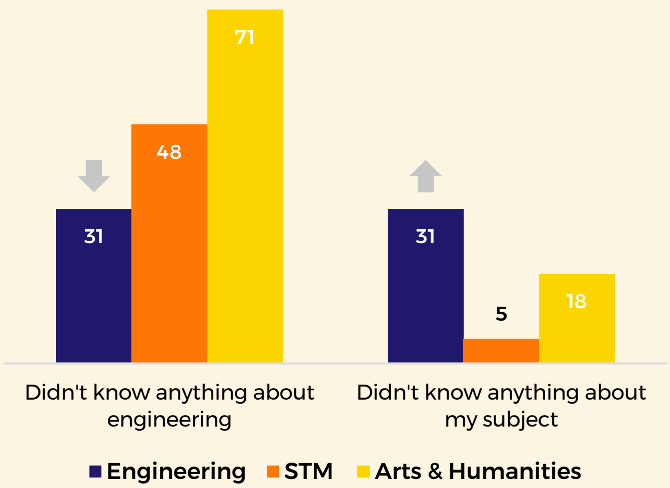
Young people's awareness of 'engineering' as a subject that can be studied in university strongly facilitates choosing an engineering course. This creates a link between their hobbies and interests that include engineering.

However, because engineering is not a formal subject in schools, awareness of the subject for future study remains low. Not only do half of STM students (48%) and almost three quarters of arts and humanities students (71%) say they knew nothing about engineering during school, three in ten of those who actually took engineering courses (31%) also knew nothing about it. This is six times greater than the proportion of STM students who say they knew nothing about their subject in school (**Figure 3.1**).

This data suggests that those who were more aware of engineering, are more likely to go onto

Lack of engineering knowledge overall, and other students had better knowledge of their own subjects

Knowledge about engineering and about their own subject at age 12-15
(% agree)



P1/P2. How much do you agree or disagree with the following about (engineering/[subject])?

Base: Engineering (306), STM (500), Arts & Humanities (251). Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 3.1: The proportion of students who agree they 'didn't know anything about' engineering, compared to those who 'didn't know anything about' their own HE subject, at age 12-15.

study it. This must be a factor in their decision-making. It is interesting to note that nearly a third of engineering students were not aware of the subject when aged 12 to 15 years old. During interviews, many engineering students explained they only built a clear understanding of engineering as a subject to study, through family networks, online researching and their wider interests and reading. This begs the question whether more students would study engineering if there was this wider understanding.

The This is Engineering campaign is an example of a wider public engagement campaign and in our analysis, x number of engineering students surveyed saw the campaign and 24% were influenced. But X STM and wider arts and humanities. There is a clearly a need for scaling its reach and to broaden out to wider audiences including parents, teachers and public.

Engineering students who did not benefit from early exposure or family connections, only found out about the subject at a late stage in the decision-making process; some of them only discovered engineering after having already applied for a different subject. Around half of those we interviewed felt that their main source of finding out about engineering was through search engines or websites that suggested courses.

> *"I would just type "I'm good at maths and physics. What should I do?" into a search engine and see what it comes out with, and it would always spit out engineering."*
>
> **Sakina, 19, Electrical engineering student**

Another common way that engineering students found out about engineering was through other people they knew who either studied engineering themselves or were in knew about the industry – through teachers and former students.

> *"I asked my school if they could put me in touch with some older students who were taking engineering. I knew I wanted an Army career, so having seen engineering as an option I wanted to know what it was."*
>
> **Michael, 18, Mechanical engineering student**

Even among students who thought that they were aware of engineering; many were unaware of the variety of separate disciplines and specialisms within it. At the time, some future engineering students thought that engineering was not for them, because they had not realised that some specialisms related directly to their hobbies and interests.

> *"I knew about it somewhat from my parents but didn't know about the separate disciplines and didn't know lots of detail around careers afterwards, when I was making the decision about which course to choose."*
>
> **Ella, 20, Architectural engineering student**

Many of our engineering students thought that few people in the public at large had a true understanding of the vast array of different disciplines that sit within engineering.

> *"Most lay people would either say cars or buildings or bridges. They think of the objects."*
>
> **Ed, 19, Electrical engineering student**

The argument for embedding engineering explicitly into a broad curriculum of school education has been detailed in reports such as the Institution of Mechanical Engineers Big Ideas project[4]. This data seems to support this position; however, subjects aligned closely to engineering such as D&T are in chronic decline and there is no guarantee that a new engineering subject would solve the problem.

4 Institute of Mechanical Engineers. 2016. Big Ideas: The future of engineering in schools. Available at: Big Ideas: The future of engineering in schools (imeche.org). www.imeche.org/policy-and-press/reports/detail/big-ideas-report-the-future-of-engineering-in-schools

Factor 4:

Enjoying engineering

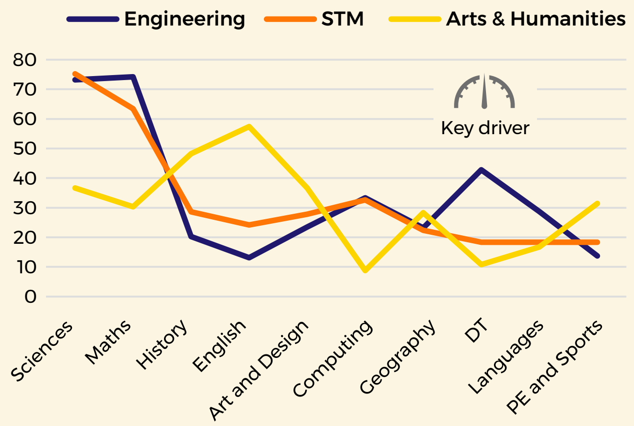
Overall enjoyment in a subject is a clear factor in the decision-making process for all students when choosing what to study at higher education.

Similar to STM students, engineering students' favourite subjects between 12-15 years old are science and mathematics, with D&T emerging as the third most popular choice for engineering students. Liking D&T was a key driver (+0.29 correlation) for engineering students to go on to study the subject, as was mathematics, although at a lower correlation (+0.20).

While enjoyment of the subject studied isn't a differentiator between engineering students and other student groups, and a generally important decision-making factor for all, what is interesting is that engineering was not a standalone subject to study between the ages of 12-15 in school – unlike STM or humanities. This means that either: engineering students were finding engineering topics through learning other subjects, or that this is a good example of present bias whereby students have post-rationalised their experience (**Figures 4.1 and 4.2**).

STM and arts & humanities students had an affinity for their subjects in school

Favourite subjects at age 12-15 (% selected in top 4)



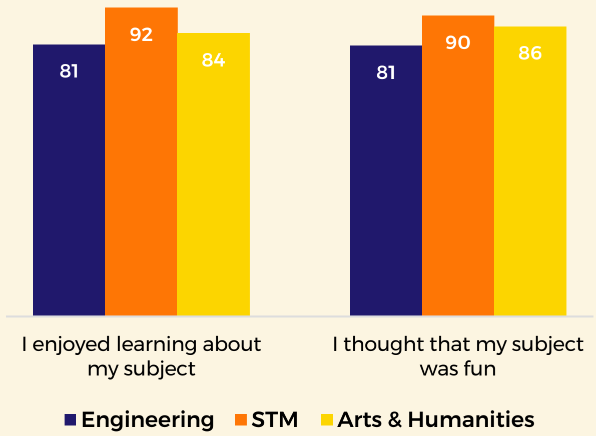
S1. Which were your favourite subjects at school when you were 12-15 years old?

Base: Engineering (306), STM (500), Arts & Humanities (251).

Figure 4.1: The proportion of students who selected each subject among their four favourites, when thinking about age 12-15. The ten most popular (out of 23) are shown in this chart.

Enjoyment for their own subject was high, for all

Enjoyment about their own subject at age 12-15 (%)



P1. How much do you agree or disagree with the following about [subject].

Base: Engineering (306), STM (500), Arts & Humanities (251). Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 4.2: The proportion of students who agree they 'enjoyed' their own subject at age 12-15.

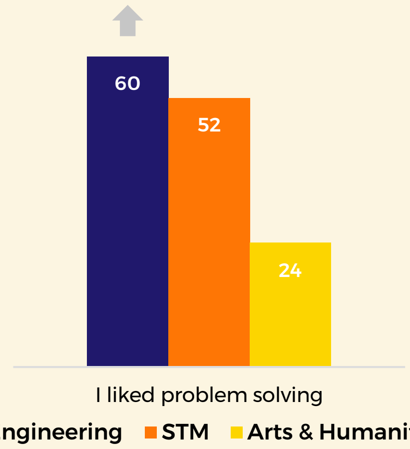
It appears that enjoyment of engineering is particularly associated with problem solving. Engineering students were significantly more likely to be motivated to choose a career that involved problem solving compared with either STM or arts and humanities students.

Many of the students in the qualitative interviews also expressed how they found engineering interesting. When it came to learning, it matched the practical, hands-on learnings style they enjoyed, and they could see how learnings could be applied in the real world (**Figure 4.3**).

> *"One of the main things I enjoy about engineering is the practical aspect of things. I tend to go for a lab classes a lot... as we do a lot of experiments and write reports from that."*
>
> **Tom, 24, Aerospace engineering student**

Engineering students were most likely to be motivated to choose a career that involved problem solving

Motivators important when thinking about a job or career when aged 12-15 (%)



S7. Which of these reasons, if any, were important to you when thinking about what you wanted from a job/career? Base: Engineering (306), STM (500), Arts & Humanities (251). Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 4.3: Top motivator for engineering students when thinking about a job or carer at age 12-15.

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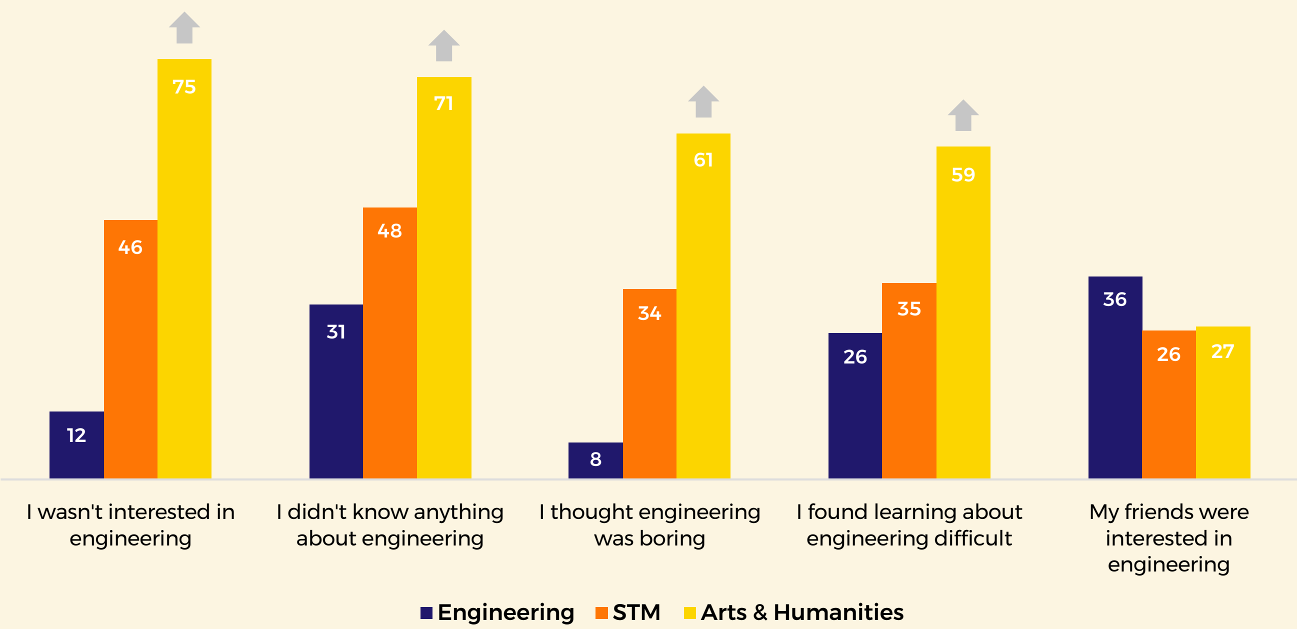
In comparison, STM and arts and humanities students were most likely to state that between ages 12-15 they did not have interest in, awareness and understanding of engineering. This was particularly strong among arts and humanities students – around seven in ten agreeing, but it was also relatively high among STM students at nearly one in two, suggesting that they serve as key barriers to decision-making.

Furthermore, perceived difficulty in learning engineering can also be a barrier for arts and humanities. Nearly twice as many arts and humanities students (59%) said they found learning about engineering difficult compared to STM students (35%) (**Figure 4.4**).

Arts & humanities students are more likely to find engineering uninteresting and not know much about it

% Agreement with statements around engineering when aged 12-15



P2. How much do you agree or disagree with the following about engineering? Remember to keep thinking about when you were aged 12-15 years old. (Agree)

Base: STM (500), Arts & Humanities (251).. Arrows indicate where Arts and Humanities students score significantly higher/lower than both engineering and STM subject groups at 95% confidence level.

Figure 4.4: Top 5 agreement with statements for arts and humanities students at aged 12-15.

Factor 5:

Engineering role models

Role models, such as those working in engineering or associated with the industry, do seem to impact engineering students' decision-making. In fact, this is the second most important driver identified to choosing an engineering course (+0.37 correlation). Two in five (42%) of engineering students claim they looked up to engineering role models between the ages of 12 and 15.

Engineering students also looked up to scientists as role models, this is unsurprising as we found during the interviews that many engineering students considered broader STM careers before deciding on engineering (**Figure 5.1**).

The interviews also showed that, engineering students were more likely to engage with personal role models (such as their parents or teachers) or heroes of theirs related to their interests/ hobbies (Lewis Hamilton for example) rather than high-achieving personalities such as Elon Musk or Mark Zuckerberg. For some, they could see how certain famous role models could influence people to go into engineering, but it was not something that related to them.

"No, I wouldn't say I had any role models in the media. I can see how Elon Musk is a really good example of how someone nowadays can 'make it' using some engineering skills/making engineering look cool, but he doesn't really influence me."

Cormac, 18, foundation course then will go onto to mechanical engineering course

"I suppose I would consider my heroes as my role models. So, for me, most of them boil down to either being musicians or race car drivers as they are my passions!"

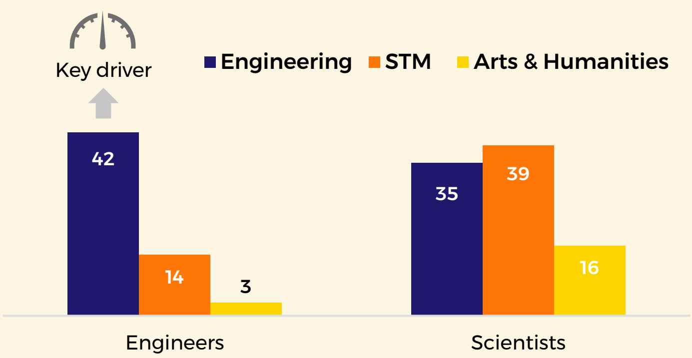
Chris, 24, Automotive engineering

"To be honest, I looked up to my parents and my cousin who actually also studied engineering, but no one really from in the media."

Lucy, 21, Mechanical engineering

Engineering students are most likely to have looked up to engineering role models

Engineering and science role models at age 12-15 (%)



H7. Keep thinking about when you were 12-15 years old. Did you follow or look up to any of these people?

Base: Engineering (306), STM (500), Arts & Humanities (251).All figures displayed as percentages. Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 5.1: STEM and science role models recalled by Engineering students at age 12-15.

Factor 6:

Liking their D&T teacher

All three student groups stated that one of their favourite teachers was likely to have taught the subject that they ended up studying in higher education. Engineering students particularly favoured their D&T teacher, that was a key driver to choosing engineering. In the interviews, engineering students commented on how their D&T teachers were open to talking about future career options.

"My D&T teacher was extremely involved, even when students were making completely different projects, he would bring things in from his own home to help them. The other D&T teacher would stand with you until you knew how to use the tool properly, which was a very nice environment to be in."

Helena, 24, Mechanical engineering student

In addition to this, science and D&T teachers actively nurtured students' interest in engineering. For example, some teachers gave them books to read on courses and others gave guidance on extra curriculum learning they could do to help them develop their understanding of engineering and the opportunities available to them. This was key in a student's decision-making.

"My maths teacher was really helpful, he talked about how he did a mechanical engineering degree. When I was doing my A levels, I went to talk to him about it asking for information about the degree they did. That teacher also gave me books to read on the course which was really nice of him."

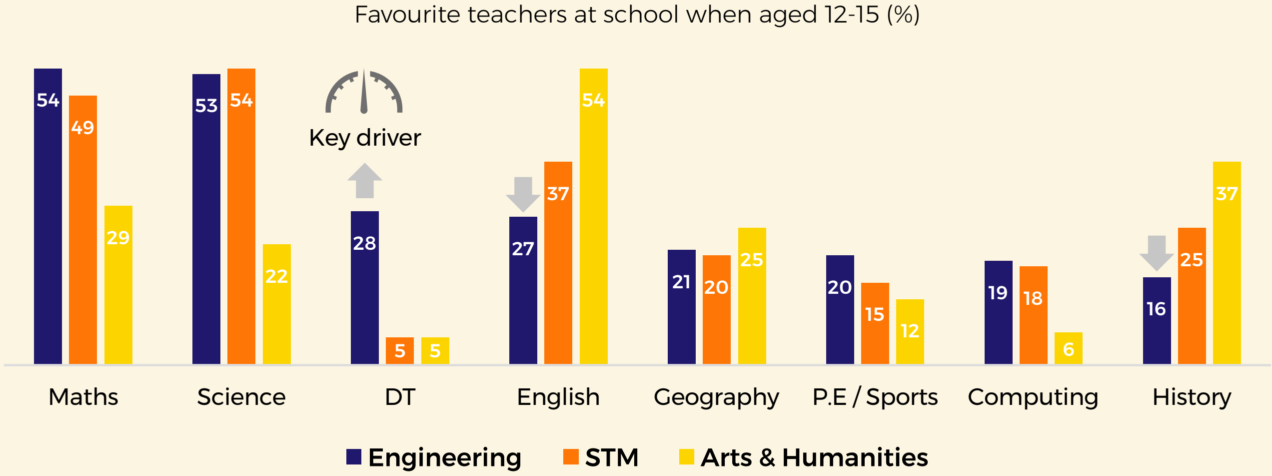
Ruairi, 18, Mechanical engineering student

"My physics teacher probably did have an impact on me. He talked about his own projects a lot and he got me into kit car. Also, he was passionate about girls going to go into engineering. So, I talked to him about this. He told me about an engineering scholarship and encouraged me to apply for it."

Madina, 22, Master's in aerospace engineering

As already shown, D&T was among engineering students' favourite subjects, so it therefore makes sense that their D&T teacher was also an important influencer for them. This highlights the important role that teachers have in engaging and motivating students and in turn impacting their decision-making (**Figure 6.1**).

The courses all students eventually choose, align very closely with how much they liked their teachers



S3. Now thinking about your teachers at school. Who were your favourite teachers? Please think about your teachers when you were 12-15 years old, likely at the beginning of (description)

Base: Engineering (306), STM (500), Arts & Humanities (251). Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 6.1: Top 8 favourite teachers for engineering students at aged 12-15.

Factor 7:

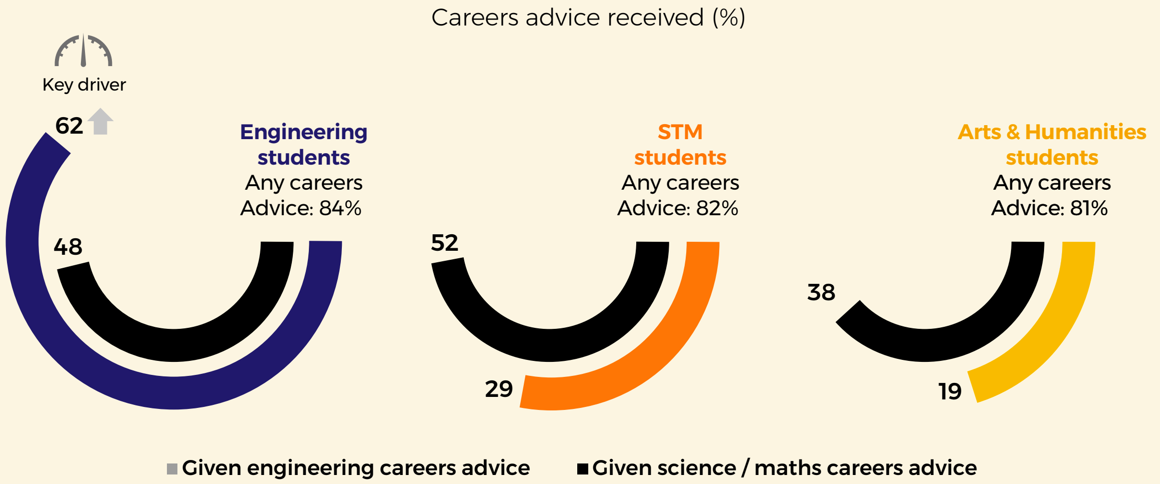
Receiving engineering-specific careers advice

The majority (around four in five) of all three student groups had received some type of careers advice between the ages of 12-15 at school. However, engineering students were much more likely to recall receiving engineering-specific careers advice (62%) compared with either the STM or arts and humanities students (29% and 19% respectively). In the key drivers' analysis, this was identified as the principal factor in choosing an engineering subject. It appears that this type of advice plays a significant role for engineering students to decide to go on to study engineering (**Figure 7.1**).

When discussing careers support with engineering students, few recalled receiving traditional, structured careers advice such as via careers talks or speaking about engineering with a career's advisor. They were more likely to cite getting more information and learning about engineering as a course from friends, family or teachers who had direct experience of engineering.

> *"We did have a careers advisor, but I didn't really find her helpful. I often found all the work experiences and internships all by myself. I actually spoke to some family members [extended] who are engineers. They were really helpful in helping me understand engineering in more detail, such as the different disciplines etc."*
>
> **Diya, 19, Chemical engineering student**

Engineering-specific careers advice is an influential factor for engineering students



S5a. Which, if any, of the following did you receive or participate in at school? Please keep thinking about when you were 12-15 years old. At this time you were likely to be at the beginning of (description). S5b. You said you received some careers advice or participated in careers activities. Were these related to any of the following career areas? Base: Engineering (306), STM (500), Arts & Humanities (251). Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 7.1: Careers advice received for all students at school.

Factor 8:

Choosing engineering over STM

Engineering students were likely to find mathematics and science subjects at school easy. Six in ten (63%) engineering students found mathematics easy, as well as half (48%) finding science subjects easy at GCSE, similar to STM students, a theme repeated in the qualitative interviews.

In addition, many engineering students subsequently enjoyed these subjects, which helped them when going onto an engineering course, as these are the foundations for content within engineering degree programmes (**Figure 8.1**).

"I just took to maths quite easily. Even in primary school I was doing topics, such as algebra, that you're not meant to do in primary school."

Zuri, 19, Chemical engineering student

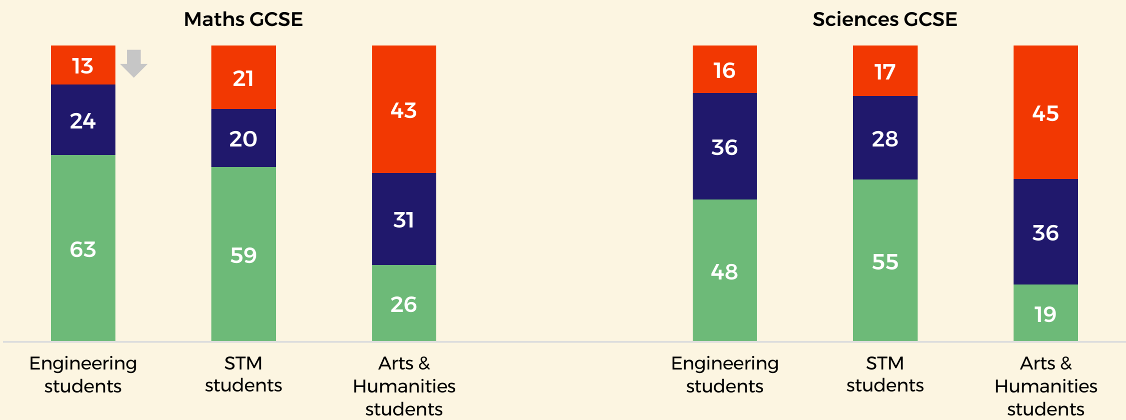
"Yes, I enjoyed maths more. It was quite unintuitive to learn about complex numbers or imaginary numbers, but now I'm learning how these are applied in computing/ electrical engineering. It helps to be good at maths and science in an engineering degree, especially when you need to do simultaneous equations to work out flow rates in process engineering."

Isabella, 19, Chemical engineering student

The influence of STM subjects and careers advice was noticeable in many of the engineering students we spoke with. Most of the students had, at one point, been on a path to choosing a science, technology or maths-related course before finding out more about engineering and realising that was actually the subject that they were interested in. Their decision was swayed by a number of reasons;

Engineers and STM students were equally likely to find maths and science easy at GCSE

Which subjects found easy / difficult at GCSE level (%)



D3b. Which subjects, if any, did you find easy at GCSE level (or equivalent)? D3c. And which subjects, if any, did you find difficult at GCSE level (or equivalent)? Base: those who remember their GCSE subjects: Engineering (304), STM (496), Arts & Humanities (248).

Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 8.1: Perceived difficulty of maths GCSE and sciences GCSE for all students.

1. STM subjects were deemed as less interesting and too theoretical compared to engineering

The majority of engineering students who were considering proceeding with a STM career felt that subjects such as mathematics and physics lacked creativity, were too theoretical and had limited ability to be 'hands-on' and do practical work as part of those courses. Thus, for many engineering students, an engineering course offered more opportunities to not only continue with the type of learning they enjoyed but also enabled them to see its real-world applicability, both in the courses they could take and career opportunities in later in life.

> *"I didn't go with doing a maths course even though I was good at it at school. The course just has lots of paper, with theories and also concepts to learn without being able to apply them to anything, so it wasn't for me."*
>
> **Matthew, 24, Automotive engineering student**

2. A perception that engineering offers more teamwork

A number of engineering students stated that they enjoyed working in teams, collaborating with others to solve problems, and saw engineering as providing this over the other subjects.

> *"I enjoy communicating with others and building my teammate skills in my engineering course because we do a lot of projects in groups with different people. You just learn how to approach questions by working with others, so you learn different methods of approaching questions and different methods of thinking."*
>
> **Amy, 19, Chemical engineering student**

3. Engineering provides broader career opportunities options than STM

Many of the engineering students we spoke to felt that an engineering course offered numerous career opportunities compared to STM subjects. Some engineering students mentioned that a degree in engineering offered opportunities to learn a wealth of transferable skills, for instance it opened up the opportunity to become an accountant later on in life. Science courses and careers were often seen by respondents as research-centric, whereas engineering was more expansive and practical.

> *"Engineering is a very technical degree. However, it is a degree that provides lots of transferable skills you can take anywhere afterwards, such as problem-solving skills, analytical thinking and time management. Time management is a massive one. There is just so much stuff to learn in this course."*
>
> **Daisy, 22, Mechanical engineering student**

The decision-making process between choosing a STM subject or an engineering one, among our engineering students in the qualitative interviews, was not a linear one. Many of the students evaluating what to do next, gave the decision careful consideration and typically ruled STM out at different stages along their decision-making journey, as demonstrated in this case study.

Case study: 'Siobhan'

Age 12-15

Favourite subjects included computer science and art, as they **were practical and involved project-based learning**. She found maths and sciences in general 'easy' at school.

Age 14-16

Decision-making: Decided that computer science was for her.

She loved her computer science teacher as they really went out of way to help her develop by doing higher advanced courses/modules that she enjoyed, and helped her deicide it is something she wanted to do in the future.

Age 16-17

Decision-making: Progressed with computer science.

Siobhan is set on computer science and applied for these courses through UCAS and is eventually accepting into several places at university.

Age 17

Considered job / career options from her computer science degree, and at this point, she released it would be quite limiting with only one or two options available. She just didn't really see herself being a software engineer.

Declined UCAS offers.

Age 18-19

Needed to work so took up a casual part-time job whilst she considered her options with the AS/A-Level courses she had.

Decision-making: Siobhan considered STM subjects but choose engineering due to the practical nature and diversity of it, and it weaved in her love of computer science too.

> **I considered maths. However, it came up to the same questions, e.g. what job could I practically could I do with maths?**
>
> **It was the same thing with biology. Again, I considered that and then I was like, oh, do I want to be in the lab nine to five all day? It's not actually as fun as you think it's going to be.**

Factor 9:

The belief that engineering can make a difference in the world

Although the desire to make a difference in the world in their future career was not a key driver in students to choose an engineering course, it was stated as being important to engineering students in the qualitative interviews.

During discussions, engineering students spoke of the role that engineering plays more broadly, and the work they were doing on their course specifically, has in making a difference to the world. While this may not have been a key decision-making driver for engineering students specifically during their younger years (as noted below), as they got older and began their studies, it appears that this desire to help, to make a difference and bring about positive societal change, was a strong driver for a number of students. This is something many of the students spontaneously mentioned as being important to them, such as how engineering can help with waste reduction (**Figure 9.1**).

"Engineering involves a lot of inventing. But innovation to help improve the world is where engineering really comes into its own, such as inventing new technology for example, creating new renewable energy sources, to help combat climate change."

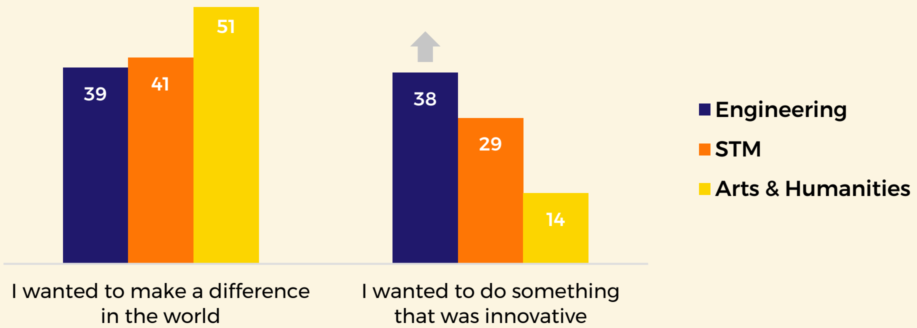
Scott, 18, Foundation course student going onto mechanical engineering undergraduate course

"For me, engineering is all about the use of scientific and maths principles to make the world a better place. So, for example, it is really important in helping combat climate change."

Nia, 18, Chemical engineering

Wanting to make a difference in the world is a motivator for engineering students but it is not in their top three

Motivators important when thinking about a job or career when aged 12-15 (%)



S7. And keep thinking about when you were aged between 12 and 15 years old. Which of these reasons, if any, were important to you when thinking about what you wanted from a job/career?

Base: Engineering (306), STM (500), Arts & Humanities (251).

Figure 9.1: Motivator for engineering students when thinking about a job or carer at age 12-15.

The driver to make a difference in the world was felt most strongly in arts and humanities student group and it was only a motivator for around four in ten engineering students. It wasn't among the top three motivators for them – in fact it was the fifth motivator behind things such as 'problem solving' and 'wanting a high-earning job'. Importantly, wanting to make a difference in the world in their future career was significantly more important for women engineering students (46%) compared to men (32%).

Given engineering's key role in addressing global issues such as climate change and the chronic under-representation of women in the profession, this finding suggests that the engineering community needs to redouble its efforts to present the role of engineers in global grand challenges.

Factor 10:

An ambitious mindset

In the qualitative phase, it was clear that there was a specific group of students who did not have an initial interest in engineering when they were younger but chose the subject as it challenged them. These engineering students were driven by an ambition to achieve, rather than an innate passion for engineering or an early interest nurtured via hobbies and activities. Engineering was seen by this group as a subject that could challenge them and ensure that they would continue to learn and progress through their careers.

"I started off in anatomy because I wanted to pursue a career in medicine, but it wasn't for me as I was learning about things that people had already discovered. I didn't see how I could apply anything to it or what differences I could make. And so, I transferred from anatomy to engineering."

Claire, 26, PhD Prosthetics and orthotics student

This drive for being challenged and for progression impacted their decision-making, as it made them more proactive. They were much more likely to have researched potential courses based on their studies and predicted grades. They were also likely to have found science and mathematics easy, so looked at engineering as a natural extension of STM university degree courses. They may not have necessarily known much about engineering initially or known anyone in the industry. They took it upon themselves to search online, ask teachers and generally try and find as much information as possible, to make an informed decision on what career or job would be best for them.

In addition, this group were more actively looking for careers that were well paid. For example, sometimes they considered high paying jobs in the medical field first and wanted a job that would match this high earning potential and the scope for professional development in the future.

"I was planning to do medicine to be a doctor, and so I took maths, chemistry and biology at A evel. But when I was doing them, I realised I didn't like biology anymore as there was too much content and the reality was I didn't want to be a doctor. I only thought about it for the money, so thought what can I do that is well paid with the A levels I had? And I decided upon engineering."

Marie, 18, Foundation course student going on to do mechanical engineering

Engineering and STM students are more likely than arts and humanities students to say that they wanted a career in their respective subjects when they were 12-15 years old.

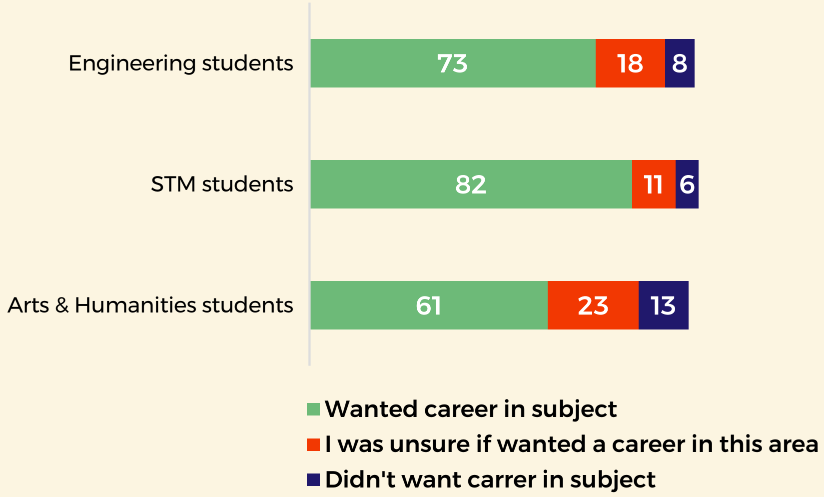
- Three in ten (34%) engineering students, and four in ten (43%) STM students were definitely sure they wanted a career in their subjects.
- Only one in five of arts and humanities students wanted a career in their subject area.
- Six in ten (61%) engineering students are fully intent on pursuing a career in engineering, as are STM students (65%).

This career focus may not be specific to engineering students, as it's shared by STM students too, but the qualitative interviews highlight that engineering students may be driven by a specific set of motivators (**Figure 10.1**).

As the case study below highlights, the points at which this mindset impacts a young person's decision-making process can start from a relatively young age, even before ages 12-15 as identified in the quantitative survey.

Engineering and STM students were more sure of their career choice when at school

Certainty of career choice when aged 12-15 (%)



S6. Still thinking about when you were aged between 12 and 15 years old. Which of these best describes how you felt about (description) at the time?

Base: Engineering (306), STM (500), Arts & Humanities (251).All figures displayed as percentages. Arrows indicate where Engineering students score significantly higher/lower than both STM and Arts & Humanities subject groups at 95% confidence level.

Figure 10.1: Certainty of student's career choice at age 12-15.

Case study: 'Jared'

Family influence from secondary school Dad wanted him to do an apprenticeship – to make money.

Older brother doing an engineering apprenticeship and 'making good money'.

"My Dad drilled it into me to do an apprenticeship. You're earning money, learning, building skills at the same time.

Age 11+

Always liked sciences, maths.

Decision-making: Considered astrophysics (but not intelligent enough)

Age 14-16

Decision-making: Career talks about 'engineering' – 'sets the seed'

Age 16-18

Decision-making: Thought would go into science, but changed schools and had to do engineering BTEC

Age 16-18

Decision-making: Science doesn't have many apprenticeship opportunities / career pathways

"There aren't the same career opportunities in science as engineering. Science is mainly research and you have to specialise. Engineering isn't like that.

Conclusions

1. Building awareness, understanding and knowledge allows young people to make an informed decision about engineering

There is a lack of understanding of what engineering is among young people, even up to the age of 14 or 15 years old. This is compounded by a lack of connections being made for teenagers between what they are interested in and their hobbies (which are engineering related) and how this translates into studying engineering post-GCSE.

Building the capability for young people to make a considered decision – by building awareness, understanding and knowledge – is the first step to creating an environment where choosing to study engineering is easy to do. This research shows that the lack of awareness of 'engineering' as a subject that can be chosen to engage with post-compulsory education, means capability is relatively weak.

Many of the students we interviewed showed a tenacity and passion underlying their decision-making processes. They actively searched out information about engineering beyond what was provided for them at school, and even by family networks. These emotional drivers were borne from a real interest and engagement in engineering, or an ambitious streak.

2. Both school and home environment play crucial roles in nurturing interest in engineering

From the quantitative study, the key driver to choosing engineering was receiving engineering careers advice at school (+0.39 correlation). However, this was not a strong or consistent theme from the qualitative interviews, perhaps reflecting the relatively low correlation levels.

Rather, in the qualitative interviews, the impact of the younger years was stronger – either in terms of parents introducing them to engineering through hobbies and activities, wider networks supporting them with developing a greater knowledge around engineering and engineering courses or developing an ambitious mindset.

However, we think that this is due in part, to the methodological approach taken and the ability of students to access their early memories.

The quantitative survey did ask about experiences in the younger ages of 5 to 11 years old, though we predominantly focused on the older ages of 12 to 15 given the survey vehicle. On the other hand the qualitative interviews were more expansive and allowed students more time to access early year memories.

We cannot concretely state whether home or school is more important than the other. What we can reinforce, as other studies have shown, is that those with greater networks at younger ages and more exposure to engineering during their younger years, are more likely to build a solid base of understanding and engagement with engineering. This knowledge is then likely to be built on during school years.

The school environment, combined with informative, engaged and encouraging teachers, plays a vital role in nurturing interest in engineering while showcasing the breadth of careers on offer. This can be harder for young people to grasp if they are not building on thought processes that are already in place. Some of the engineering students who developed a real interest in engineering from a young age were particularly vocal about advocating for more exposure in schools in order to help young people understand what engineering is and the career options available

3. D&T can act as a conduit to engineering at school

D&T as a favourite subject at school or a D&T teacher being selected as a favourite teacher were both identified as drivers to deciding to take an engineering course at post-compulsory level (+0.29 and +0.32 correlation levels respectively). As engineering isn't a subject taught separately to other topics in school, engineering students find D&T provides the type of learning style they enjoy, it is practical and hands-on. It also explores many of the interests that engineering students have – how

things are built, how do things work, how can things be developed and made to work more effectively.

4. Explicitly differentiating engineering from wider STEM will help boost awareness.

Across both phases of the research a trend emerged that finding science and maths easy was an important part of the decision-making journey to taking up an engineering course. And from the qualitative research many students spoke of going down the science, or medicine route particularly, before becoming more aware of the paths available to them around engineering. This was often an active decision that engineering students took, rather than something they 'fell in to' and thus an opportunity for further communications and engagement from the sector.

Engineering is seen to offer a greater variety of well-paid, interesting careers that can positively impact wider societal issues.

5. Decision-making is nuanced and multifaceted

There are multiple factors that influence whether a young person chooses an engineering course at post-compulsory level. This is clear from the fact that there was no one significant or strong driver identified during the key drivers' analysis and that we found multiple factors with relatively low correlation levels.

Interviews with engineering students highlighted the gradual nature of decision-making as well, with myriad subtle factors influencing students during their younger years. Many weren't consciously aware of what had actually influenced their decision-making, but could, on the whole, pinpoint active engagement with the subject of engineering from ages 14+.

What this tells us is that young people need multiple touchpoints to make them feel that engineering is 'for them' and to consider it as an option for future education. The research also showed that realistically, the younger age ranges are the most formative.

Annex report

Annex A: Methodology

Annex B: Analytical Approach

Annex C: The strengths and limitations of our approach

Annex A: Methodology

The Royal Academy of Engineering commissioned Walnut to undertake a mixed method approach to this research study:

1. Quantitative

Walnut conducted a 15-minute online survey with:

- N=306 engineering students
- N=500 STM students
- N=251 arts & humanities students

All were aged between 16 and 26 years old and were currently enrolled in school, sixth form, university, an apprenticeship or vocational course.

Of the respondents, 350 identified as men, 663 identified as women, 32 identified as non-binary, 6 identified as self-describing and 6 preferred to not say.

All sample was accessed via research panels, apart from N-56 interviews with engineering students which were obtained using Royal Academy of Engineering networks.

Fieldwork took place between 13th October and 14th November 2022.

Questions were predominantly designed to be asked to all three student audiences for comparability. Code lists were designed to cover the range of influences, factors and impacts that we assumed would reflect all three audiences. As an example, please see to the right one of the questions we asked with has a mixture of engineering activities, arts & humanities and general activities for a child to be engaging with.

2. Qualitative

Following the quantitative study and a topline debrief to Royal Academy of Engineering, Walnut then undertook a phase of 20 45-minute in-depth online interviews with engineering students aged between 16 and 26 years old.

The discussion guide for interview was designed to explore emerging themes from the quantitative phase in greater detail.

Thirteen of the 20 participants were recruited via the online survey and 7 were recruited using qualitative recruitment partners, who used a mixture of database and snowballing recruit methods.

Interviews were conducted by a core member of the research team.

Now thinking about when you were a child, between the ages of 5 to 11 years old. What types of activities or hobbies where you interested in? Your memory of these may not be perfect – that's fine! We're just asking for as best as you can remember.

	Playing video games
	Drawing, painting, crafts activities (e.g. making birthday cards/ completing a drawing book)
	Reading
	Building things (e.g. LEGO, train sets, dens in the garden)
	Exploring outdoors
	Going to the park
	Building or playing with gadgets (e.g. remote-controlled cars, drones)
	Listening to music
	Playing puzzles or quizzes
	Watching TV / streaming shows / videos (either live or on-demand)
	Building electric or non-electric vehicles (e.g. building your own bike/scooter)
	Playing sport or dancing
	Going to the cinema
	Playing instruments
	Something else (please specify)

Annex B: Analytical approach

Quantitative

To really understand what factors were driving decision-making in engineering students we undertook a key drivers analysis.

This analysis provided the ranking of attitudes and behaviours that have the greatest influence on whether the student took an engineering course.

We used both simple correlation and a technique called Relative Importance Analysis to look for relationships in the data. Simple correlation looks for relationships between individual variables and the overall measure. Multivariate techniques then consider all variables at the same time and assesses their relative impact on the overall measure.

Qualitative

We undertook a systematic, iterative approach to analysis. All data was captured in an analysis matric before being sorted into codes and categories. Halfway through interviews, the research team conducted an interim analysis session to explore key themes arising from the interviews and whether further depth of insight was needed.

We identified areas of commonality across participants, either by theme or demographic, alongside areas of divergence, classifying these as either an anomaly or part of a broader trend that correlated with the quantitative data findings.

Annex C: The strengths and limitations of our approach

1. Research material design

We designed our research materials using our proprietary behavioural science framework 'Shortcuts'. This framework helps us to consider and aims to overcome some of the behavioural biases that occur when people taking part in research, an overview of which is included below.

Three biases we were particularly aware of were:

- **Introspective illusion:** We do not have as good a view into our own mental states and decision-making as we like to think
- **Present bias:** We give more weight to our current environment
- **Familiarity bias:** We tend to develop a preference for things merely because we are familiar with them.

Rather than asking students about the relative magnitudes of each decision-making factor, which would be susceptible to the **Introspective illusion** bias, the questionnaire was descriptive and factual. Our Shortcuts framework tells us that it is difficult to describe what we *Feel*, and we are more accurate at recalling past facts and events than past emotions and attitudes.

To minimise the **Present bias**, open-end questions prompted respondents to write about their childhood memories. These psychologically 'set the scene' for the following sections. Furthermore, the questionnaire structure ensured a smooth *Flow*; we began with questions in chronological order e.g. firstly thinking about when they were aged 5-11, followed by when they were 12-15 years old, and ending with the present day.

We reminded respondents about the age range we wanted to know about. This *Framed* their perspective at every question, thereby reducing the chance that present day familiarity with particular hobbies, interests or role models could influence how they responded.

In addition, throughout the survey we displayed a progress bar and included encouragement to *Motivate* respondents to focus on giving rich, accurate answers.

As with any survey, it was important that our question wording did not to *Lead* respondents towards particular answers, such as those which could be seen as more socially desirable. Therefore, question wording remained as neutral as possible throughout.

SHORT CUTS
By Walnut Unlimited

Our behaviour science framework 'Shortcuts' brings together key thinking from behavioural economics, psychology, neuroscience and the social sciences. We know people do not make rational decisions, so by applying these 'Shortcuts' throughout the research process it helps us understand the decisions respondent's make beyond the typical rational response. The 'Shortcuts' focus on 5 core pillars as below.

FEEL
How emotions influence choice

MOTIVATE
How behaviour is altered by tools that motivate people

LEAD
How to tap into social biases to understand decisions

FRAME
How a change in perspective can modulate the choice

FLOW
How to make things as easy and simple as possible to get accurate data

2. Quantitative

This research includes robust sample sizes that allow us to conduct significance testing at 95% so where we identify differences in the data they are statistically different. We are also able to analyse each group by demographic sub-group.

However, by its nature a quantitative approach predominantly requires participants to answer questions using a pre-selected list of answer codes. We built our question set and code lists using insight from the Science Capital framework, and other research studies, including Engineering UK, IMechE and University of Manchester's Young People's Educational Choices and Career Aspirations. We incorporated the principles of behavioural science to ground participants in thinking about their decision-making when they were younger.

It is clear, though, that it is not easy for a respondent to conceptually access what has impacted their decision-making over time. This tells us that it is not an easily accessible set of thought processes to unpick in a survey format which will impact the depth of insight uncovered.

See section on 'Bringing the findings together - Interpreting the findings' in the main report for greater detail.

3. Qualitative

On the other hand, whilst a relatively small sample of in-depth interviews (20) this provided us as researchers with greater depth of insight into what decision-making may look like over time.

Nevertheless, it did highlight that, even during a 45-minute interview, conscious awareness of what ultimately impacts decision-making is still limited. Many of the connections made in this report around what influences decision-making based on the qualitative findings are based on analysis from the research team, rather than self-awareness or reflection from the participants themselves.

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Together we're working to tackle the greatest challenges of our age.

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