Career guide to

# design engineering

Find out more at:
**aqa.org.uk/tech-levels**

Sheffield Hallam University | Sheffield Institute of Education | Women in science Engineering and Technology

AQA
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## Acknowledgements

Thanks to the employers who were happy for their staff to appear as case studies and who contributed to this guide.

autodesk.co.uk/

baesystems.com/home

CREATEeducation.co.uk

dyson.co.uk/

schneider-electric.com/ww/en/

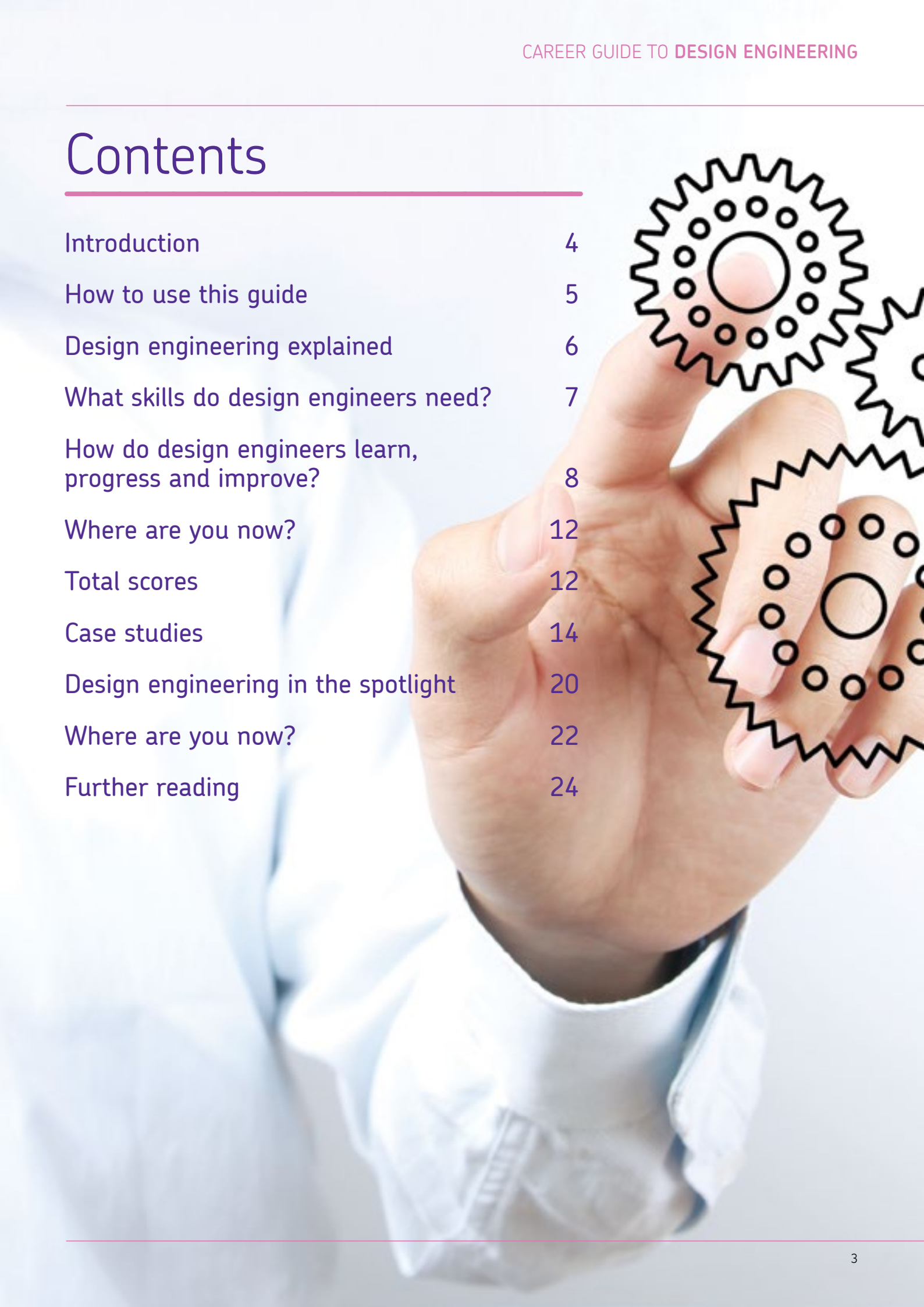
spx.com

ultimaker.com

www.ied.org.uk

# Contents





# Introduction

## Welcome to the wonderful world of design engineering

This guide highlights the career opportunities open to design engineering specialists.

Design is an essential creative element of engineering. It combines imagination and creativity with the knowledge and application of technical and scientific skills.

Learning about design plays an important role in engineering and today's design engineers do everything from conceiving and creating the latest smartphones, to designing offshore drilling components.

**Phillip Bryant**
AQA Sector Strategist for Engineering

## A career as a design engineer is extremely rewarding

The design community is diverse and dynamic and never dull.

Many design engineers travel the world during their career and work with people in diverse industries.

The Institution of Engineering Designers is delighted to support this career guide, and those who choose to enter the world of design engineering. We look forward to welcoming you into our design community.

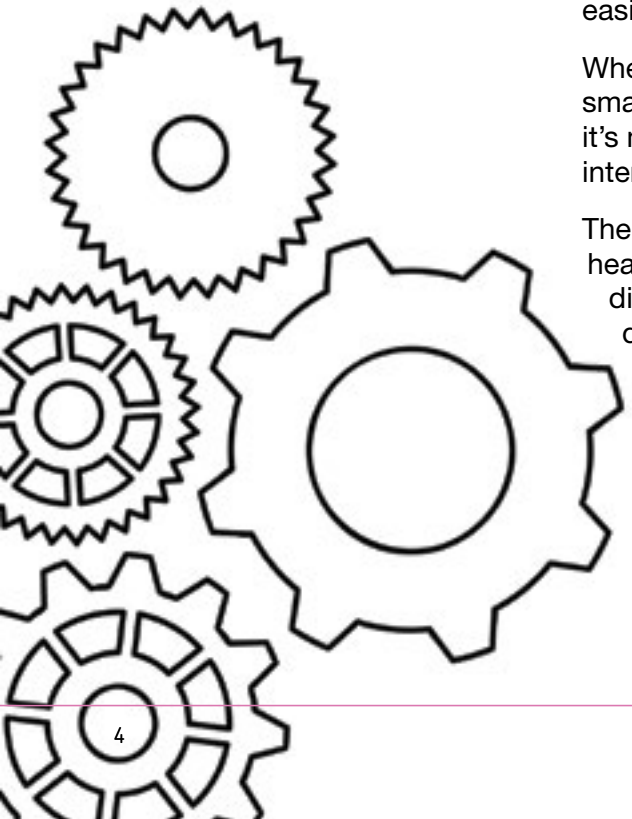
**Libby Meyrick**
Chief Executive
Institution of Engineering Designers

## Design engineering is an incredibly diverse and exciting field

You'll be surprised how much of the world is created by design engineers. They make people's lives easier, safer, cleaner and more exciting.

Whether you're reading this guide via a laptop, leaflet, or a smartphone, all the decisions about its design, the material it's made of, the way it's been manufactured and how you interact with it, will have been made by designers.

The design community work on every aspect of life, from healthcare to consumer goods, to sports and even waste disposal. Design engineers consider what the product has to do and look like, safety, environmental impact and how the item will be disposed of or recycled at the end of its life.



# How to use this guide

## This guide will give you an understanding of the skills, progression routes and potential careers available through our Level 3 Tech-level Design Engineering qualification.

We've showcased the jobs and workplaces that a career in design engineering could take you. We've linked these case studies to the units and transferable skills within our qualification. We've also included questions and exercises to help you think about your career and subject choices, and whether design engineering is right for you.

This guide will:

- dispel the myths about design engineering
- provide information on industry statistics, skills shortages and starting salaries
- highlight different routes into design engineering, including apprenticeships
- highlight the academic, technical and 'employability' skills used in design engineering
- highlight the people and diversity of roles and sectors in design engineering
- direct you to further reading and support
- help you reflect on your own strengths and interests and consider whether design engineering could be for you.

# Design engineering explained

## What does a design engineer do?

In your opinion, which of the following are done by design engineers?

- work in 3D printing
- work on exhausts for fighter aircraft
- work on technology which can control central heating remotely
- talk to people around the world about problems with equipment
- make sure production lines are efficient.

That was a trick question. All of the above are done by design engineers.

Design engineering involves design, creativity and investigation into ways to improve the efficiency of existing products.

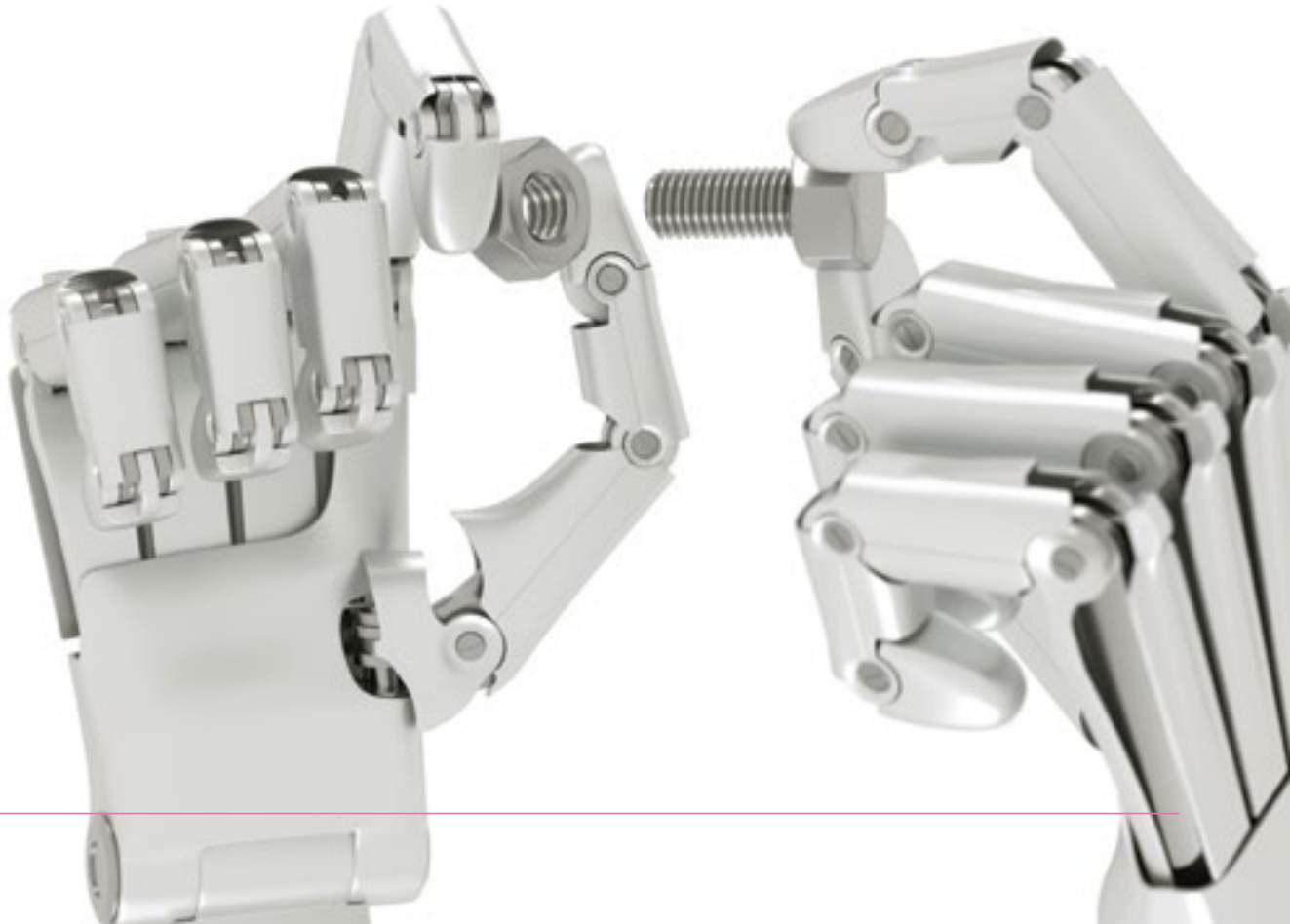
The job requires design and technical skills and often appeals to creative people with a good eye for detail.

It also suits individuals who enjoy art, design, maths, science and design and technology.

## Where do they work?

Industries include:

- construction and building services
- electronics and consumer goods
- transport such as shipbuilding, aerospace, railways and motor vehicles
- power generation
- research and development.



# What skills do design engineers need?

## Communication skills

At the start of a project, design engineers are given a 'brief' of what is required. These allow the engineer to negotiate in order to reach the best outcome for their employer.

## Problem-solving skills

This is integral to the work of a design engineer and goes hand in hand with thinking creatively. Even when a design engineer undertakes a project on their own, there's likely to be an element of teamwork involved – for example, agreeing the best method with the people who will be making and selling the product.

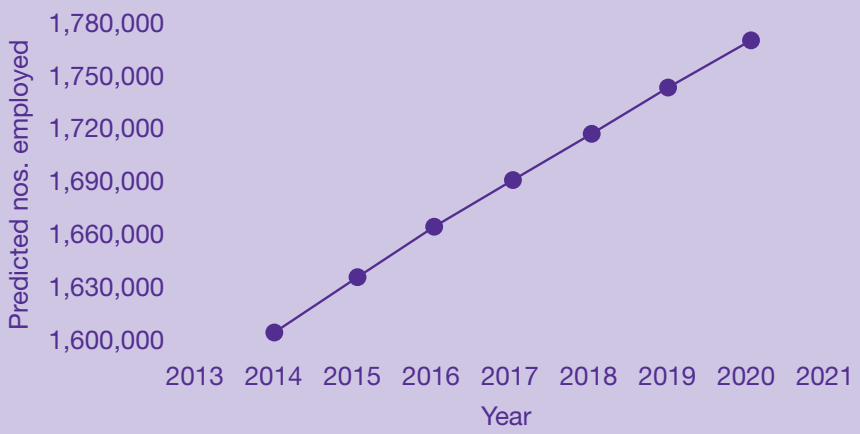
Product engineers develop technical skills and knowledge linked to the area of design they're working in. They must identify the best materials to use, the most effective production methods and anticipated costs.

Technical reports are produced, and the product engineer must explain the information in the report and answer questions if required.

## Research

The ability to research and find out about alternative, up-to-date, options before starting work on a new product saves time and money.

**Employment forecast: Sci & eng profs**




This graph shows the predicted numbers of people that will be working in this sector between now and 2020.

## How much could you earn?

Starting salaries are between £20,000 and £27,000 a year. Experienced engineers can earn between £30,000 and £40,000. Senior design engineers can earn over £50,000 a year (2015 guidelines), and with experience you could progress to project manager, strategic planner or consultant design engineer.

The 'Where are you now?' section explains specific skills required for design engineering.

### Want to know more about being a design engineer?

Visit:

nationalcareersservice.direct.gov.uk

brightknowledge.org

Employment forecast: science and engineering professional jobs

National Careers Service website, 2015

# How do design engineers learn, progress and improve?

Design engineers are highly skilled, versatile and creative. They develop their skills at work and training courses. They learn to use computer-aided design (CAD) and other techniques to produce accurate plans and create new and updated products.

After GCSEs (particularly science and maths), you can progress to design engineering by studying a vocational course (such as a Tech-level in Engineering) and/or A-levels. Next, you might progress to an HNC/HND or Foundation Degree in engineering product design, industrial design or computer-aided design engineering.

The Engineering UK route map shows ways to progress in to engineering roles after GCSEs.

## Where do I start?

### Level 1

**School/college/workplace**

- **GCSE D–G**
- **Traineeships**: For 16–23 year olds qualified below Level 3

### Level 2

**School/college/on-the-job training**

- **Apprenticeship (Intermediate)**: Engineering, IT, Construction, Built Environment, Manufacturing
- **GCSE/IGCSE A*–C**: Maths, Science (ideally triple science)
  (Useful subjects: D&T, ICT, Computing, Engineering)

### Level 3

**Sixth form/college/on-the-job training**

- **Advanced Apprenticeship**: Engineering, IT, Construction, Built Environment, Manufacturing
- **A-level**: Maths, Physics
  (Useful subjects: Chemistry, Computing, D&T, Further Maths)
- **IB Diploma**: Higher Level Maths, Physics
  (Chemistry – for chemical and biomedical engineering)
- **Tech-level qualifications:** Design Engineering, Mechatronics or Power Network Engineering

## What next?

### Training and education

**Advanced/Higher Apprenticeship**

- available in a variety of industries including: advanced manufacturing, aerospace, automotive, power, IT, construction, sustainable technologies
- combine workplace training with study
- typically 3 to 4 years
- can include vocational qualifications or a degree
- approved by the Engineering Council

**Higher National Certificate (HNC)/Diploma (HND)**

- vocational higher education qualifications, often taken whilst in employment
- can be taken at FE colleges and universities
- typically 1 to 2 years

**Foundation Degree (FD)**

- usually undertaken as a part-time qualification whilst in employment
- typically 2 years
- Further learning to Batchelor's level required for Eng registration.

**University degrees**

- in general engineering, a specific field of engineering, computer science, manufacturing or technology
- accredited by the Engineering Council.

**Bachelor's Degree (BEng)**

- 3 to 4 years
- can include a year working in industry/a year abroad
- can be followed by a 1 year MSc to register as a Chartered Engineer.

**Master's Degree (MEng)**

- 4 to 5 years
- can include a year working in industry/a year abroad

## Progressing to

### Professional registration

- Engineering Technician (EngTech) or ICT Technician (ICT Tech)
- Incorporated Engineer (IEng)
- Chartered Engineer (CEng)

Image courtesy of the Women in SET team at Sheffield Hallam University, ‘Celebrating National Women in Engineering Day’

# What's your approach to problem-solving?

Some people like to contribute to team discussions and come up with solutions together, while others prefer to think about a problem on their own before seeing what other people have to offer and then adjust their thinking.

## What's your usual approach?

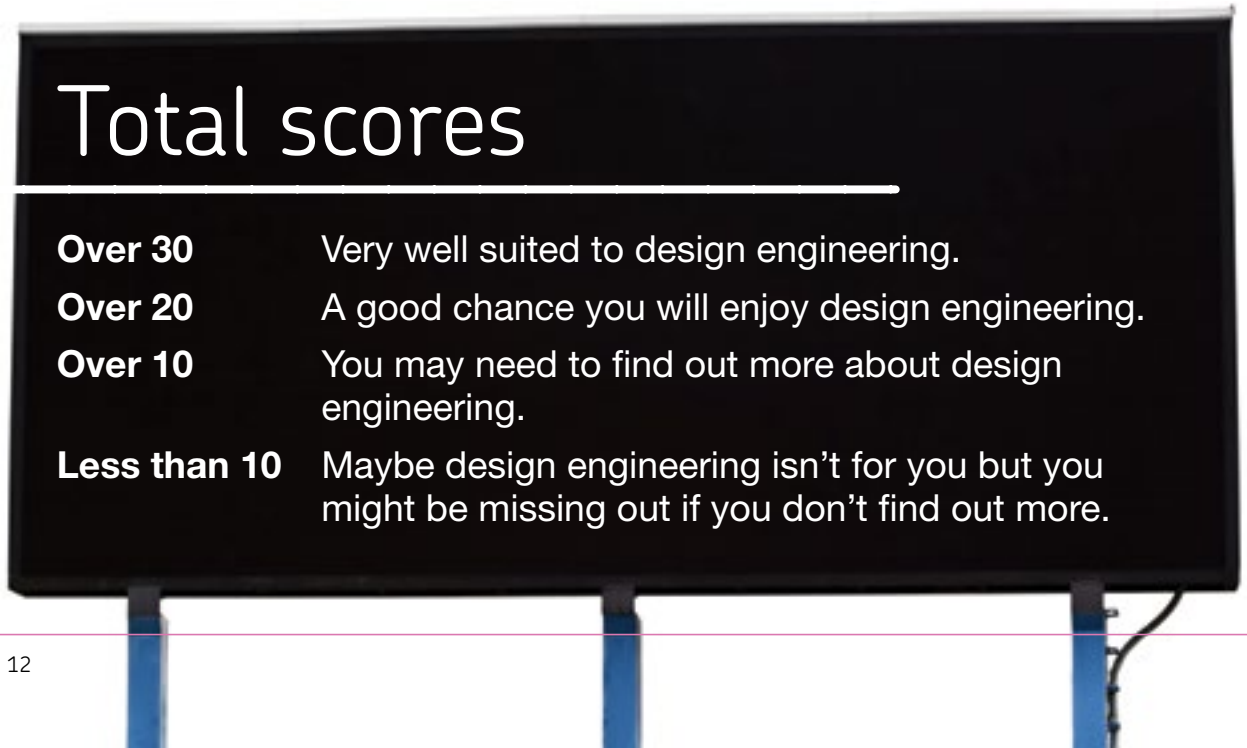
# Where are you now?

## Are your skills and interests suited to a career in design engineering?

### Successful design engineers possess the skills and capabilities shown opposite, how many do you have?

Think about examples of your own work and add a score from 1 to 5 for each area.

| Design engineers need | You have (examples) | Score |
|---|---|---|
| **Communications** | Prepared and delivered presentations in english lessons. | |
| **Research and innovation** | Collected and analysed data and presented the results in science. | |
| **Problem-solving** | Identified and solved problems in maths. | |
| **Teamwork** | Planned group assignments and team activities. | |
| **Design visualisation** | Used your ability to work accurately and imaginatively. | |
| **Advanced design for manufacturing** | Adapted or invented things to make life simpler at home or school. | |
| **Design engineer project management** | Been involved in (and enjoyed) enterprise activities or heard about them from visiting speakers. | |
| | **Total score** | |



## Total scores

| | |
|---|---|
| **Over 30** | Very well suited to design engineering. |
| **Over 20** | A good chance you will enjoy design engineering. |
| **Over 10** | You may need to find out more about design engineering. |
| **Less than 10** | Maybe design engineering isn't for you but you might be missing out if you don't find out more. |

| Design engineering skills | Examples of how design engineers use these skills |
|---|---|
| **Communications** | Prepare a good presentation.<br>Use language, vocabulary, tone and style suited to the complexity of the topic and the context.<br>Use varied methods to engage the audience.<br>Select appropriate formats for presenting information as a report.<br>Select and use an appropriate style and tone to suit your audience.<br>Organise material coherently, to suit the length, complexity and purpose of your technical report, proofread and re-draft documents. |
| **Research and innovation** | Design a research study.<br>Conduct data collection and analysis.<br>Present findings of the research and evaluate the research activities. |
| **Problem-solving** | Identify a problem and the tools and techniques that could be used to explore the problem.<br>Implement the plan to investigate and solve the problem.<br>Check if the problem has been resolved and review the approach to tackling problems. |
| **Team work** | Plan the work with others.<br>Develop and maintain cooperative ways of working towards agreed objectives checking progress.<br>Review working with others and agree ways of improving collaborative work in the future. |
| **Design visualisation** | Carry out design engineering concept development.<br>Plan for the use of 3D parametric CAD systems in design engineering.<br>Produce 3D parametric models.<br>Apply rendering and animation to design engineering using CAD. |
| **Advanced design for manufacturing** | Carry out design optimisation.<br>Use advanced manufacturing technology to improve product manufacture and concept development.<br>Produce product designs for manufacture and assembly.<br>Produce technical reports to communicate design information. |
| **Design engineer project management** | Apply project management and design methodology to engineering problems.<br>Generate ideas related to designing new or appropriate solutions, systems, components or processes.<br>Apply appropriate science and engineering tools to the analysis of unfamiliar problems.<br>Coordinate a creative and innovative design solution with the effective use of appropriate design and project management methodologies.<br>Understand the links between technical design and commercial risks.<br>Design a component, system or process using appropriate design techniques and describe key elements of those processes.<br>Use of appropriate computer based design and project management tools to solve problems. |

# Case studies

## Sioned Owen

### Senior Design Engineer, Schneider Electric


Sioned works as a senior design engineer for Schneider Electric in Plymouth. Her interest in engineering began when she was eight. She would spend time with her father in his workshop and had her own toolkit.

She was always interested in design, and studied art, maths and physics at A-level. At 15, she gained work experience at Camel Laird Shipyard, she familiarised herself with AutoCAD.

While at school, Sioned attended a taster course on engineering, which involved a trip to Jaguar Land Rover.

"I remember being fascinated by the production lines, the testing equipment and how everything was so well integrated. I knew then that I wanted to design things that would have a positive impact on people's lives."

Sioned found her perfect university course at the Glasgow School of Art in collaboration with the University of Glasgow's Engineering department.

She spent four years in Glasgow with a placement year in Trondheim, Norway where she specialised in Industrial Design.

Her university years provided plenty of opportunity to design, make, test proof of principle, and realise concepts into useful objects.

After working for design consultancy Design Reality Ltd, Sioned worked in Japan.

"It's vital you think about different end-users. If you understand another country's culture, that influences how you make design considerations for products to be sold worldwide and it helps you keep an open mind."

At Dyson, Sioned started in new product development, then moved to product innovation. She really enjoys coming up with an idea, creating a model and putting it to the test.

"I developed technology for Dyson products. I would take a piece of technology and see how it could be applied to different situations. This can be seen in many of Dyson's products".

Sometimes specialist research teams gather data, analyse the results and consider how to improve the design. Once those ideas are refined, Sioned and her team present them to the design directors – she's presented to James Dyson himself.

"I present ideas to help the company decide which products to market. When I'm putting a presentation together, I stick to key themes and messages. It also helps to ask a colleague to observe the room for me and give feedback on how the audience react to elements of my presentation. It gets easier with practice."

At Schneider Electric, it's helpful that she can sketch, although the designs can be far from perfect at the ideas stage. She thinks design engineers need to think about commercial risks and usability versus design issues. There's no point increasing power for the performance of a product if it becomes too noisy to use.

Alongside technical ability, Sioned feels being a good team member is essential.

"It's really important we keep each other up-to-date with what we're working on – we have to share our work and document everything clearly. Weekly meetings give us a chance to make an impression on colleagues."

Sioned is thinking about her future and joined the design team at Schneider Electric. She is professionally chartered as an engineer and product designer.

She was nominated for the Karen Burt award and awarded the Kathbert Trophy by the IED in 2014.

"When I first thought about becoming chartered, I wasn't sure I needed it, but I understand the value now. It's a third party assessment of skills you develop after university and helps you see you're moving to the next level."

Sioned enjoys her job and says the workforce is made of people of all ages. Everyone is encouraged to put forward their ideas.

"Our weekly meetings and research environments offer an opportunity for cross-collaboration and 'accidental discovery' which lead to more innovative products. I'm excited about working on the next generation of smart products for Schneider Electric".

### Sioned's journey so far:

Schneider Electric

schneider-electric.com/ww/en/

mi-genie.co.uk/

dyson.co.uk/

jamesdysonfoundation.co.uk/

gsa.ac.uk/study/undergraduate-degrees/product-design-engineering/

www.ied.org.uk

## What do research and innovation mean to you?

Think about a time you've felt proud of research you've done. Reflect on what aspects were positive and consider why.

Think about when you came up with ideas and thought creatively, and consider what may have contributed to this.

Image courtesy of Create Education

# Mike Westlake

## UK and Ireland Manager, Autodesk

Mike Westlake is UK and Ireland Manager for Autodesk, a multinational corporation that makes software for the architecture, engineering, construction, manufacturing, media and entertainment industries. He is responsible for Autodesk's education programmes in the UK and Ireland.

I took A-levels but struggled to adapt to the self-learning model at college. I wasn't taught the relevance of learning for the real world. I started looking for alternative learning. My mum mentioned an apprenticeship at the local nuclear power station.

I applied and embarked on a role as a multi-skilled engineering apprentice. At college I grew to understand the value of learning and how it can change your life. A teacher sparked my interest in computer aided design. I loved the freedom of design paired with the accuracy and exact application of maths and science, and started taking evening classes to develop my skills further.

Then I entered into the WorldSkills competition. I was successful at the regional level and attended the WorldSkills national final. I wasn't confident, but I won the national final and became the best young design engineer in the country.

"My career has been so rewarding that I've gone full circle and am now in education. I try to encourage others to choose design engineering as a career path. With the current skills shortage in the UK, now is the perfect time to get into it."

The following year I represented the UK at the WorldSkills international competition in Japan. I was pitted against the top design engineers in the world. It was an amazing experience that shaped my career. I felt confident in my ability and took a job as a design engineer that allowed me to travel the world designing equipment for international food and pharmaceutical companies.

Mike says he uses problem-solving skills in all aspects of his work and has tackled unusual problems during his career. He created a four metre high frame to support equipment for a food manufacturer. It had to be earthquake resistant because it was going to Chile.

autodesk.co.uk/

# Pav Bhogal

## Apprentice, BAE Systems

Pav has always been interested in aerodynamics and design. After completing his A-levels Pav joined BAE Systems as an apprentice. His first year was spent at a local training centre where he gained a BTEC Diploma in Aeronautical Engineering. Following this, Pav worked at BAE Systems in manufacturing.

His apprenticeship involved different placements including one in 'concept demonstration'. He worked with up and coming designs and future technology. Apprentices in BAE Systems select their placements, depending on their interests. As Pav says, "I moved up to Preston because I love aircraft – the first time a I got to work on a Typhoon Eurofighter was pretty cool."

Apprentices are often 16 or 17 when they join the company and from a very young age they are trusted with expensive equipment. Pav feels that he matured very quickly, and is supported with his professional and personal development.

"At the end of every placement we presented our experiences and learnings to our managers. We had an open invitation to talk about our future."

At 18, BAE Systems selected Pav to the WorldSkills 'Vocational Olympics' project which involved a series of challenges using Autodesk Inventor at a major event with 10,000 people.

"WorldSkills involved a brief, with drawings and instructions – normally related to an engine. We had to reproduce this in CAD and assemble it on screen and animate it within a tight time frame."

Having had a great experience with WorldSkills, Pav wanted to compete again with younger people in the company. He got other entrants together and persuaded company directors to build a new apprentice team whom Pav and his colleagues then mentored.

"Being involved with WorldSkills has been a massive confidence booster with my soft skills."

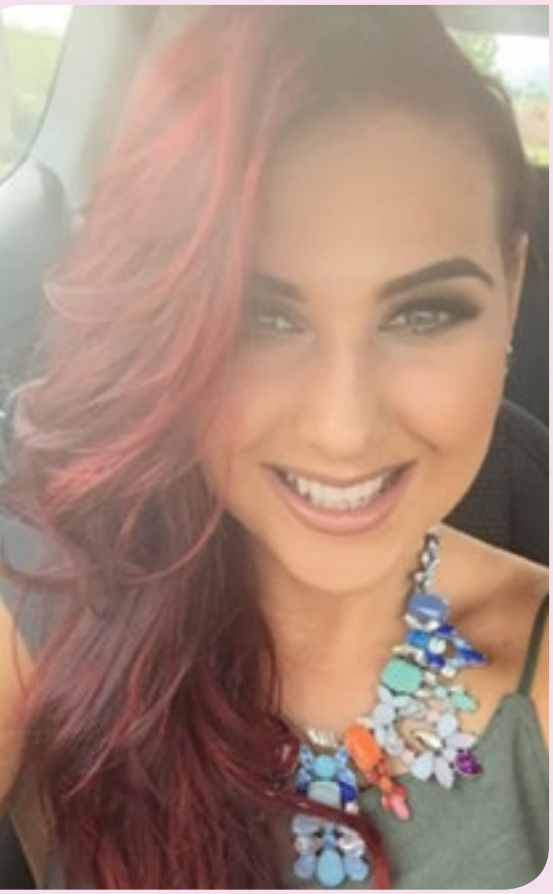
Teamwork and communication skills are absolutely vital in Pav's job.

"I'm working on unmanned air vehicle air intakes and exhausts. Using computers, the work is around figuring out the maths which will lead to best performance. We produce technical reports including requirements for the vehicles which goes to the designer."

Having already gained an HND in Aeronautical Engineering during his apprenticeship, BAE Systems is now sponsoring Pav to study towards a BEng in Mechanical Engineering. He's on track to enjoy a life-long rewarding career.

baesystems.com/home

worldskills.org/



# Kellie McGrevey

## Aftermarket Engineer, SPX Flow Technology

Kellie was one of two girls studying engineering in her group of 123 at college. Having enjoyed maths and physics at school, Kellie's teacher encouraged her to apply for an engineering apprenticeship and after school, she joined injection mouldings company, Rosti.

Her first year was at East Kilbride Training Association, she continued her education at New College Lanarkshire.

As a little girl, Kellie was always interested in how things worked and loved the idea of becoming a mechanic, but her experience as an apprentice was the first time she wore a set of overalls. At Rosti, she worked in milling, turning and tools maintenance, before moving to a design role.

"I loved the tool room, but taking design from a concept to an actual tool was amazing."

Kellie has an HNC in Mechanical Engineering, a second HNC in CAD and Design, a Lean Engineering qualification, and is about to enrol at night school on a BEng Degree in Engineering Management.

She works at SPX Flow Technology as an aftermarket engineer and has developed a new area of expertise relating to pumps, parts and repairs. Kellie's role brings her into contact with customers from across the globe, in sectors as diverse as oil and gas, to food. She enjoys the variety and this new role is building her communications skills and networks.

Dealing with customers across the world can pose difficulties with language barriers and cultural differences, Kellie is learning how clear, accurate communication develops a shared understanding. Kellie hopes to travel to build new markets for the company's products.

Kellie works in a small team and enjoys the working environment. Her role involves collecting data and identifying problems identified by customers which can be referred to other colleagues.

"We are a very close-knit team and support each other with our different projects. We understand what each other is doing and know when we need to help each other out."

> "I am regularly in touch with colleagues in our Middle East office and am building strong working relationships."

In her early 20s, Kellie has responsibility for making her own decisions at work, and this has developed her confidence.

Kellie is looking forward to starting her undergraduate studies at the University of the West of Scotland and plans to become a Chartered Mechanical Engineer in the future.

spx.com

## What kind of team player are you?

- Do you prefer working on your own?
- Are you happy taking responsibility whilst helping others?
- What role might you play in supporting your team?
- What are your strengths and weaknesses regarding working in a team?

## What is your communication style?

Think about a time you had to communicate complex information in a presentation and/or written form.

- What tools and techniques did you use?
- What worked well?
- What could you have done differently?
- How did you know your intended audience understood the information you were trying to communicate?
- What are your strengths and weaknesses regarding working in a team?

Read the case studies again and see how they emphasise the importance of clear communication and excellent interpersonal skills.

# Design engineering in the spotlight

## Design visualisation

### Paul Croft, Ultimaker (GB)

Director of Ultimaker (GB) and founder of the exciting CREATE Education Project, Paul's engineering career began in Chorley, Lancashire.

Paul and school friend Alex spent many hours 'putting the world to rights' and knew they wanted to use their entrepreneurial skills in a fast-paced environment.

After studying A-level Physics, French, Business and General Studies, Paul headed to Hull University where he gained a 2:1 Honours Degree in International Management.

As the 'odd-one-out' in a family of teachers, Paul decided setting up a business was the only way to go. Chance led Alex and Paul to discover a robot figurine created by an Ultimaker Desktop 3D printer. The friends realised this exciting innovation would engage young people and inspire creativity and innovation.

They approached Ultimaker HQ in the Netherlands and secured exclusive distribution rights for the 3D printer in the UK and Ireland.

"We wanted to give people access to this technology and stimulate their creative tendencies."

Paul realised if their venture was to work, they needed to develop the right approach.

"We didn't want to throw technology at schools and let them find their own way. There are too many unused laptops and iPads in our classrooms, so we asked teachers about the challenges they'd faced in the past and what would work for them. We discovered they wanted affordability, reliability, the confidence to use technology to maximise its potential and link it to curriculum content, and an understanding about where 3D printing could be used in job opportunities. Teachers also needed to know how to get support in an emergency."

Paul and Alex developed and launched CREATE Education Project in February 2014. It's already 'gone global'. It helps schools use 3D printing technology to stimulate creativity and excitement across the curriculum, particularly in science, technology, engineering and maths.

To provide support, they developed CREATE Education regional hubs which share best practice.

Paul emphasises the need for a broad range of transferable skills and an aptitude for 'design thinking' in this sector.

"There's a great deal of teamwork in this field. People in this sector use problem-solving, analytical skills and 'design thinking' to break things down, examine individual components, look for solutions and test different hypotheses."

Paul is very clear about the opportunities for young people with design and engineering skills.

"3D printing or 'additive manufacturing' is such an exciting world to work in, with new developments happening all the time.

Technology allows you to scan an object, then export its digital coordinates for printing in 3D. At the 2014 Royal Institution Christmas Lecture the audience witnessed how a scan of a young girl's face could be replicated by a 3D printer live – exciting stuff.

It's great to be involved in an industry that's continually learning and growing. The UK's leading the charge on aspects of 3D printing and there will be good jobs in this field."

Ultimaker GB has recruited three students with engineering BTEC qualifications from a local college. As more companies embrace 3D printing and new technology, people with design thinking and engineering skills will find themselves with lots of opportunitie.

ultimaker.com

CREATEeducation.co.uk

youmagine.com

# Where are you now?

## Taking stock

### Now that you know more about design engineering, think about your skills, experience and aptitudes again.

#### Still interested?

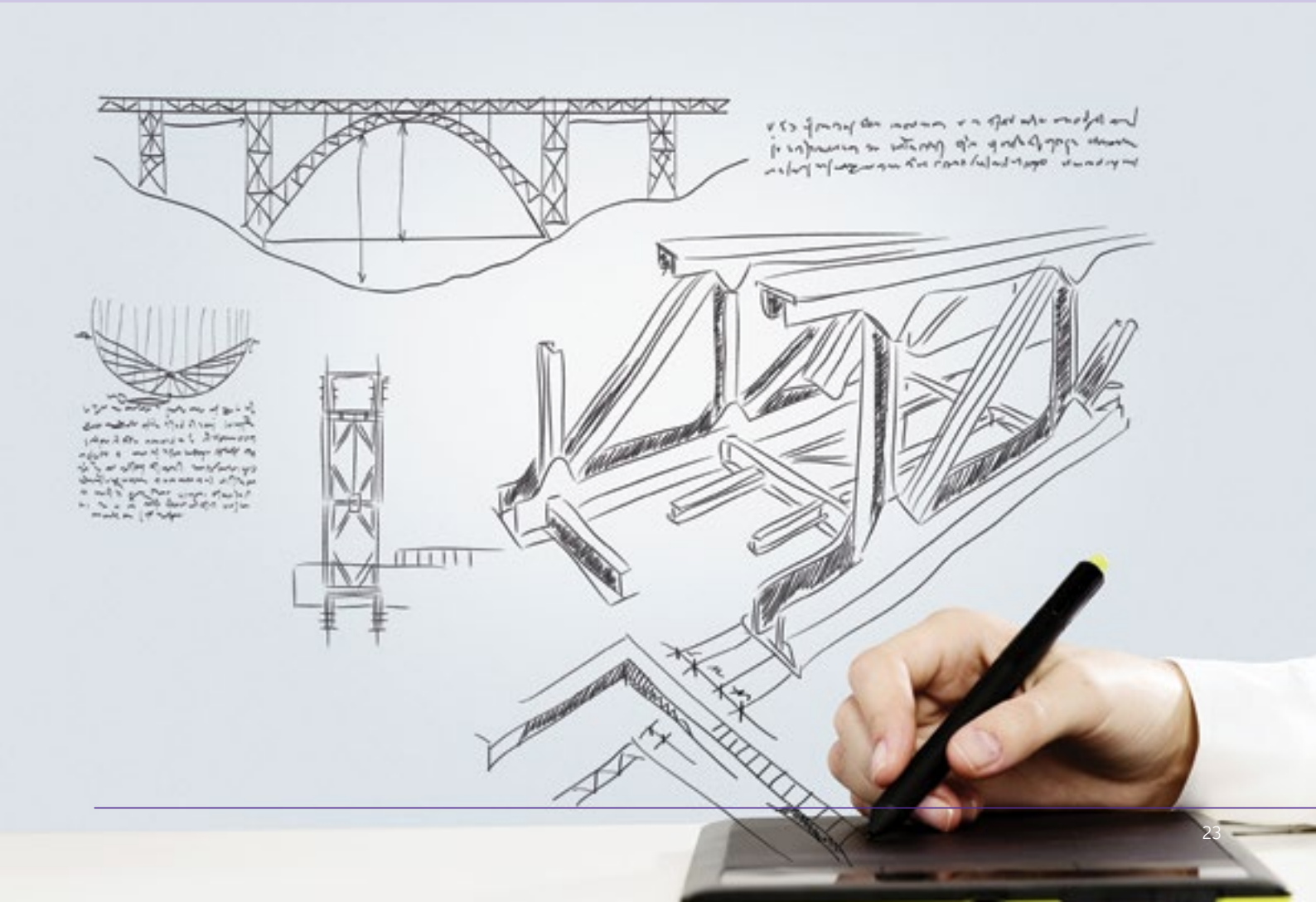
Use the table on page 12 as a reminder of how you rated yourself before reading the case studies. Use the space below if you'd like to add any new information eg "I didn't realise design engineers did...."

In the space, summarise anything you'd like to know more about:

# Could design engineering be for you?

Having thought about your skills, knowledge and experience, in the space below, list what you're going to do (eg find out more about design engineering; research different routes to suit your learning style; talk to someone about possible options for study and work; arrange work experience; show this guide to a teacher/tutor/career's adviser/parent or family member/friend).

I'm going to:



# Further reading

| | |
|---|---|
| AQA | aqa.org.uk/ |
| Institution of Engineering Designers | www.ied.org.uk |
| The Institution of Engineering and Technology | theiet.org |
| Royal Academy of Engineering | raeng.org.uk/ |
| Engineering Council | engc.org.uk/ |
| Tomorrow's Engineers | tomorrowsengineers.org.uk |
| SEMTA – Engineering Skills for the Future | semta.org.uk |
| WISE Campaign | wisecampaign.org.uk |
| Women in Science, Engineering and Technology | wiset.org.uk |
| Women's Engineering Society | wes.org.uk/ |
| Future Morph | futuremorph.org/ |
| I'm an engineer, get me out of here | imanengineer.org.uk/ |
| Maths Careers | mathscareers.org.uk/ |
| National Apprenticeships Service | apprenticeships.gov.uk/ |
| National Careers Service | nationalcareersservice.direct.gov.uk/advice/planning/jobprofiles/Pages/DesignEngineer.aspx |
| Just Engineers | justengineers.net/ |
| The Engineer | theengineer.co.uk/ |
| The IET | theiet.org/index.cfm?origin=foot-vert |
| Research Councils UK (case studies) | rcuk.ac.uk/skills/percase/ |
| Research Councils UK (case study booklets) | rcuk.ac.uk/skills/percase/booklets/ |
| iCould | icould.com/ |
| CareersBox | careersbox.co.uk/ |

## Are you thinking about becoming a design engineer?

To discover our engineering qualifications visit:

aqa.org.uk/engineeringtech-levels

aqa.org.uk

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