FUTURE OF ENGINEERING

03 REMOVING GENDER STEREOTYPES

08 SOFT SKILLS AND HARD TRUTHS IN EMPLOYMENT

10 FRACTURED SYSTEM NEEDS URGENT FIX

The Institution of Engineering and Technology

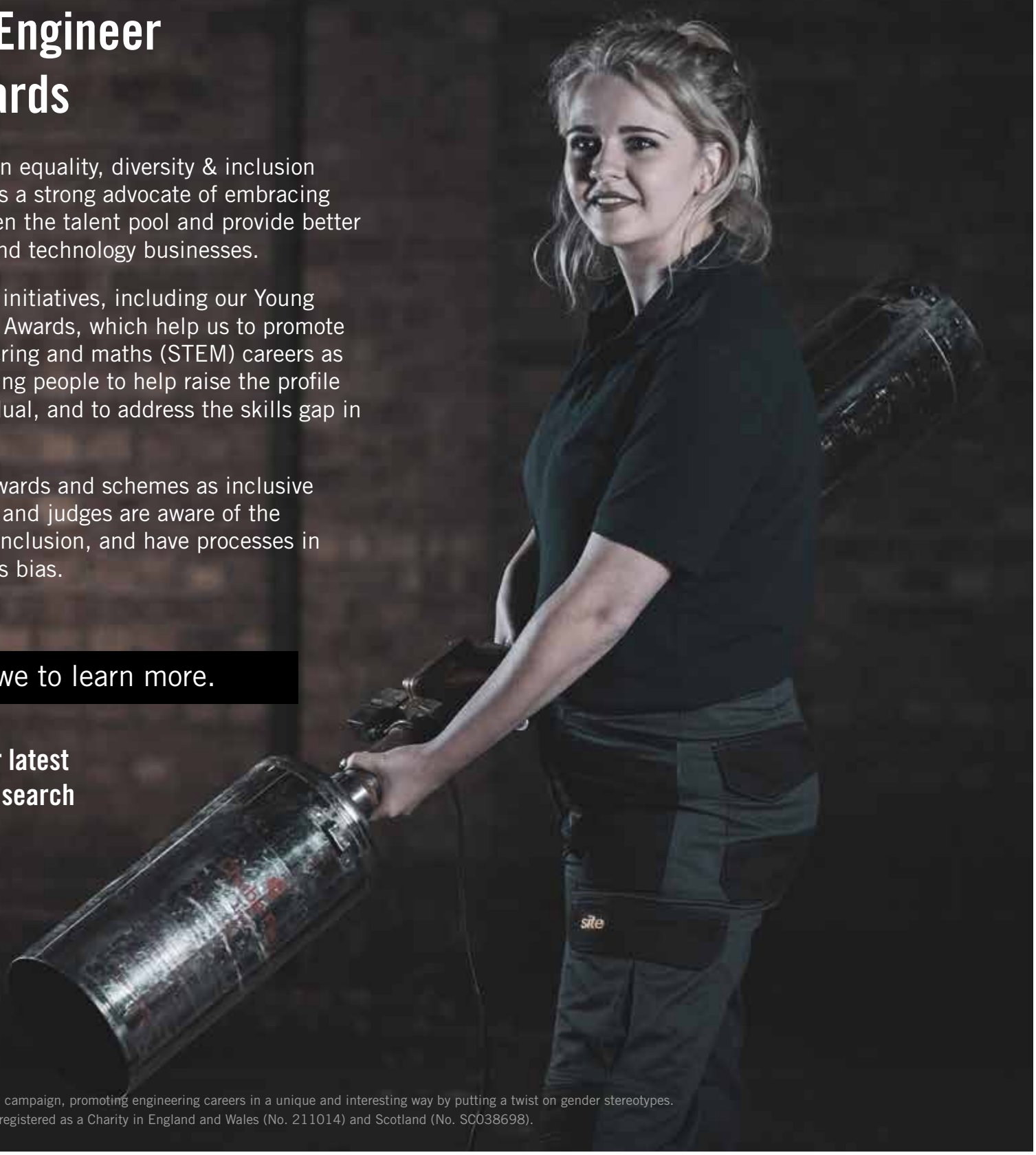
Young Woman Engineer of the Year Awards

The IET is proud to champion equality, diversity & inclusion (ED&I) in all its forms, and is a strong advocate of embracing this important theme to widen the talent pool and provide better workforces for engineering and technology businesses.

We have many schemes and initiatives, including our Young Woman Engineer of the Year Awards, which help us to promote science, technology, engineering and maths (STEM) careers as exciting and desirable to young people to help raise the profile of the profession, the individual, and to address the skills gap in our society.

We work hard to make our awards and schemes as inclusive as possible, ensure our staff and judges are aware of the importance of diversity and inclusion, and have processes in place to address unconscious bias.

Visit www.**theiet**.org/ywe to learn more.



You can also check out our latest campaign on Twitter – just search

#Smash Stereotypes To Bits

Images from our #SmashStereotypesToBits social campaign, promoting engineering careers in a unique and interesting way by putting a twist on gender stereotypes.

FUTURE OF ENGINEERING

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Removing gender stereotypes

Engineering is missing out because of latent prejudice and unconscious bias preventing women from entering the profession

MAGDA IBRAHIM

The look of disbelief when Hayaatun Sillem tells people she is a chief executive in the engineering sector is all too familiar. "Some people are better at rearranging their faces than others, but the fact that many people don't immediately assume I could be a CEO can be frustrating at times," she says.

As the first female chief executive of the Royal Academy of Engineering (RAENG), Ms Sillem is committed to replacing outdated stereotypes with a true reflection of the myriad faces of 21st-century engineering.

"There is a huge array of exciting, stimulating opportunities, but a mismatch in people's perception of the profession," she says. "We need to make sure that engineering's fantastic role models are even more visible and their voices heard so the negative gender perceptions start to break down."

With women making up just 12 per cent of engineering professionals, the race is on to accelerate gender diversity in the UK.

Roma Agrawal, associate director at American multinational engineering firm AECOM, feted for her work on London's Shard, says a major factor is promoting an inclusive and varied culture.

"I used to go to sites and there would be pictures of naked women in the site cabins," she says. "Thankfully, the culture has changed and I haven't seen that for a very long time.

"Going into an organisation, you can tell very quickly whether it is an open environment, whether for women, people of colour, introverts and extroverts, working class, or with English as a second or third language. If company culture is inclusive, then it will be self-perpetuating."

Strategies can include transparent recruitment practices, promoting flexible working for all, securing management buy-in and exploring policies such as corporate social responsibility.

"It is a virtuous circle. The more women who enter, the more we can promote them so they are able to act as role models for the next generation," adds Ms Agrawal.

A key issue is the pipeline for professionals; currently 16 per cent of engineering graduates and fewer than 8 per cent of apprentices are women, and not all end up working in the sector.

Companies must distinguish themselves to attract women recruits, says Helen Wollaston, chief executive of the WISE Campaign, which promotes gender balance in science, technology and engineering.


Hayaatun Sillem, the first female chief executive of the Royal Academy of Engineering, says negative gender stereotypes need changing
RAENG

"Companies need to up their game as there is a lot of competition for female engineering graduates, who can choose from a good range of options outside the profession," she warns. "Women engineering graduates are highly sought after, so to attract them there must be a good range of benefits, reputation and a track record in having a diverse workforce."

Around 60 major companies have signed up to WISE's ten-step programme focusing on career opportunities, committing to challenging bias, being creative in job design and sharing good practice.

Among signatories are Airbus, with a target of 25 per cent women in its workforce by 2020 and 20 per cent in senior leadership, and Shell, which showcases inspiring female engineers through its Engineering Real Life Heroes project.

Setting targets is important, argues Elizabeth Donnelly, chief executive of the Women's Engineering Society (WES), but they must be "relevant, achievable and measurable".

"We are often approached by companies that really want to increase the number of women in engineering, but don't know how to do it," says Ms Donnelly.

Immediate actions include ensuring images reflect a diverse range of people, tackling any unconscious bias in how teams share work to cut out gender stereotyping and examining recruitment processes.

"We know language in job adverts can be subtly gender coded, which can make a woman feel a company is not the place for her," she says. WES has an online gender decoder tool for recruiters to analyse their job adverts and highlight potentially off-putting language.

It also plans to run a recruitment fair alongside its next student conference, so employers can start developing relationships with future engineers. Separateresearchwillexaminethevalue of mentoring in converting graduates into employees.

Practical tools to "help businesses convert their aspirations to reality", are critical in changing the conversation, says RAENG's Ms Sillem. Its inclusive recruitment toolkit helps companies avoid unconscious bias, while a pilot project is helping start-ups and smaller businesses tackle low gender diversity.

A graduate recruitment programme is also bringing together employers, universities and young people from under-represented groups to grow their understanding of the recruitment process. "Ultimately, people have to be appointed on merit, but we can help to reduce the gaps," says Ms Sillem.

However, more young women choosing to study engineering is paramount for a seismic shift in industry representation, she emphasises. RAENG's This is Engineering digital campaign launched this year and will run for at least three years, showcasing the range of engineering careers, from the film industry and aerospace to problem-solving in the developing world.

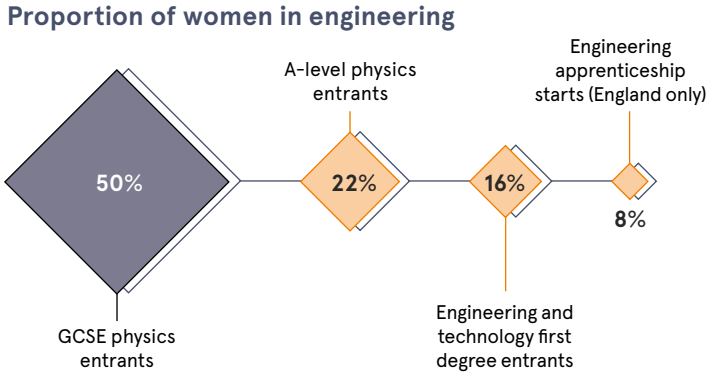
Meanwhile, the government's own Year of Engineering aims to tackle the skills shortage and could impact on the talent pipeline for the next decade. Initial findings show interest among girls has grown, with 53 per cent saying they would consider a career in engineering, up from 34 per cent last year.

Government minister Nusrat Ghani, who is heading up the Year of Engineering campaign, explains: "It's vital we encourage more girls to consider careers in the sector, not only so they can enjoy creative, well-paid jobs, but also to ensure young people with diverse experiences, viewpoints and skills are part of shaping a world that works for everyone."

Working with partners including Apple, Siemens and the RAF, a focus has been dismantling "misconceptions of engineering careers and who these are for", adds Ms Ghani.

"The industry is currently missing out because of latent prejudice and unconscious bias," Ms Donnelly at WES concludes. "Get it right and the diversity of thought will make a massive difference." ◆

Proportion of women in engineering



Engineering UK 2018

R&D FUNDING

Projects at risk unless funding continues

Additional funding for research and development is key to UK innovation and engineering excellence

Carl Court/Getty Images

The Bloodhound SSC on a test run at Newquay Airport last year

EMMA WOOLLACOTT

If proof were needed that UK engineering businesses are short of research and development funding, the demise of the Bloodhound SSC project should serve as a warning.

Plans to create a car that could race at more than 1,000mph were recently scuppered after the company behind the project went into administration. Despite the car being close to completion, it ran into a brick wall after £25 million, needed for the final stages of R&D, failed to materialise.

"Despite overwhelming public support, and engagement with a wide range of potential and credible investors, it has not been possible to secure a purchaser for the business and assets," says joint administrator Andrew Sheridan. This despite the fact that the £25 million over which the project foundered is insignificant compared with the cost of, say, finishing last in a F1 season.

Research shows that the project is not alone in being starved of research funding. Earlier this year, a report from the Office for National Statistics revealed that the UK spent just 1.67 per cent of GDP on R&D in 2016, compared with an EU average of just over 2 per cent. The UK, in fact, is 22nd on the R&D funding list.

The shortage of research funding in the engineering sector is particularly marked when it comes to the development part of the cycle. A recent report for the Royal Academy of Engineering (RAENG) concluded that this is holding back the potential of an otherwise strong system of innovation in the UK.

"The UK undoubtedly has many attributes that already attract engineering businesses to locate their high-quality, early-stage R&D activities here, not least our world-class academic research base and its excellent collaboration with industry," says RAENG president Professor Dame Ann Dowling.

"Unfortunately, this is undermined by gaps in the R&D and innovation system at a highly risky and expensive time in the development cycle. Plugging these gaps would help innovative engineering businesses, boost productivity, and create better jobs and social outcomes in the UK."

There are plans, under the government's Industrial Strategy, to increase research funding to 2.4 per cent of GDP by 2027. The government says it will start with an extra investment of £2.3 billion in 2021-22, raising total public investment in R&D to £12.5 billion that year.

"Domestically, one of the key things is that we're waiting for the UK Research and Innovation roadmap to say how the UK is going to reach that 2.4 per cent target," says Lorraine During, business environment policy adviser for EEF, formerly the Engineering Employers' Federation.

Ms During cites initiatives including the government's Catapult Network, which was recently awarded an extra £780 million in funding to help deliver the Grand Challenges set out in the Industrial Strategy, as extremely encouraging.

A problem for engineering businesses is that support for R&D is available in a somewhat patchy way, with some UK regions and business sectors eligible for more than others. For example, a government grant scheme for R&D in agritech is restricted to Cornwall and the Isles of Scilly, while innovation support is offered to companies developing transport equipment in the East Midlands.

> **Until now, the UK has been able to benefit from the Horizon 2020 programme, which is the biggest ever EU research and innovation programme**

Sonali Parekh, head of policy at the Federation of Small Businesses, says she would like to see some of these schemes expanded.

"*The Jürgen Mayer Review* led to a government funding pilot in the North West to accelerate digital technologies," she says. "It's a step in the right direction and we would like to see more initiatives like that adopted in more sectors."

In fact, says Ms Parekh, many small businesses are unaware of the help available. "Forty six per cent of small business innovators who don't use government support didn't know it was available in the first place," she says.

"We'd like to see increasing awareness of R&D tax credits in particular, where there is a small firm that's not actually got a new-to-market product, but is depending on the transfer of existing ideas to improve its productivity."

R&D tax credits come in several forms, but essentially consist of either a payment or a reduction in corporation tax.

"The scheme is relatively well known now, so awareness really shouldn't be an issue. However, roughly half of our new clients every year come from businesses that have never claimed under the scheme," says Steven Garrod, managing director at tax credit specialist MPA Group.

"There are some simple and understandable reasons for this. Something we regularly hear from new clients is that they never considered their work as 'R&D' or 'innovation'; they're simply trying to improve a product or meet their customer's need."

Alongside tax credits comes the Patent Box scheme which, says Mr Garrod, is equally underused. It can reduce corporation tax on a qualifying product line by 10 per cent.

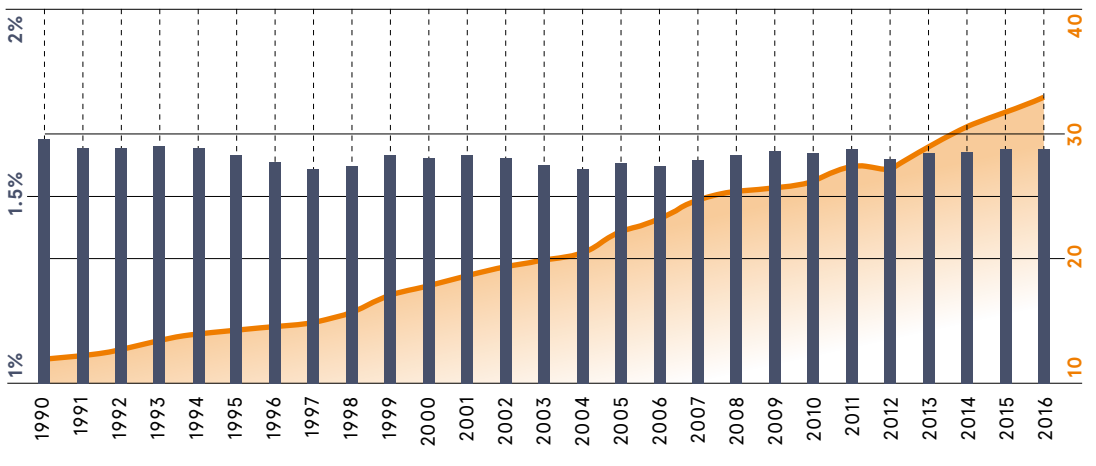
"It is designed to work alongside R&D tax credits to further reward UK's innovative businesses. If a company is already claiming under that scheme it may well have a claim under this scheme, but only if they have a patent," Mr Garrod explains. "It's a major opportunity for business, but HMRC statistics show that 97 per cent of companies engaging in R&D are missing out on it."

So UK research funding is set to increase. But as for European Union funding, who knows? Until now, the UK has been able to benefit from the Horizon 2020 programme, which is the biggest ever EU research and innovation programme, making nearly €80 billion of funding available between 2014 and 2020.

While the government has agreed to continue payments that have already been approved up to the end of 2020, it's not clear how it will be involved after that. "Horizon 2020 in the UK has always been a success and it's great the government has agreed to fund the bits that have already been assigned, but in terms of the future, there's some uncertainty," says Ms During. ◆

R&D funding in the UK

Funding has grown, but remained stagnant relative to GDP



Office for National Statistics 2018

Product designers turn to open data to drive materials innovation

Designers and engineers have traditionally relied on limited information when selecting materials, but now they are turning to a new digital platform for data to drive effective and robust innovation

The ways in which product designers select materials for projects has for many years remained unchanged. The prevailing tendency is one of human nature, towards a reliance on experience, existing contacts, web search or sticking to the same range of materials they know has worked well before.

This tendency has been further cemented by a need to meet numerous strict standards in materials, particularly around safety. Many designers respond to this by staying with previously used materials and may be unaware of equivalent materials standards that permit a range of alternative selections.

Designers' reliance on existing ways of working has limited innovation. It has also left open enormous scope for them to offer much more interesting and effective solutions to their manufacturing clients.

Some 84 per cent of product designers and engineers still carry out a simple Google search as their first port of call when looking for materials for a project, according to research by online materials platform Matmatch, in conjunction with BCG Digital Ventures. Other key resources include supplier websites and scientific journals. People typically search for the elements, materials, brands and standards they already know, rather than seeking new items.

"We've found that designers and material engineers, when they take on a new project, tend to start with their own knowledge and explore limited places from there," explains Melissa Albeck, chief executive of Matmatch. "They think along the lines of materials that have worked well for similar applications in the past. And those materials might well do the job, but there could also be something out there that would really be a much better fit for that product.

"In effect, many designers' reliance on web search engines as the primary means through which they look for materials has a problem consumers know well; they start by typing in terms they already know something about. The aim for us is to help people break out of that cycle and give them instant access to information on other viable and potentially more advantageous alternatives."

84%

of materials research starts with a Google search

50%

of engineers surveyed consider new materials or suppliers in the design process at least once a week

> **Using new tools, designers and manufacturers can shake off less effective ways of working and instantly tap an online database of materials to transform their product creation**

Matmatch is opening up an easy route to finding and accessing these other materials, having developed a free-to-use online platform, which allows designers to search a database of more than 80,000 different materials, including metals, polymers, ceramics, glass, composites and biological materials. Designers can assess the particular properties of different materials, compare their viability for specific uses and discover equivalent standards of the available materials where needed.

"Until now, a lot of people have tended to rely on their own knowledge, or asked people around them, because it has been so hard to find the right data. That's the issue we are solving," says Ms Albeck.

Matmatch's database gives product designers access to a range of key details about different materials, with all the information having come from reliable sources and verified by an in-house team of material scientists. The company also uses machine-learning to predict materials data and sees potential in using technology to match designers with materials automatically.

Crucially, suppliers of many materials can be contacted directly through the platform, enabling orders to be placed easily. Before Matmatch, companies would have had to search, sometimes extensively, for where to procure those materials.

The platform, designed to provide users with a much more straightforward route to pertinent information, is used among product designers and engineers creating prototypes for everything ranging from wind turbines to ship parts to consumer goods and beyond.

A development engineer at a major sports carmaker recently found the platform useful as a means of identifying quality materials and suppliers for vehicle interiors. Typically, in the car industry, designers would search online, visit exhibitions and discuss the details with contacts before deciding on materials for a new project.

Melissa Albeck
Chief executive, Matmatch

A key benefit of Matmatch's system proved to be the ability to have an overview of, and comparisons between, different material suppliers. The engineer comments: "Exhibitions contain mainly a closed circle of companies and to open that circle with a platform will be important in making materials sourcing in the automotive industry more dynamic."

For smaller firms too, the potential impact of opening up free access to vast swathes of data, on tens of thousands of different materials, is essentially limitless. Innovation around materials has tended to be the preserve of some of the very largest companies. Apple, for example, might roll out a new product using a completely unconventional material. But as Ms Albeck explains: "It has the resources and in-house expertise to focus on experimenting with multiple unusual materials where others generally would not. Now other companies can more easily try useful alternatives.

"Historically, smaller companies have perhaps lacked the resources to spend lots of time or money on research and therefore consider alternatives. That restricts innovation because, if they're not looking into the options and asking if there might be better materials available, then it is harder to take things to the next level."

With the Matmatch platform being free to use, it is expected to democratise information across industries, encouraging consistent innovation from early-stage startups to large businesses.

Ultimately, for Matmatch, the goal is to continue opening up and making more easily digestible details on as many different types of material as possible. There is already information on more than 80,000 distinct materials on the company's database, but more are being added every day.

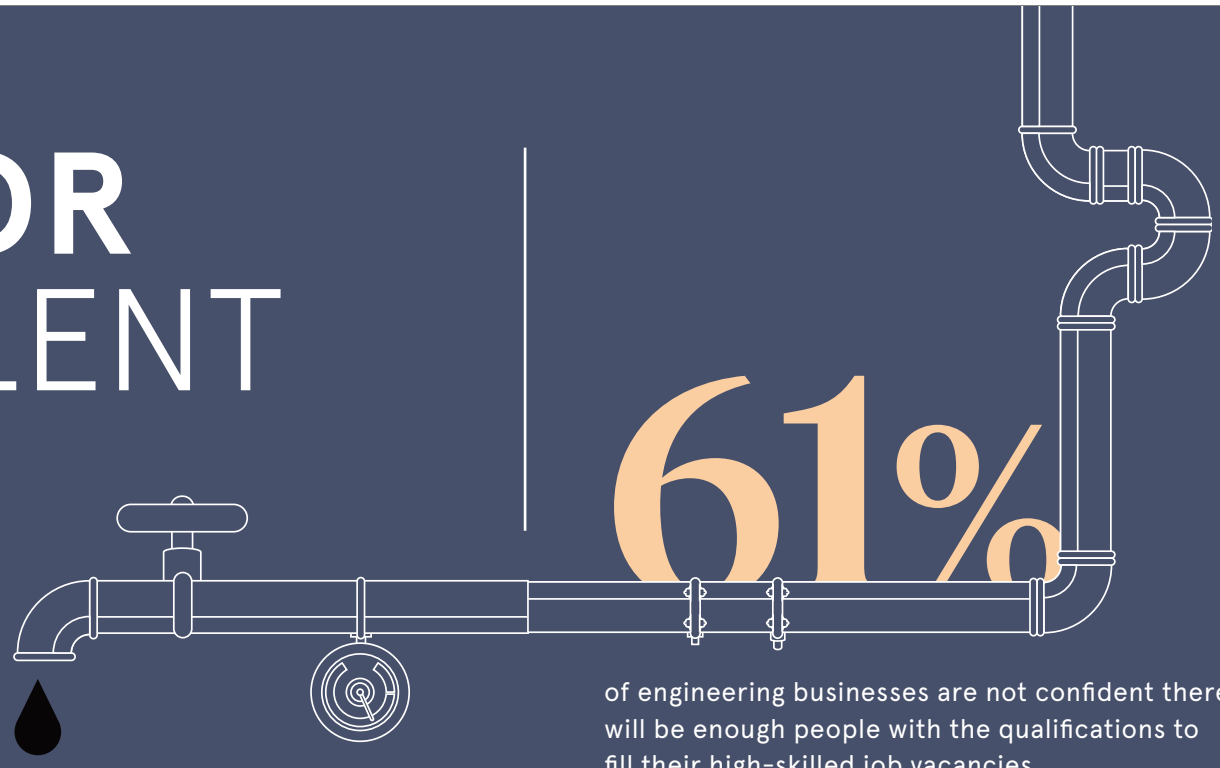
By using the new tools, designers and manufacturers can shake off less effective ways of working, and instantly tap an online database of materials to transform their product creation.

To find out more about how to find the best innovative materials for powerful product design please visit matmatch.com

Matmatch

QUEST FOR MORE TALENT

Engineering is facing significant shortfalls in suitable graduates and technicians entering the workforce, so more work is needed to fight the talent drain with the problem set to intensify in years to come



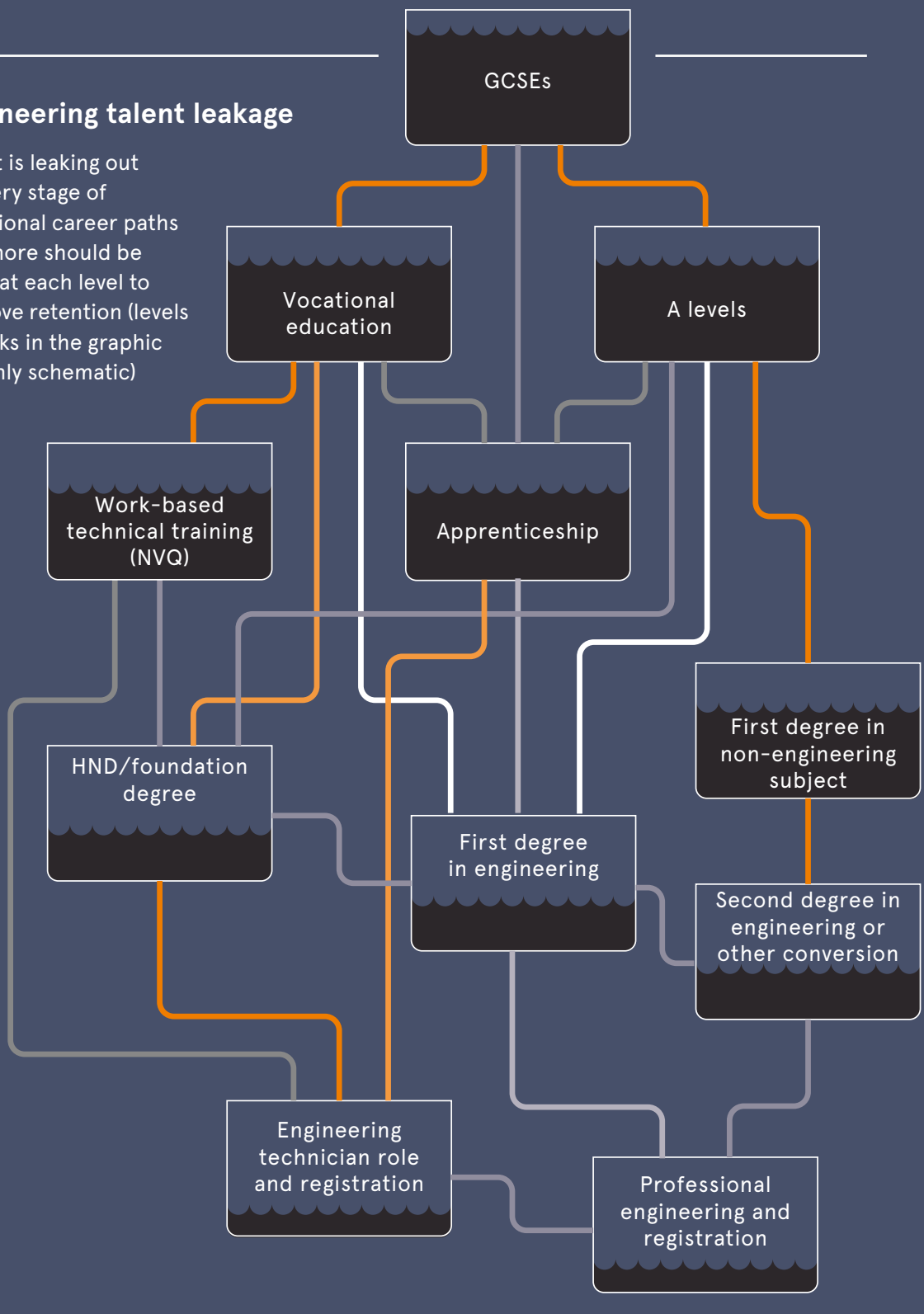
61%

of engineering businesses are not confident there will be enough people with the qualifications to fill their high-skilled job vacancies

EngineeringUK 2018

Engineering talent leakage

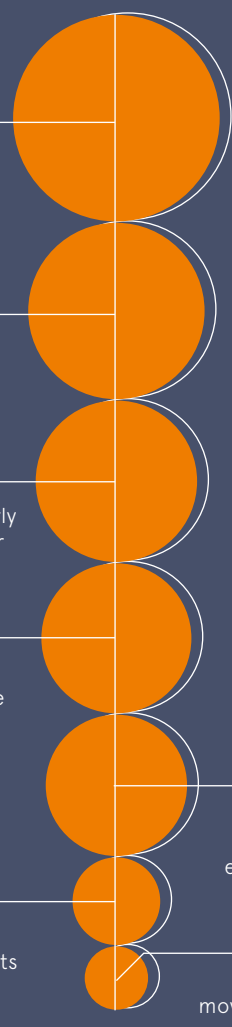
Talent is leaking out at every stage of traditional career paths and more should be done at each level to improve retention (levels in tanks in the graphic are only schematic)



John Perkins/Department for Business, Innovation and Skills 2013

Main drivers of skills gaps

Reported by employers in the engineering, science and technology sectors



83%
Strong competition for qualified candidates

60%
Lack of candidates with appropriate qualifications

50%
Careers advice poorly aligned to the sector

43%
Lack of awareness among young people of education routes

38%
Changes in the work not reflected in education or training

14%
Difficulty accessing highly skilled migrants

7%
Qualified individuals moving to other regions

CBI/Pearson 2017

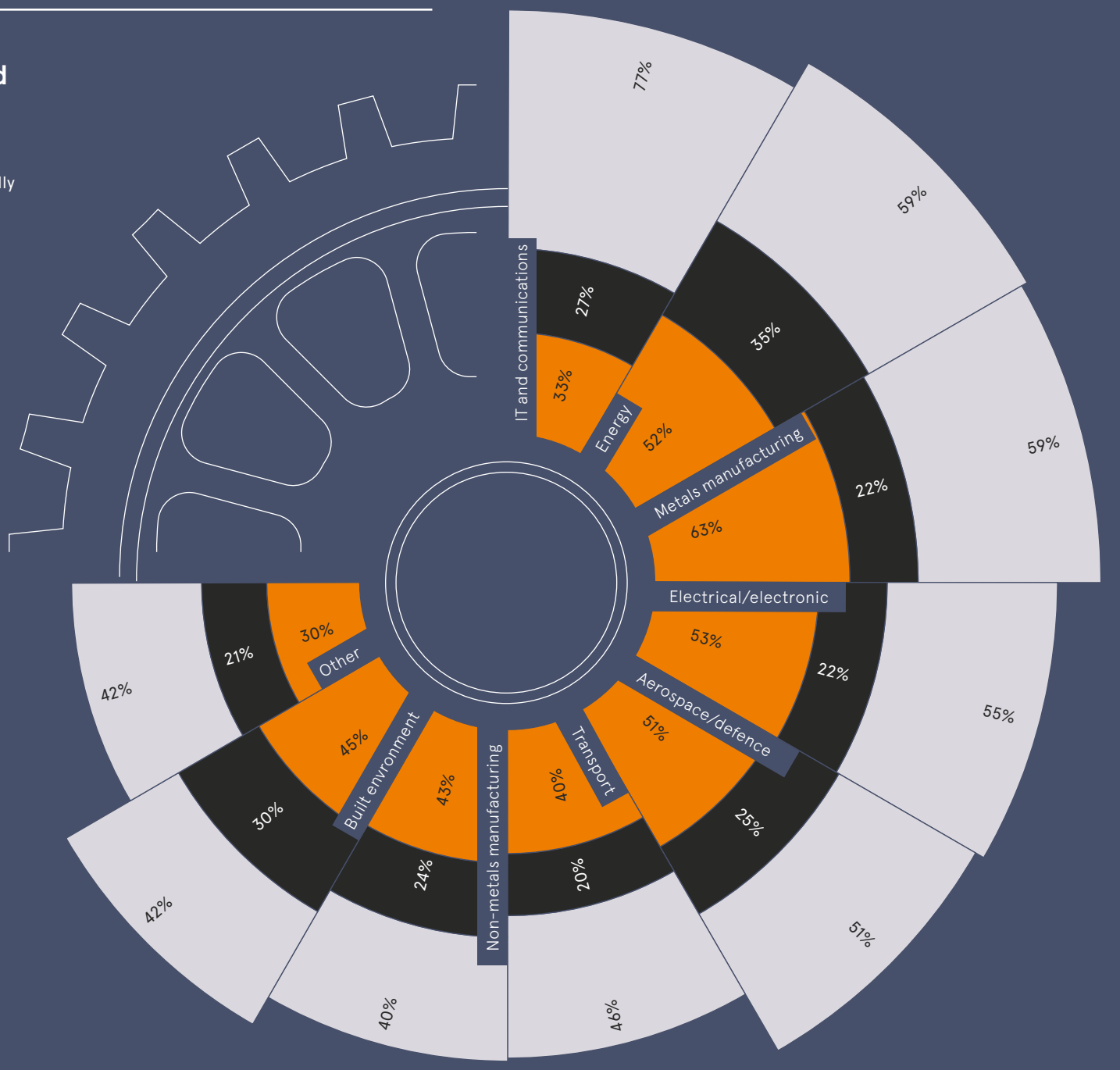
203k

people with at least Level-3 engineering skills will be needed every year to meet demand through to 2024

EngineeringUK 2018

Engineering sub-sectors in need of more staff

- Those reporting skills shortages externally
- Reporting skills shortages internally
- Expecting an increase in staff over the next three years



59k

annual shortfall of engineering graduates and technicians to fill core engineering roles

EngineeringUK 2018

What engineering companies are doing to increase the skills supply

Providing good career paths in your company **75%**

Offering older workers arrangements that help them to stay **69%**

Work experience for young people still at school **49%**

Work experience for young people in further education **48%**

Engineering or technical apprenticeships **40%**

Work experience for young people in university **37%**

Encouraging suppliers to offer training or apprenticeships **27%**

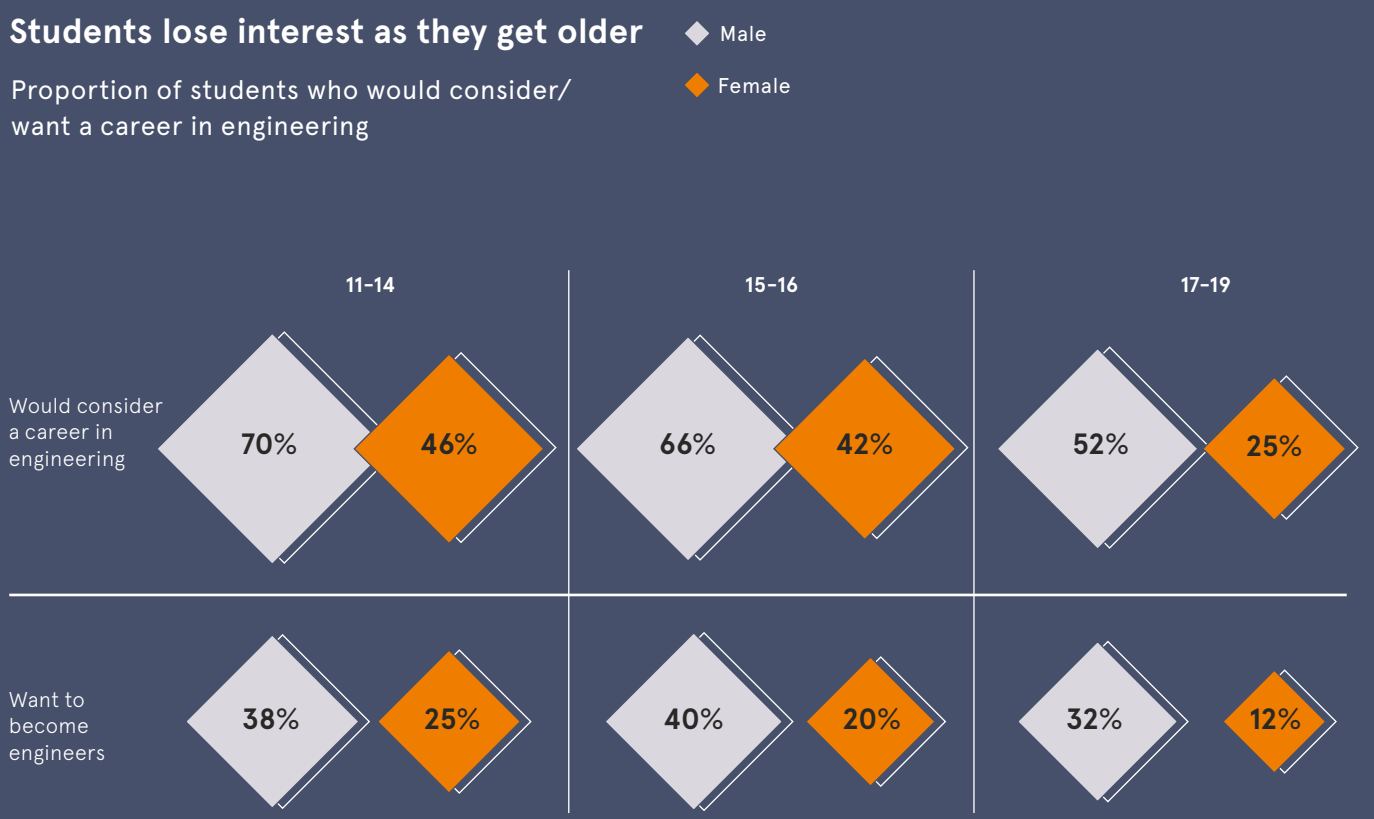
Partnering with further/higher education to develop courses **24%**

Going to schools/careers events to inform students about engineering careers **17%**

IET 2017

Students lose interest as they get older

Proportion of students who would consider/ want a career in engineering



EngineeringUK 2018

New Model in Technology and Engineering's Ingenuity Studios are equipped with hi-tech equipment and transported to schools, colleges, community spaces and public events to engage students to solve local issues through engineering

Soft skills and hard truths in employment

In the grip of a choking skills shortage, the engineering sector faces tough questions of how best to attract new recruits and equip them for lifelong employment

JIM McCLELLAND

Demand for engineering skills in the UK could mean onboarding as many as 265,000 new recruits a year through to 2024, equivalent to the population of Plymouth, every 12 months. That is a lot of engineers.

Fast-growing customer-acquisition platform Mention Me closed its first funding round of $7 million this summer. While it has been successful finding new hires with engineering skills, getting the talent mix right has been tough, chief technology officer Tim Boughton concedes. "Barriers to entry to be a software engineer have never been lower," he says. "Technical skills matter less; it's the engineering thought-process and structured problem-solving which are in demand."

Core attributes still hold good, says Will Jones, head of engineering at online mortgage broker Habito and external lecturer at Imperial College London. "Good engineers have technical expertise, are critical thinkers and ultimately creative. With these broad abilities, graduates should be able to succeed in the majority of software jobs. But, with the rapid pace of technological change, the number-one skill is adaptability," he says.

In under three years, Habito has grown from a team of six to 120, raised £27 million in fintech funding and hired 35 engineers. Demand is up too in connected and autonomous vehicles.

"For the next generation of engineers, there has never been a better time to look for a job," according to Adrian Bedford, chief scientist at StreetDrone, a driverless car tech startup from Oxford.

As well as building the cars themselves, engineering skills will be needed for artificial intelligence and driving software, plus infrastructure.

However, a recent UK report published by StreetDrone with the Centre for Economics Business Research reveals the creation of 10,000 new jobs with driverless cars by 2035 looks set to outpace the emergence of young people with the right skills. "Currently, there is only one university in the UK offering dedicated courses to the autonomous vehicle industry, meaning companies need to look beyond direct skills and experience," says Mr Bedford.

Combining a mix of talents and types calls for communication and team-working, as well as engineering skills, says Jens Roehrich, professor of supply chain innovation at the University of Bath School of Management. "Apart from technical expertise and maths skills, 'modern' engineers need to work in international and diverse teams to deliver projects. Engineering students will therefore need to learn to communicate effectively," says Professor Roehrich.

Personal attributes such as positivity, coachability and emotional intelligence can boost employability, says Mr Boughton. He says: "Soft skills offer engineers a way to differentiate in the workplace and also at interview stage."

Not everyone likes the terminology, though, argues Ljiljana Marjanovic-Halburd, head of the School of Engineering and Sustainable Development at De Montfort University (DMU). "I think the so-called lack of soft skills is actually a symptom of a lack of understanding about how engineers can solve the world's burning societal issues," says Professor Ljiljana.

To develop a more socially minded approach, DMU sets its students to work on live projects with Engineers without Borders, focusing on practical, sustainable solutions to problems in some of the world's poorest communities.

Tim Ibell, professor of structural engineering at the University of Bath, is even less sold on the phrase. "We do not need engineers with soft skills. We need emotionally intelligent people with engineering skills. This represents an entirely new paradigm for recruitment of engineering students."

Inaugurated in Hereford this October, NMiTE (New Model in Technology and Engineering) is the first in a new wave of

> **We need emotionally intelligent people with engineering skills**

universities appearing in the UK, following a government shake-up of the sector. It aims to help resolve the estimated annual shortfall of 40,000 engineering graduates by opening opportunities to a more diverse cohort.

"Engineering lacks diversity," says chief executive Elena Rodriguez-Falcon. "Britain has a huge shortfall of talented engineers and part of this problem is too few young females see it as the sort of career they want, and they are not inspired to take maths and physics A levels."

NMiTE is aiming for a gender-balanced intake. It is also seeking to embed students directly into the fabric of industry. Ms Rodriguez-Falcon says: "To produce engineers who are work ready, agile and lifelong learners, we are setting out to ensure they experience being engineers from day one. This will happen working entirely on real-world problems provided by UK employers."

Higher education institutions should promote and encourage lifelong learning, says Matthew Cooper, head of school, business and management, at Arden University. "The ongoing and voluntary acquisition of knowledge is key to a successful career, as it helps the individual to develop adaptability and attention through continuous learning," he says.

Continuing professional development can require some adjustment, though, says Professor Ibell, chair of judges for the 2018 Institution of Structural Engineers' Structural Awards. "New graduates coming into structural engineering these days might have digital skills their line manager does not," he says. "This represents a different era of knowledge-transfer in the workplace. It is a real challenge as chartered engineers usually feel their study days are behind them. They are wrong."

Engineering must treasure and retain talent it has, says John Kirven, senior value proposition consultant at Canon UK. He says: "As we enter a new era of digitisation, bridging the skills gap isn't just about attracting new entrants, employers should also be investing in existing staff by retraining and upskilling teams."

Some engineers may need to move not just jobs, but sectors to continue careers and, according to Mr Kirven, transferable skills can be role related, technical or general. There are also resources such as the OPITO Skills Connect tool to help oil and gas workers transition elsewhere. However, as economic pressures worsen, so too can attitudes to risk. He warns: "In industries such as construction, employers can be reluctant to invest time and money in workers from other sectors experiencing temporary downturn, as they fear they may leave."

The hard truth is engineering cannot afford any loss of talent whatsoever, whether new, existing or transferable. From software and structures to self-driving cars, the demand is present, but it is changing, rapidly and repeatedly. The question is can education and industry respond? ◆

Insight

Apprenticeship levy

Dubbed everything from a stealth tax to a boon, the apprenticeship levy divides opinion. It is payable at a rate of 0.5 per cent by employers with wage bills bigger than £3 million.

"The complexity and inflexibility of the scheme has impeded its success," says Hollie Ryan, associate and employment specialist at law firm Stevens & Bolton. "Some industry-specific training and qualifications are not covered."

Despite 30 per cent of UK business being engineering related, recruitment specialists such as Encore Personnel have seen a real decrease in skills availability within blue-collar positions. Limited levy money, plus cost, prove a big deterrent, but it is also generational, says technical operations manager Louise Bragg.

"These manual positions are mainly held by the older generation," she says. "The younger people are opting for disciplines that require less manual work, such as design engineering. There are exciting projects within rail and road crying out for these skills."

Nevertheless, funding inequalities, disparities over standards duration, as well as lack of choice in higher levels persist, says chief executive of Skills4STEM Sarah Davis. But she remains bullish. "It's an excuse to say the levy is not working and for employers not to engage. For those who do, it's a fantastic opportunity to upskill existing talent and encourage new," Ms Davis concludes.

Education system and engineering skills

Percentage of engineers, teachers and employers who think the education system develops the following characteristics fairly to very well

- Engineers
- Teachers
- Employers

01 Deciding what is the actual question, finding out if solutions already exist

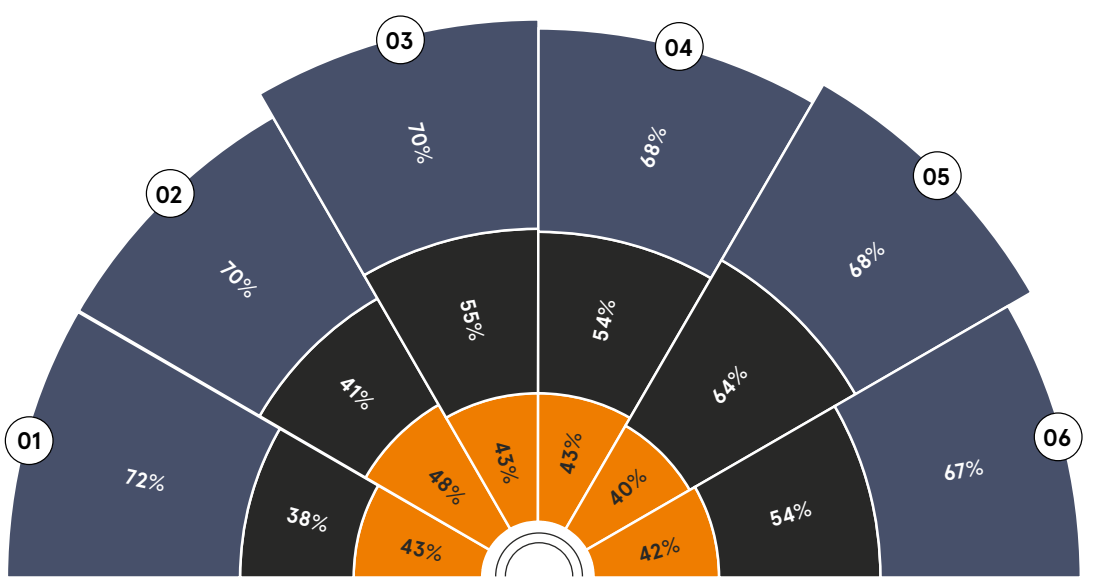
02 Visualising or moving from abstract ideas to concrete thinking

03 Making things better through experimenting, designing, sketching

04 Testing, rethinking, changing

05 Seeing connections between things, seeking out patterns

06 Generating ideas and solutions as creative problem-solvers



Royal Academy of Engineering 2016

PATENTS

Fractured system needs urgent fix

Lack of a universal patent system to protect intellectual property leaves innovating companies open to potentially ruinous infringements

DANIEL THOMAS

When British inventor James Dyson won £4 million in damages from Hoover, a rival vacuum cleaner manufacturer, for infringing one of his company's patents, he saw the risk of losing the case, had his firm been smaller.

Mr Dyson – he had yet to be knighted – explained that high costs and an effective bias towards infringers meant many small UK companies felt unable to seek redress over stolen intellectual property (IP). He said that only about 18 per cent of legal disputes were won by rights holders and called on the government to simplify the system.

"Patents are expensive to file in the first place. Then you've got renewal fees; there's no other walk of life where you lose your rights on your work of art if you fail to 'renew' it. And then the costs of actually fighting a case are out of this world," he said.

More than a decade on, and gripes and grumbles remain about the patent system, which is still the only legal route available to firms that want to protect their ideas. This is no more so than in engineering, where companies file countless patents in multiple sub-sectors, from aerospace to software design, telecoms to architecture, and rely heavily on the system to license essential technologies from each other.

One of the biggest challenges they face is in protecting their IP in multiple jurisdictions around the world, which is an important requirement in an evermore globalised world. According to the World Intellectual Property Association, there is no one single patent that covers IP worldwide, and there are at least six different regional patent offices and many more which are country specific, only protecting rights in one specific country or region.

Mario Bitter, head of IP at Siemens, says there has been a huge push for harmonisation throughout the European Union, but a fully international system is still a long way off. The issue is this can leave you exposed to legal and financial risks as you seek to expand internationally.

"If you write a patent application and you get it in Europe, but you don't get it in Japan, then it could have serious repercussions on your business in Japan. It happens quite frequently. You see people struggling to get their patents in the US because the system is so different," he says.

This feeds into wider concerns about cost which are less an issue for big firms than for small and medium-sized enterprises. Patent applications by their nature are complex documents that can run to hundreds of pages long and it can be difficult to know what IP is owned by rivals, particularly when they hold hundreds of patent applications.

James Leach, partner at IP law firm Mewburn Ellis, says: "These documents are very large for a reason. They take expertise to write and expertise to unpick. You generally need a patent attorney to understand a patent. Seeking expert advice from a patent attorney costs money and big firms are often better placed to pay these costs compared with small firms."

So the system tends to favour larger firms with more resources. IBM, for example, spends billions of dollars a year on research and development, and employs more than 300 dedicated patent attorneys, an outlay most small firms could only dream of.

Such firepower not only helps firms protect their inventions, it also enables them to license essential technologies from rivals through a royalty system, which is key in areas such as telecoms.

"It enables those types of companies to build on an existing platform for the benefit of their consumers," says John Brunner, partner at Carpmaels & Ransford. "Most of the technology in today's mobile phones exists because of this cross-licensing, otherwise you would end up with devices with very narrow types of functionality."

Again this leaves smaller firms and startups at a disadvantage because they are less likely to own their own IP and must buy it, often at prohibitive costs. In 2012, Google bought telecoms firm Motorola for $12.5 billion to obtain its patent portfolio, for instance. It kept hold of the patents, but sold the rest of the Motorola assets to Lenovo just two years later for under $3 billion, along with the right to license the patents from Google, calling the deal "a success".

"That's why you don't often see new handset companies. When Apple started making phones, it needed to buy a load of intellectual property, but it could afford it," says Mr Brunner.

Experts say making the system less complex and improving international alignment would bring down the costs and allow a wider range of companies to benefit from protection. However, the system is likely to continue struggling to keep up with the latest innovations in rapidly changing sectors such as software.

There is a common misconception that software cannot be protected by law, when in fact patents are now available in many countries. But cutting-edge inventions in sectors such as blockchain or artificial intelligence remain a grey area; a pattern sure to continue as new discoveries are made.

It has led the biggest names in Silicon Valley, including Google, Amazon and Microsoft, to open up their patent portfolios for others to use and build upon. This will help drive the whole sector forward by improving collaboration, widening the available talent pool and creating economies of scale, or so the argument goes.

Electric carmaker Tesla boss Elon Musk has gone as far as saying he avoids patents wherever possible, describing them as "intellectual property land mines" that inhibit progress. But while the system may be imperfect, others say it needs improvements around the edges rather than radical reform.

> **You see people struggling to get their patents in the US because the system is so different**

"When you look into the history of the system, you realise there have been many changes," says Siemens' Mr Bitter. "Currently, because change is so fast, people don't have trust in it. However, I have seen the pendulum reach near equilibrium and I am certain it will with computer technologies."

Mr Leach at Mewburn Ellis concurs, arguing there simply isn't a better means of protecting innovation available. "It is an imperfect system, and it could be implemented better and in a more cost-effective way. But it does do an important job. If we want a system that protects technological innovation, then we will always need some way of legally defining inventions. It is difficult to see how such a system could work without the involvement of experts and the associated costs that go with that," he concludes.◆

OPINION COLUMN

‘Sustainability engineers are predicting impending disaster unless the global community can be shaken from its deep slumber’

People may be coming round to the idea that the impact of climate change on our tiny blue-green planet is real.

That’s good news, right? Yet for those of us trying to mitigate such impacts, the message is stark.

Sustainability engineers are trapped in a nightmare that echoes that of many engineers through the ages, predicting impending disaster unless the global community can be shaken from its deep slumber.

At this point, people like me worry because you may be thinking... tree-hugger. You switch off and my point is lost. Please. Do read on.

The fact is we simply can’t carry on burying our heads in the sand when it comes to climate change, hoping this will all just blow away or that someone else will come along and avert catastrophe.

We have the technology, ingenuity and tenacity to sort this. But does the political will, leadership and machinery exist to inspire the global action needed and make things happen?

Up until 12 months ago, we sent half the world’s plastic waste to the Far East. No longer prepared to be the world’s dustbin, China’s ban on plastics imports sent shockwaves around the globe. Here in the UK, we watched distressing footage of marine life ensnared by ocean pollution, on the BBC series *Blue Planet II*. People got upset.

Looking back on 2018 some startling predictions emerged.

The publication of the Intergovernmental Panel on Climate Change (IPPC) report, in October, warned us that we have just 12 years to act to keep global warming to a maximum of 1.5C or else face the increased prospect of floods, heatwaves, droughts and other extreme conditions. That is urgent.

This year we have seen whole communities decimated by forest fires in California and Queensland, and by flooding in Kerala, south-west Japan and East Africa.

If the IPPC’s predictions prove to be right, this may well be the shape of things to come. How do we prepare our people and organise resource to even begin to cope with this?

The United Nations tells us the world has barely 30 years of fertile soil remaining such is the level to which we are over-farming the land. This timescale coincides with anticipated increase in global population from today’s 7.5 billion people to 9.8 billion by 2050.

Many engineers across the world are already working on technological solutions, from more efficient fridges to new architectures for a distributed energy grid, from cars that can do over 200mpg (equivalent) to the massive scale of geo-engineering.

These technologies are a key part of the jigsaw of activities that will form a solution. Other parts include government policy and changes to consumer behaviour.

We also firmly believe that engineers have a more direct and more urgent duty to ensure that the systems they work on are as resource efficient as they can be.

Global industry generates more than 30 per cent of climate impacts.

Resource productivity means making more while using less. We need to massively accelerate the take-up of this common sense engineering approach if we’re to stand any chance of managing the climate, providing clean air and reducing pollution.

Resource productivity engages the brain and challenges our norms, but it needs to be convened.

The Nissans and Toyotas of this world have written the book on resource efficiency. They regularly achieve 8 per cent year-on-year resource productivity gains. That’s world class. Achieve even 3 to 4 per cent across all industries and we begin to start taking significant strides towards keeping our planet liveable, advancing the prospect of higher productivity and profits too. So it makes sound financial as well as environmental sense.

These are urgent and substantial challenges that engineering can either ignore or choose to be at the heart of.

Professor Steve Evans
Manufacturing policy panel chair
Institution of Engineering and Technology

Commercial feature

Route to sustainable products is complex but achievable

Humans already use one and a half times the Earth’s capacity. Product-makers play an important part in improving sustainability and should address multiple aspects of operations

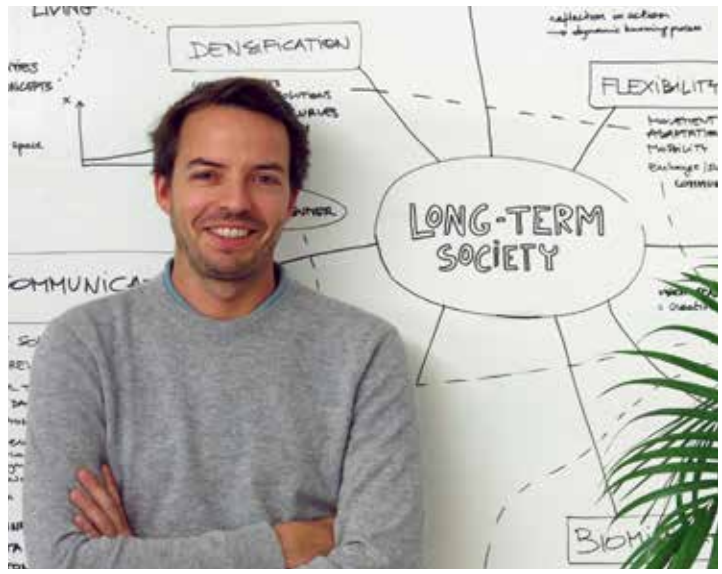
It is now widely accepted that there is an environmental crisis gripping the Earth. Climate change affects people living across continents and is expected to worsen as the global population nears nine billion by 2050.

Product-makers have an urgent responsibility in helping ensure sustainability and they are increasingly doing so, motivated by the environmental challenge, customer preferences and, in some cases, regulation. But they need an all-encompassing approach.

“A lot of people still think of sustainability in waste and recycling terms, but there is a whole picture of what is needed,” says Vincent De Smedt, founder of product design firm Edmire Design. “A full approach to sustainability involves those aspects, but also careful design, choice of materials, selection of manufacturing destinations, environmentally friendly transport, energy-saving usage and human aspects, such as suitable working conditions and pay. It is a complex challenge.”

Recently, Edmire Design evolved its strategy to focus on projects with a sustainable approach. It began by working on its own transformation and it is now pursuing BCorporation.net certification, which demonstrates positive purpose for the planet.

“As designers, we all have a responsibility around natural resources, energy consumption, transport, conditions and all aspects of sustainability,” he explains. Some of the company’s clients are moving towards a more circular model, in which product materials at the end of their life go back into production; an advanced change.



25%
of executives include sustainability in their business model

200%+
outperformance of rivals by companies excelling in design

<6.5%
of produced plastics recycled since 1950

Typically, clients begin their sustainability journey by assessing the impact of every aspect of their products. “Each decision has a significant sustainability impact. For example, producing goods further away from home will entail transport challenges, though producing locally may be more expensive,” says Mr De Smedt.

Faced with this dilemma, some companies put up resistance. He notes: “They might want to produce a low quantity of cheap products, locally, but this is not necessarily achievable. A smarter approach is to look at what can change: can the products be more premium quality and price, or can the business model be changed to offer additional revenue streams?”

The answers to many of these questions are not necessarily as people would expect. “It’s important to see the whole picture; if a product has a long life cycle, then producing it further away from home has a lesser impact. But for something being replaced every few years, then there is a strong opportunity to produce premium goods locally,” Mr De Smedt explains.

Having decided on a sustainability strategy, companies need to work with the right partners. Many of the businesses working with Edmire Design are small to medium-sized enterprises (SMEs) and startups, a group for which achieving affordable sustainability is challenging given lower volumes of production.

“To help businesses succeed with sustainability, we have a very different business model from other design companies,” he says. Startups receive extensive design consulting to launch products, in return for a small stake in their business. For SMEs, too, all risk is removed, through a shared royalty model that allows for payment to the design firm only as the product’s sales grow.

“We’ve created a model that allows businesses, which we share values with, to become more sustainable in this way, without the risk and the high cost normally associated with research and design. Typically, they learn as they grow their sustainability and are able to create excellent, successful goods that no longer have a big detrimental impact,” says Mr De Smedt.

The opportunity for businesses to achieve sustainability is strong, but if the Earth’s product-makers do not urgently address this question, the future looks bleak. For small businesses, the time to act is now and success is very achievable.

To find out about sustainable design for your business please visit www.edmire.design

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