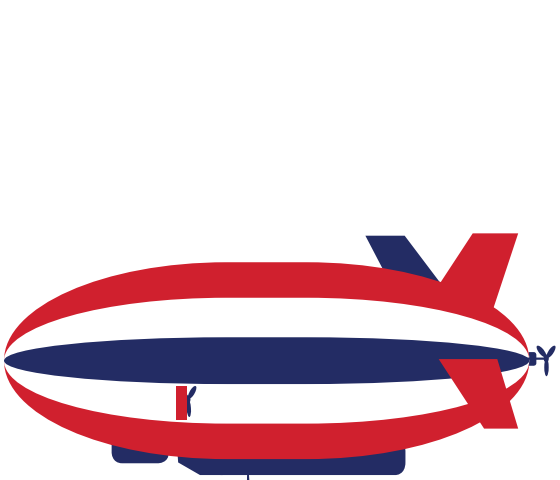
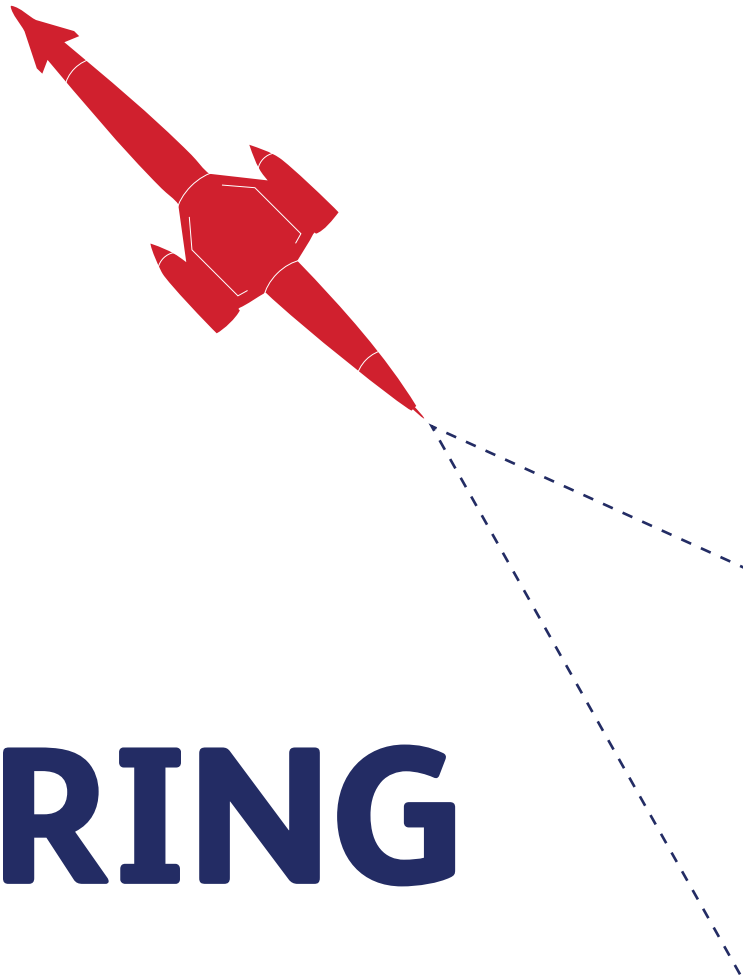
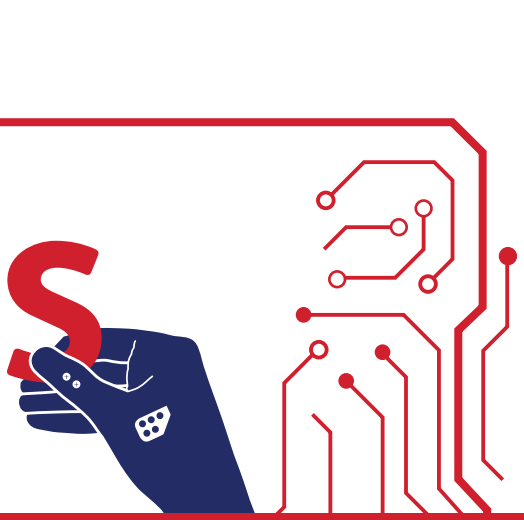
eef The manufacturers' organisation

MAKE IT BRITAIN
EEF - CAMPAIGNING FOR A STRONGER MANUFACTURING BASE



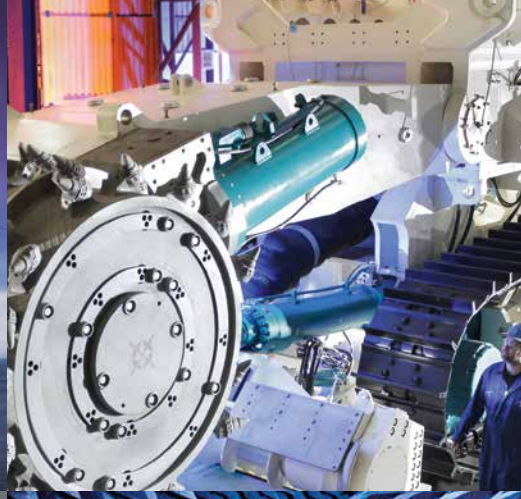


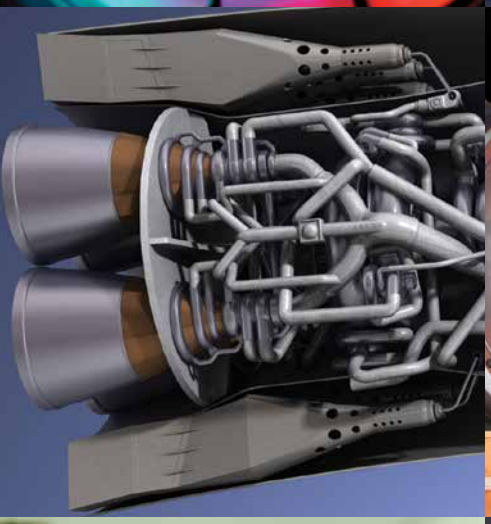
PIONEERING GREAT BRITISH PRODUCTS

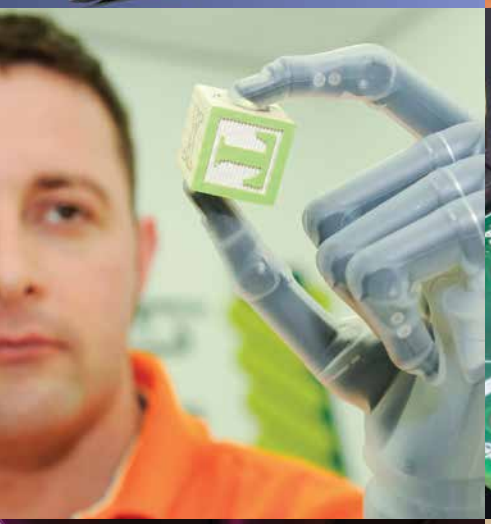


In partnership with SIEMENS Liverpool Life Sciences UTC


AIRLANDER








SAMSUNG
Raspberry Pi
(c)2011.12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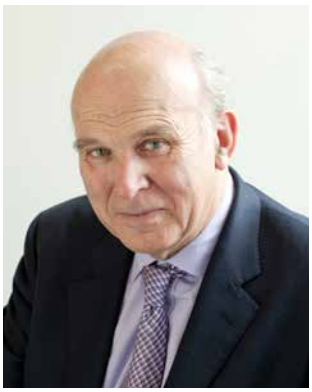
Vince Cable MP, Secretary of State for Business, Innovation and Skills



This report celebrates the huge range of Great British Products and the innovative and pioneering techniques used to make them. Britain has a long industrial history and our manufacturing industry is experiencing a revival which is key to economic restructuring and growth.

In order to continue this revival we must inspire the next generation of young people to consider careers in the manufacturing industries.

The government recently launched the Your Life campaign. This campaign talks directly to 14 to 16 year olds as potential key decisions makers, redefining how young people understand careers in science and engineering.

The campaign also acts as a call to action for businesses, educators and government to increase the number of women in the science and engineering fields.

Last year the See Inside Manufacturing programme facilitated student visits to manufacturing companies throughout the UK. 6,300 students and their teachers were given the opportunity to see a modern manufacturing facility. The programme will run again this year and will give more young people the chance to gain an insight in what it is like to work in today's manufacturing sectors.

I would like to thank EEF for the hard work they have put into this report. My hope is that this will encourage industry and education to work together so we can inspire the next generation to choose a career in British manufacturing.

Vince Cable MP
Secretary of State for Business, Innovation and Skills

Foreword

Terry Scuoler, CEO of EEF, the manufacturers' organisation

This report is the first in a series we are producing, showcasing what Britain does best.

It sets out just how important it is for Britain's young people to have the right skills and mind-set to carry on the great tradition we have in this country of inventing and manufacturing pioneering products.

We are world-class innovators, problem-solvers and solution-makers. We have a proud track record of giving the world life-changing products and designs. We are a nation of inventors.

However, this report isn't just a celebration of past glory. It is forward-looking too – identifying new products that could be future game-changers. It demonstrates that our heritage is still alive and reinforces my belief that inventiveness and resourcefulness are in our collective DNA.

At the same time, it also raises some challenges. It clearly identifies that Britain's role in creating some of the most-widely used and every-day inventions, such as the telephone, the TV and the jet engine, is not fully recognised by its own people. There is a worrying lack of awareness of what British inventiveness has contributed, and continues to contribute, to the world.

Little over half of consumers know the jet engine is a British invention. Only a quarter know that British brains are behind the ATM or cashpoint. And while seven in ten are aware that Britain invented the steam engine, just two in ten know we are also behind modern-day carbon fibre.

Should we be worried? Surely the fact that people simply absorb British inventions into daily life is a sign of good technology and design? Are our inventors and inventions simply victims of their own success?

There is an element of truth in all this. However, the underlying issue here is that we appear to be failing to champion and celebrate our successes, or indeed to fully capitalise commercially on them. Too often we are letting our successes fly under the radar, going unnoticed and unremarked. And in doing this we are denying our future generations of the heroes and heroines who could encourage them to learn the science, technology, engineering and maths skills required to invent, design and innovate.

This lack of recognition means that only half of consumers think that Britain is good at both inventing and manufacturing. If this is the message that children hear at home, at school or in the media, then it's little wonder so few are choosing a career in industry.

Our ability to innovate in the future hinges on the talents of our young people. Aspiration comes not only from inspiration, but also from the patience and perseverance required to see inventions brought successfully to market. I firmly believe that this stems from giving due recognition and profile to our great inventors. If Make it Britain is to carry on at a pace, then we have to wake up Britain to the incredible innovation, creativity and design going on within our shores today. More importantly, we have to give our potential inventors of the future every reason and encouragement to be involved.

Terry Scuoler
CEO of EEF, the manufacturers' organisation

Introduction

Welcome to EEF's first 'Pioneering Great British Products' publication which showcases the immense creativity and diversity in British manufacturing today. As part of our 'Make it Britain' campaign, this independent report by the Information and Research Team was launched at the International Festival for Business (IFB) at Liverpool UTC on 23rd June 2014, the start of Manufacturing, Science and Technology Week. Siemens and EEF worked in partnership at the IFB.

Part 1 of the report focuses on the inventiveness of Britain's manufacturing sector and some of its incredible achievements throughout history, including our ability to significantly improve existing concepts and our high end value add. Using consumer research[1], we identify our need to recognise and celebrate our unique heritage and list the top 10 British inventions.

To further inspire the next generation of engineers, part 2 features 5 high-profile and truly revolutionary products from Hybrid Air Vehicles, Raspberry Pi Foundation, Reaction Engines, Soil Machine Dynamics and Touch Bionics. All of these amazing products have the potential to make it into a future top 10 best British inventions. This is, of course, just a sample of what British manufacturing has to offer.

Part 3 of the report features apprentices and young people who are currently employed in engineering and manufacturing careers. They tell us how they are finding the sector a rewarding and interesting place to work. You will also find more information on how to enter the sector and progress your own career within manufacturing.

Britain has the skills and pedigree in manufacturing and will continue to innovate and influence. The outlook for the sector is positive. Across the country, organisations and institutions are working on tomorrow's 'Pioneering Great British Products'; we feature the work done at The University of Manchester on graphene as an example of what the future will bring.

If you want to know more about how to have a challenging and rewarding career, read on…

[1]Consumer research conducted on behalf of EEF by YouGov. Total sample size was 2,284 adults. Fieldwork was undertaken between 28th and 29th April 2014. The survey was carried out online. The figures have been weighted and are representative of all GB adults (aged 18+)

Part 1

BRITAIN'S CREATIVE PAST, PRESENT AND FUTURE

Making things is in our DNA

Britain has always been home to pioneering inventors, engineers and manufacturers and the industrial revolution further reinforced its reputation as a country that makes things. To truly appreciate the ingenuity and diversity of the manufacturing sector in Britain today, we have to take a look at events leading up to the present time.

Finding innovative solutions to problems and improving existing designs is not new. The first steam engine was patented in 1698 by Thomas Savery and was designed to resolve the difficulties that were faced in pumping water from coal mines.

The steam engine continued to develop throughout the 18th century, eventually leading to its use within transportation. Steam power fuelled the industrial revolution.

Although he was not the first person to design a steam locomotive, George Stephenson is often referred to as the 'father of the railways'.[2] He created the Stockton and Darlington railway which opened in 1825. This was the first railway in the world specifically designed to use locomotives. He is also credited for building the inter-city railway between Liverpool and Manchester. It was on this line that the 'Rocket' locomotive proved the potential of this form of travel.

Radical changes throughout the industrial revolution enabled the textiles industry to flourish. The use of machines meant the beginning of mass production, factories and industrialisation.

Although scientists began to understand and utilise electrical energy as far back as the

EEF Photography Award Winner[3]

18th century, communication technology changed forever when Scottish-born Alexander Graham Bell made the first ever telephone call in 1876. However, it was another British pioneer - Charles Parson - who ensured that electricity became cheap and easily accessible, with his invention of the steam turbine in 1884. Next time you turn on your television, just remember that the first one was created nearly a century ago by British inventor John Logie Baird.

The invention of the jet engine in the 1930s revolutionised air travel throughout the world. Coventry-born Frank Whittle recognised that the future of flight meant that aircraft would need to fly at higher altitudes and faster speeds than propeller-powered planes. His ground-breaking jet engine design made it possible to build bigger planes, which in turn increased passenger capacity on commercial flights, making it a more accessible form of transport. When you fly off on your next holiday, just think without visionaries like Whittle this would not be possible.

You can see a common theme running throughout history: innovativeness is often the result of a need to find a solution to a problem. A more recent example of this is when James Dyson produced the world's first bag-less vacuum cleaner in 1983. He became frustrated with traditional vacuum cleaners which used disposable bags to collect dust. As the bag filled the machine lost suction. Dyson transformed the manufacture of vacuum cleaners and turned this innovation into a successful business. His company has not only developed vacuum cleaners but is also continuing to use its engineering expertise on a range of products, such as the Airblade hand dryer and the bladeless fan.

Being innovative is not always about harnessing the latest technological developments. Take, for example, the wind-up radio, invented in 1991 by Trevor Baylis. After watching a TV documentary about the spread of the AIDS virus throughout Africa, he recognised that those affected needed to be educated about the condition. The wind-up radio uses a manual action to generate power, negating the need for electricity or batteries. This was exactly what Africa needed to fight back against the spread of the disease.

CONSUMERS THINK THE BEST BRITISH INVENTIONS ARE THE TELEPHONE, THE TV AND THE JET ENGINE[1]

[2]Network Rail, 'George Stephenson (1781-1848): Civil and mechanical engineer', http://www.networkrail.co.uk/VirtualArchive/george-stephenson/ (accessed May 2014)
[3]'Tidal Turbine Base', taken by Mike Brookes Roper, winner of the Professional Photographer category in the EEF Photography Competition 2011 in partnership with Lombard

Manufacturers today continue to progress

Manufacturing in Britain is advanced and highly creative. To ensure its survival in this country and in the global economy the industry has become flexible and leaner, focusing on the delivery of quality products. EEF's recent 'Backing Britain' report revealed that almost half of manufacturers feel that product quality is one of the main areas where they have a competitive advantage.[4]

Current awareness of our planet's fragility presents the need to reduce environmental impact and drives new innovation. British entrepreneur Steve Lindsey has done this by inventing a device that replaces piston technology with a rotary compressor. The invention minimises wastage during the compression process and therefore improves engine efficiency.[5]

A prototype of the Blade Compressor has been in use at Severn Trent Water since 2012. Analysis has shown it is able to deliver the same output as the old system while utilising 21% less electricity on average.[7] This technology could be used in the future for virtually anything that requires an engine. It would improve efficiency, reduce costs and ultimately decrease carbon emissions.[7]

The threat of terrorism continues to be a major challenge and requires us to constantly be one step ahead and find creative solutions. EEF award winner Rapiscan Systems has done just that and has designed and built a scanner capable of X-raying rail cargo that is moving at up to 60km per hour. This enables the fast monitoring of huge amounts of transported goods. Images recorded are used to identify illegal and potentially dangerous items such as explosives, weapons and drugs.[8]

Manufacturers seek continuous improvement of their product designs. What better illustration of this than Rolls-Royce's amazing work to improve the strength of the turbine blades in their jet engines?[9] To deal with the incredible temperatures and stress they have to endure, each of the 66 blades needed for the Rolls-Royce Trent 1000 engine is grown from a single crystal of alloy.[10]

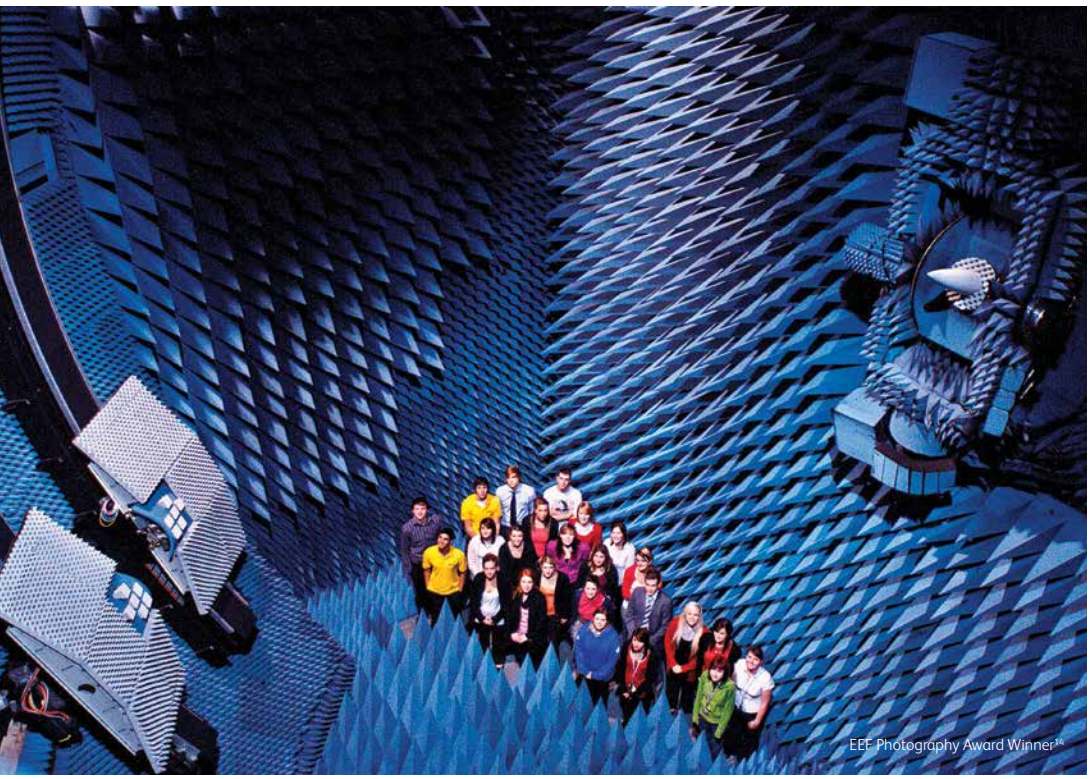
Globalisation has inevitably led to foreign ownership in Britain, but our ability to make and invent means that British manufacturing remains strong and British-made goods are sought after across the world. Look no further than car manufacturing which is thriving. Did you know 'every 20 seconds, a car, van, bus or truck rolls off a British production line',[11] making us the fourth largest automotive producer in Europe? Britain is known for many car brands including Aston Martin, Bentley, Jaguar Land Rover, Lotus, McLaren, MG, Mini, Morgan and Rolls-Royce. Home to eight Formula 1 teams we are also an attractive location as we can provide high end engineering skills to this market.

DESPITE OUR STRONG TRACK RECORD, ONLY 51% OF US AGREE BRITAIN IS GOOD AT INVENTING AND MANUFACTURING[1]

EEF Photography Award Winner[6]

An example of investment in car manufacturing is Indian-owned automotive giant Jaguar Land Rover's recent announcement concerning the creation of a further 1,700 jobs at its site in Solihull, Birmingham as well as an investment of £1.5 billion in 'technically-advanced aluminium vehicle architecture'.[12]
Jaguar Land Rover is also making great strides in innovation. It recently showcased its 'Transparent Bonnet', where cameras under the grille send video to a display in the windscreen, allowing the driver to see clearly the terrain under the vehicle.[13]

ONLY 1/4 OF CONSUMERS ARE AWARE BRITAIN GAVE THE WORLD ATM/CASHPOINTS – EVEN FEWER (23%) KNOW WE INVENTED THE AUTOMATIC KETTLE TOO[1]



EEF Photography Award Winner[14]

[4] EEF, 'Backing Britain, A manufacturing base for the future', 2014
[5] The Telegraph, 'Designer hailed as next Dyson for compressor blade discovery', http://www.telegraph.co.uk/finance/newsbysector/industry/10582833/Designer-hailed-as-next-Dyson-for-compressor-blade-discovery.html, (accessed May 2014)
[6] 'Precision', taken by Mike Smith, winner of the Professional Photographer category in the EEF Photography Awards 2012 in partnership with Canon, Lombard, The ERA Foundation
[7] Lontra, 'Lontra Blade Compressor Set to Slash Energy Costs for Severn Trent Water', http://lontra.co.uk/wp-content/uploads/2014/03/Lontra-Severn-Trent-Water-Case-Study1.pdf, (accessed May 2014)
[8] Rapiscan Systems, 'Rapiscan Rail Scanner Fast Track', http://www.rapiscansystems.com/en/products/cvi/rapiscan_eagle_r60, (accessed May 2014)
[9] Rolls-Royce, 'The extraordinary Rolls-Royce Technology behind your flight', http://www.rolls-royce.com/news/featured_stories/technology_flight.jsp, (accessed May 2014)
[10] Rolls-Royce, 'How does a jet engine work?', http://www.rolls-royce.com/Images/journey_poster_eng_tcm92-51769.pdf, (accessed May 2014)
[11] Engineering UK, 'Engineering UK 2014, The state of engineering'
[12] Jaguar Land Rover, 'Jaguar Land Rover reaffirms commitment to the UK', 2013
[13] Jaguar Land Rover, 'Jaguar Land Rover previews pioneering automotive research technologies', 2014
[14] 'Today's Engineering, Tomorrow's Future', taken by Melissa Garratt, winner of the Young Photographer category in the EEF Photography Competition 2010 in partnership with Canon, Lombard, The ERA Foundation

The automotive sector is another area where environmental considerations are crucial and manufacturers are finding innovative ways to reduce fuel consumption and carbon emissions. We are increasingly seeing the production of hybrid vehicles - for example, luxury car maker Bentley plans to have 90% of its production available as hybrid by the end of the decade.[15]

Many organisations are attracted to setting up in Britain because of our skills base. There is no doubt that the quality of our universities helps drive our country's ability to innovate and invent new products. Thirteen of the UK's universities are ranked in the top 100 in the world for Engineering and Technology, 3 of which (University of Cambridge, University of Oxford and Imperial College London) are in the top 10, having a particular strength in the quality of their teaching.[16]

Picture courtesy of Bentley Motors

Britain's got talent; we just don't recognise it

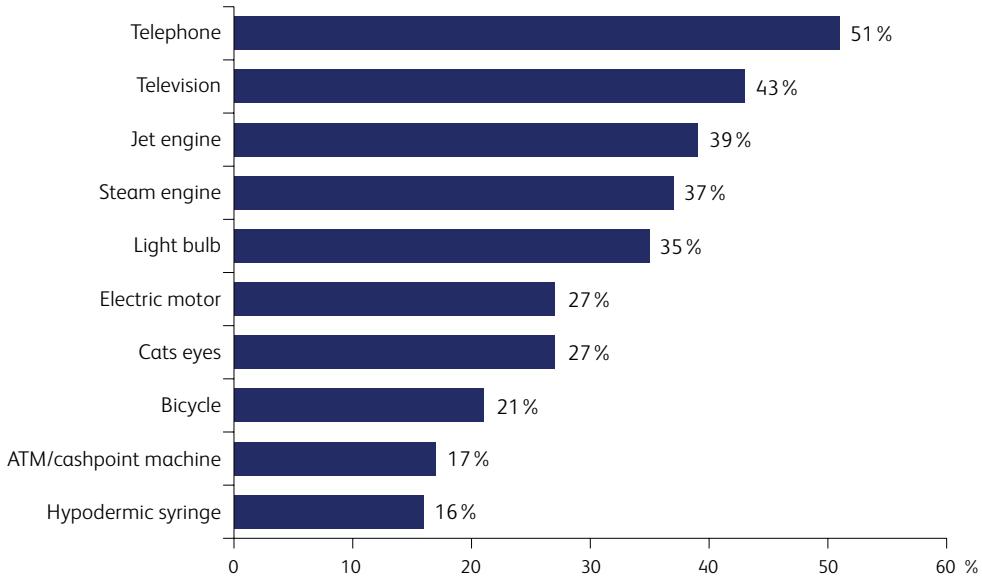
As a nation we need to celebrate Britain's irrefutable pedigree in inventing and making things. According to consumers,[1] Britain's best inventions are the telephone, the TV and the jet engine. However, even though items such as the telephone are a common part of our everyday lives, nearly two-fifths of us (39%) are unaware that it was invented by a British person. Additionally, only just over half (54%) recognise that the jet engine, an invention that transformed air travel, has British roots.

The television fares slightly better, with 57% aware that it is a British idea, but 4 in 10 of us are still ignorant that we created this technology. Chart 1 details the British products that feature in the top ten best inventions, based on our recent survey.

Interestingly, it appears that we are much more able to identify Britain's creativity and inventiveness if we go back in time, 69% of consumers are able to pinpoint the heritage of the steam engine, whereas only just over a fifth (22%) think carbon fibre[17] is a British invention.

In fact, only 51% feel that Britain is good at inventing and manufacturing, further suggesting that we are not all aware of the heritage surrounding our British-made goods. Furthermore, familiarity and use of products also seems to have no bearing on whether we recognise their origins. Only a quarter of consumers know that the ATM/cashpoint is a British invention and slightly fewer still - 23% - think the automatic electric kettle has a British pedigree.

CHART 1 TOP TEN 'BEST' BRITISH INVENTIONS



Source: EEF survey, conducted by YouGov, April 2014

The main reason why we would identify something as a 'great invention' seems to be its ability to impact our lives. Two-thirds say they think something is great if it improves quality of life, with 59 % suggesting it needs to radically change everyday life and 57 % believing it must make life easier or solve a problem.

It is testament to the brilliance of our inventions that many ideas that were once pioneering are now considered every-day. However, it may also make us victims of our own success. We get used to new products and ideas very quickly, with just over half (51 %) of consumers taking a new gadget for granted within only 1 month and by 6 months, the novelty has worn off for most people (69 %). If we continue to remain humble and reserved and hide our talents instead of flaunting them, we will suffer, as the brightest talent will be attracted to study alternative subjects and join other sectors.

It is essential that we do more to raise the profile of Britain's inventive past, its present and its potential, as without change we could limit our future innovative prospects. The next generation needs to see high profile role models in manufacturing and aspire to become the next great inventors. They should want to join a sector that is championed for its ability to drive progress and make a real difference to lives. We need youngsters to want to study the STEM subjects so they can ensure they get a job in manufacturing and engineering and make a difference for the next generation.

A LITTLE MORE THAN HALF OF US TAKE A NEW GADGET FOR GRANTED WITHIN ONLY 1 MONTH

[15] Bentley Motors, 'Bentley's electric future debuts in Beijing', 2014
[16] Times Higher Education, World University Rankings, top 100 universities for Engineering and Technology 2013-14
[17] Carbon fibre composite was created by the Royal Aircraft Establishment in Farnborough in 1963

Celebrating today's pioneering great British products

If you are still in doubt about Britain's manufacturing creativity, take a look at part 2 of our report. We feature a hybrid air vehicle which is set to re-introduce commercial airship travel. We also examine a new form of engine that could increase our ability to travel into space and introduce air travel at hypersonic speed.

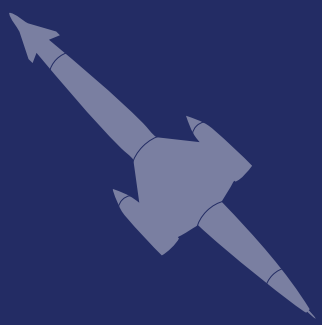
From space to deep under the world's oceans, we look at a development in subsea mining that will enable access to rare metals and minerals on the seabed.

We also take a look at a mini computer that addresses the programming skills gap. Another of our pioneering companies has created a life-changing development in upper-limb prosthetics, with its mobile-app-controlled bionic hand. Finally, the future for manufacturing is even brighter, as we preview the potential for wonder-material graphene.

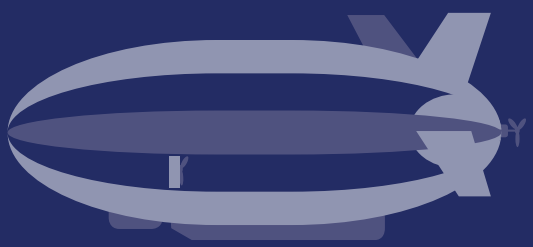
These pioneering innovations will become tomorrow's every day products.

Part 2

A LOOK AT THE PIONEERING PRODUCTS OF TODAY



Read on to find out more…



THE WORLD'S LARGEST AIRCRAFT AND MOST SOPHISTICATED AIRSHIP

The **AIRLANDER**
by Hybrid Air Vehicles

Not so common to see in our skies today, but believe it or not airships are making a comeback.

What an amazing sight will greet passengers and spectators when Hybrid Air Vehicles launches the first passenger flight in its AIRLANDER airship in 2016. Heavy metal band Iron Maiden's lead singer Bruce Dickinson, who is also a professional airline pilot and an investor in the AIRLANDER programme, will be joined by other celebrities for this maiden voyage.

Britain is able boast the launch of the world's biggest airship, because of the inspiration and technical genius of the original designer of the hybrid air vehicle Roger Munk.

Picture courtesy of Hybrid Air Vehicles

The **AIRLANDER** by Hybrid Air Vehicles

History

Described as 'self-propelled lighter than air aircraft',[18] airships have been around for centuries and have a fascinating history. The first engine-powered flight in a steam-powered airship was developed by the French engineer Henri Giffard in 1852.

Britain was later to develop the R33 and R34 rigid airships, which flew from 1919. The R34 was the first airship to make an Atlantic crossing. Following on from the early British models and developed as part of a government programme, the R101 was housed in Cardington, Bedfordshire and made its first flight on 14th October 1929.

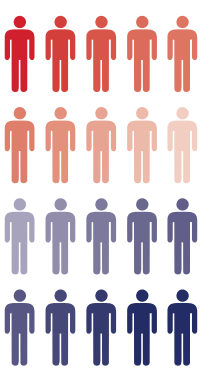
Tragedy struck just 1 year later in October 1930 when the R101, on a flight from Bedfordshire to India, crashed to the ground in France, killing nearly everyone on board. Safety concerns, at that time, following this incident heralded a decline in the use of commercial airships in the UK. Although there has been occasional use of non-rigid airships since, the industry has not taken off until now...

A new and exciting era of airship travel has begun

The technology has improved dramatically in recent years and British company Hybrid Air Vehicles is at the forefront of airship development.

The AIRLANDER 10 was designed and manufactured by Hybrid Air Vehicles as part of a US military contract to develop a vehicle that could provide intelligence, surveillance and reconnaissance for ground troops in Afghanistan. At 300ft in length it is almost 60ft longer than a Boeing 747. The airship was first flown in the US during 2012, although the programme was cancelled in 2013 following defence cuts. Hybrid Air Vehicles subsequently purchased the aircraft from the US Army and brought it back to the UK to use as a prototype. The intention now is to develop the AIRLANDER as a commercial airship.

The 800ft long and 150ft high hangars that originally housed the R101 provided the only space in Britain large enough to resurrect the development of commercial airships. What a great way of paying homage to the original pioneers of airship travel!



IF YOU LINED UP ALL OF ONE DIRECTION HEAD TO TOE 10 TIMES OVER THEY STILL WOULDN'T EQUAL THE LENGTH OF AIRLANDER 10

[18] Dictionary.com, 'airship', http://dictionary.reference.com/browse/airship?s=t , (accessed May 2014)


Picture courtesy of Hybrid Air Vehicles

How does the AIRLANDER fly?

AIRLANDER aircraft are known as hybrid air vehicles as they use a combination of buoyancy and aerodynamic design to generate lift. Unlike most of the original airships, they are inflated with non-flammable helium gas.

This combination allows the AIRLANDER to take off and fly with a heavier load than conventional airships, which rely solely on buoyancy for lift.

In addition, AIRLANDER aircraft have four turbine engines to provide thrust. The thrust is vectored which means the aircraft are able to hover as well as undertake vertical take-off and landing - something traditional airships are incapable of. This enables AIRLANDER to land 'lighter' than conventional airships - as the engines can power the craft to the ground, removing the need for a ground crew to pull the aircraft down.

AIRLANDER 10 IS CAPABLE OF 5 DAYS CONTINUOUS FLIGHT AT AN ALTITUDE OF UP TO 16,000FT

TIMELINE

EARLY 2000s
First Hybrid Air Vehicle, SkyKitten (45ft remote control)

2010
US Army contract signed

2012
AIRLANDER 10 flown in US

2013
AIRLANDER 10 returned to UK

2014/15
First UK flight for AIRLANDER 10

2015
UK demonstrations

2015/16
Proposed tour of US and Canada

2016
Manufacture of AIRLANDER 50 begins

2018
First flight AIRLANDER 50

The **AIRLANDER** by Hybrid Air Vehicles

What makes the AIRLANDER so special?

- Although it looks like a conventional airship, it really is quite different, combining elements of airship, aeroplane, hovercraft and helicopter design
- AIRLANDER aircraft are designed to cruise on just 1 of their 4 engines, which offers a huge safety benefit
- In the event all 4 engines stop working they can glide to the ground
- If the AIRLANDER were to be punctured mid-flight, even with multiple holes, testing indicates it would take a number of hours for the helium (which is under very low pressure) to leak out, giving plenty of time to land
- There is no internal skeleton within the AIRLANDER; stiffness is provided by the hull itself
- Helium provides 60% of lift; the other 40% comes from the specially designed aerodynamic body
- The AIRLANDER 10 is flown by a pilot, although it was originally designed to be controlled remotely or operated autonomously
- 80% of the AIRLANDER 10 is made by British companies

What will AIRLANDER vehicles be used for in the future?

There will ultimately be two commercially produced AIRLANDER variants following on from the AIRLANDER 10 prototype - one for communications roles and one for heavy lift operations.

The heavy lift model - the AIRLANDER 50 - will be able to transport people, cargo or a combination of the two and will have a maximum load of 50 tonnes - 5 times more than a Chinook helicopter.

It will also have significantly lower running costs than conventional cargo planes, consuming a quarter of the fuel and only requiring one day of maintenance per month.

The AIRLANDER 50 will have a range of 2,600 nautical miles, which is equivalent to travelling from London to Halifax in Canada. Owing to a special 'Air Cushion Landing System', it will be able to land on practically any flat surface on the planet including: water, ice, snow and sand; giving it the ability to operate in remote areas. A potential application could include the delivery of supplies to disaster zones or regions with little or no infrastructure.

The communications model could be used for crowd monitoring, border control, surveying and communications. Importantly, this model offers the opportunity to undertake manned surveillance of up to 5 days at 16,000ft.

The company plans to produce 10 of the AIRLANDER vehicles per year for the next 5-10 years. This would lead to the creation of 1,800 jobs in the UK, centred around Bedfordshire.

IT WOULD TAKE HENRY HOOVER 10 AND A HALF DAYS TO SUCK OUT THE CONTENTS OF AN AIRLANDER 10's ENVELOPE

Who makes this possible?

Roles involved in the development and manufacture of the AIRLANDER are highly skilled and technical. They offer those employed fulfilling and interesting jobs, in a ground breaking area of manufacturing:

David Stewart – Head of Flight Sciences

Master of Aeronautical Engineering, University of Glasgow,
Post Graduate Certificate in Management, University of Bath

David has worked at Hybrid Air Vehicles for 3 and half years and is responsible for the aerodynamic shaping of the AIRLANDER vehicles. In addition, he produces performance models and has responsibility for ground and flight testing.

David is tasked with improving the lift and drag characteristics for the vehicle, which is important as the vehicle relies on both aerodynamic design and buoyancy (helium) for lift. To do this David uses Computational Fluid Dynamics (CFD) and wind tunnels to gain knowledge of the air flow around the vehicle. Ideas are also tested on the mini hybrid air vehicle, which is flown to understand how the bigger vehicle will behave.

David also produces performance models which look at variables such as fuel flow, engine power, wind speed, the friction of the vehicle when it is moving across the ground, and atmospheric conditions such as temperature and altitude. He uses these variables to predict how long the vehicle can fly with a full tank of fuel or how much it can carry.

He loves his job because:
"You can't beat walking into a huge hangar and seeing a huge aircraft in front of you. While airships have been around for over a century, the hybrid air vehicle concept is still relatively new and we're learning things every day. We design and build the entire aircraft so you get to know everything about the aircraft. People who work in aerospace, and in particular aerodynamics, have usually loved planes since they were kids so it does make us ridiculously happy to play with bigger versions of our childhood toys."

Picture courtesy of Hybrid Air Vehicles

The **AIRLANDER** by Hybrid Air Vehicles

Paul Macey – Principal Engineer

PhD Aircraft Fire Safety
MEng Aeronautical Engineering
MSc Aerospace Vehicle Design

Paul is responsible for the size, shape and layout of any new aircraft designs. It is his job to focus on developing novel features such as the air-cushion landing systems and thrust vectoring controls.

Rosie Ward – Project Coordinator

Higher National Diploma Aerospace Engineering
Higher National Certificate Engineering

Rosie has worked in both the UK and the USA on the AIRLANDER 10 build, with the Production, Engineering and Procurement departments. The two years from contract award to first flight resulted in a challenging, but fun, working environment.

Tom Grundy – Operations Director

MEng Aerospace Engineering
MSc Advanced Systems Engineering
Chartered Engineer & Royal Aeronautical Society member

Tom oversees manufacturing, ground operations, flight operations and support to the company's vehicles. In addition, he leads the company's military marketing activities.

Nick Allman – Programme Director

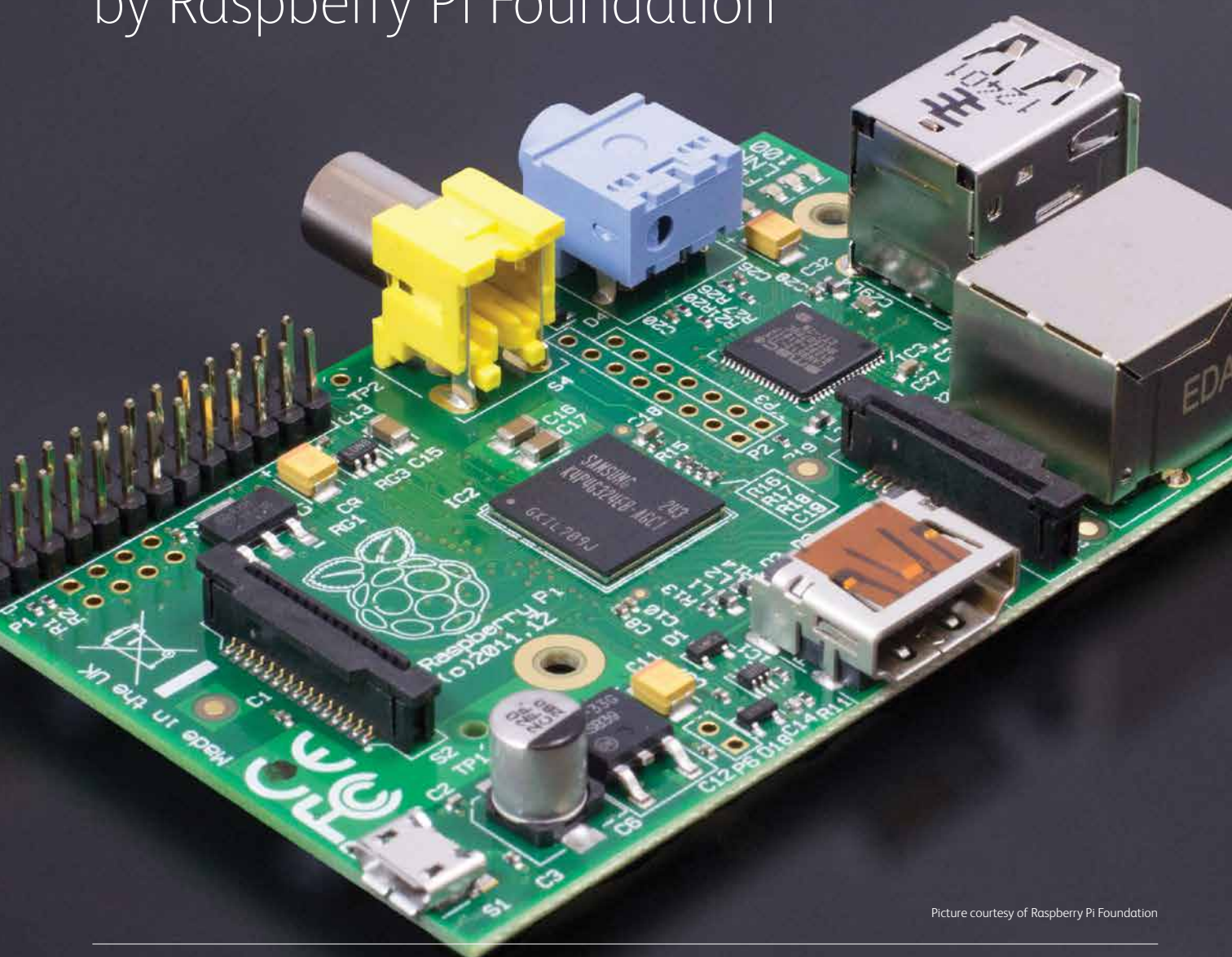
BSc Aeronautical Engineering

Nick was fundamental in Hybrid Air Vehicles winning the contract to produce the Airlander 10. He then led the programme management during design, testing and beyond its successful maiden voyage. His wide range of project engineering experience was essential to him becoming a Programme Director.

Picture courtesy of Hybrid Air Vehicles

PI-ONEERING COMPUTING

Raspberry Pi
by Raspberry Pi Foundation



Picture courtesy of Raspberry Pi Foundation

Raspberry Pi by Raspberry Pi Foundation

Do you want to improve your French, learn to read Braille and perfect your skiing? What you need is a Raspberry Pi.

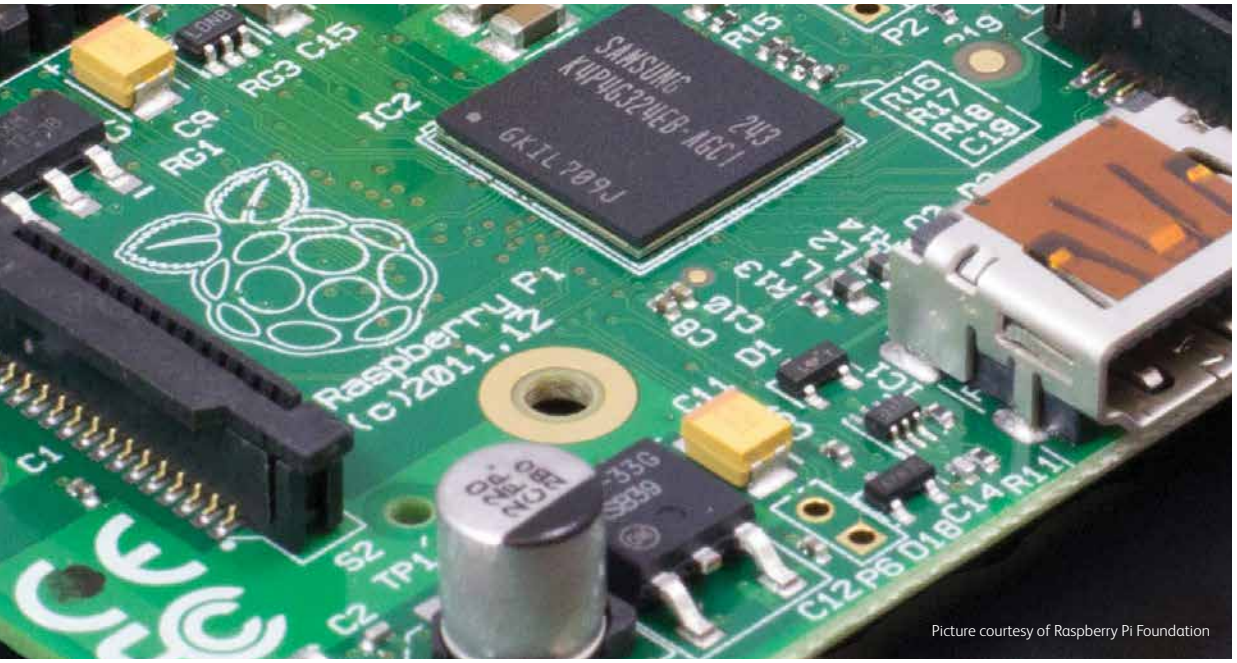
The Raspberry Pi is a tiny computer, no bigger than a credit card, which plugs into your keyboard and monitor/TV. As well as having the ability to do word processing, create spread sheets and surf the internet, the Raspberry Pi is designed to encourage the creativity of the user. Its primary purpose is to enable computer programming. It can be used for a multitude of applications, from incredibly simple beginner projects to the more advanced tasks for experienced programmers.

What can Raspberry Pi do?

The applications for Raspberry Pi are only limited by your imagination:

Babbage the bear beats record breaking skydive

Babbage, a teddy bear from Berkshire, was carried vertically 39km into the air via a hydrogen-filled weather balloon, in order to beat the 2012 record-breaking skydive held by Felix Baumgartner. Upon reaching the optimum altitude, the bear was automatically tipped from its cradle by the Raspberry Pi and started its descent with the computer feeding live video, flight data and its location back to Earth.



Picture courtesy of Raspberry Pi Foundation

Raspberry Pi by Raspberry Pi Foundation


Picture courtesy of Raspberry Pi Foundation

Sixth Form students reach dizzy heights

Using a Raspberry Pi, 3 sixth-form students from Cumbria, with a passion for physics, were able to conduct a successful weather-balloon project that recorded gamma rays, UV flux, temperature and pressure.

The balloon reached a height of 31km and recorded temperatures as low as -34°C.

Creative minds find innovative ways to learn Braille

With a creative mind, the Raspberry Pi can be used in the most innovative ways to overcome existing problems. As proof, 2 students have created 'Mudra' – a tool to help blind people learn Braille. The device allows the user to feel the Braille symbols while listening to the audio output.

This is an accessible, inexpensive and faster way to learn Braille. The 2 students had little programming experience before the project and were inspired while taking part in a Raspberry Pi workshop in college.

Pi 'n' Mighty robot makes it easy to recycle

For the last 2 years the 'PA Raspberry Pi competition' has challenged young students to create clever solutions to real-world problems, using a Raspberry Pi. One of the 2014 winners in the Year 4 – 6 category was a recycling robot known as Pi 'n' Mighty. The robot is capable of scanning packaging barcodes to tell you whether it is recyclable and if it is, which bin it should go into.

TIMELINE

2006
The first Raspberry Pi prototypes designed

2008
Mobile technology advances, making it possible to include more multimedia applications

2009
Raspberry Pi Foundation formed

2012
Raspberry Pi Model B enters mass production

2012
Production reshored from China to plant in South Wales

2014
More than 2 million units sold

Raspberry Pi by Raspberry Pi Foundation

Picture courtesy of EEF

Smart glasses that see in another language

If you have trouble learning another language this is the one for you. Another user built his own automatic translation system, using: a couple of Raspberry Pi's, 'smart' glasses, a microphone, a headset and a smartphone. The result was an instant translator which allowed the wearer to listen to another person talking in a foreign language and read the translation as subtitles from the glasses display.

Improve your skiing with a Pi

Users have programmed the Raspberry Pi to capture video footage for a variety of applications, from bird watching to home security. One sporty Pi programmer used the computer to capture video footage of him skiing, using GPS to show the route, his speed and his altitude.

A MULTITUDE OF APPLICATIONS ON A DEVICE NO BIGGER THAN A CREDIT CARD

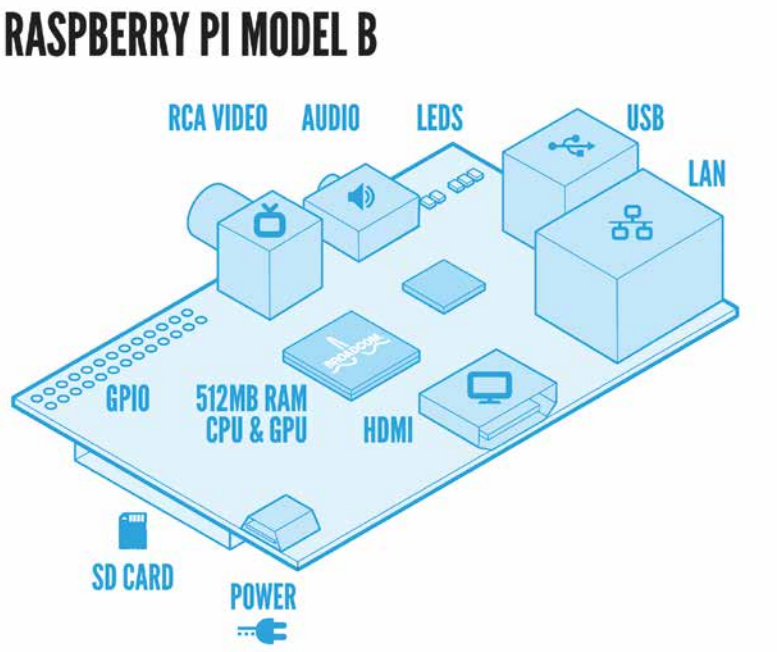
Is Raspberry Pi easy to use?

There are a number of programming languages installed on the Raspberry Pi, with simple languages such as Scratch, which is useful for younger children and Python, which is the language recommended for beginners by the Raspberry Pi Foundation.

Users can make simple projects and there are step-by-step guides on the website. Example projects include:

A user is taught how to create the Python code to make a scream to emit from a speaker when a jelly baby is pressed.

Using the Scratch programming language, a piece of paper, a toilet roll and a few electrical components, it is possible to make a robot that beeps and flashes its antennae.



Who invented Raspberry Pi?

The idea was formed by 4 colleagues from the University of Cambridge who witnessed first-hand the dwindling number of applicants to the Computer Science Programme. They also observed that modern-day students have limited programming experience.

Due to current technology, children now interact with computers differently. What was needed was a cheap computer platform that made programming more accessible and attractive. Raspberry Pi was created to be a low-cost solution when compared to today's PCs, laptops, tablets and other electronic computerised gadgets.

The Raspberry Pi Foundation continues to grow and develop. In 2012, manufacturing was moved from China back to Britain. The South Wales manufacturing plant has won awards for best factory and best electronics factory.

Raspberry Pi by Raspberry Pi Foundation

Who makes this possible?

Taking an idea or a problem and turning it into a viable solution, is the basis of engineering. The Raspberry Pi Foundation has cleverly turned a solution into a manufacturing business as well. The profile below highlights one of Pi's creative minds.

Eben Upton – Chief Executive Officer

PhD Computer Science, University of Cambridge
Executive MBA, University of Cambridge

Eben is the Chief Executive Officer and one of the founders of the Raspberry Pi. As the CEO Eben is responsible for driving forward the manufacturing strategy and for Operations Management within the company.

While Director of Studies at St John's College, Eben created the idea for Raspberry Pi, along with colleagues from the University of Cambridge's Computer Science Laboratory. He also played a fundamental role in designing the Raspberry Pi.

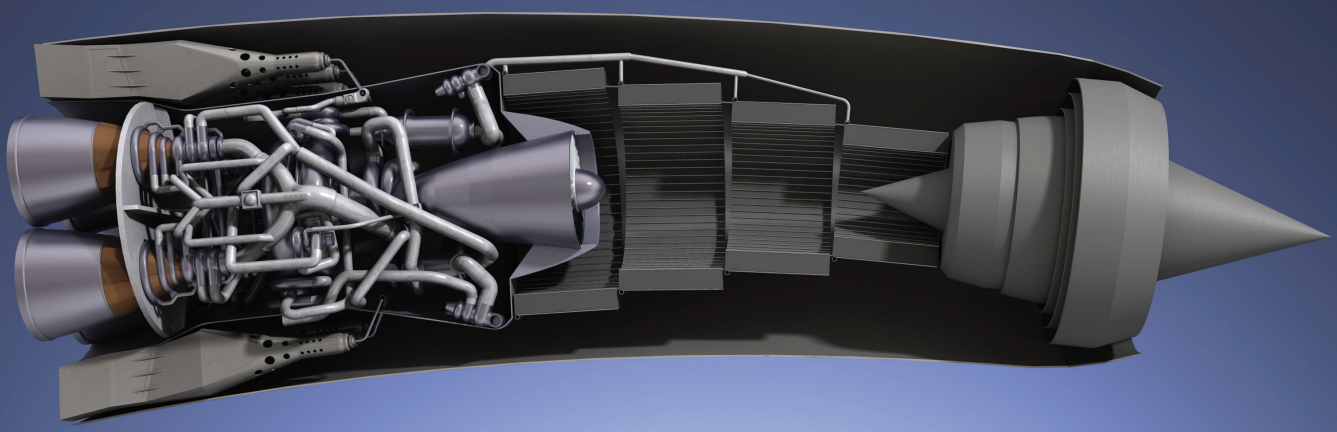
Eben divides his time between his roles at Broadcom, where he is a Technical Director and the Raspberry Pi Foundation. It was through his work at Broadcom that he and his team developed the chip which is now used within the Pi, enabling it to become the cheap, small and relatively powerful platform he had envisioned.

Since the launch of the Pi, Eben has devoted a large portion of his time helping to educate and interest children, while promoting the Foundation.

Eben loves his job because:
"We're doing something meaningful: creative engineering which empowers other people, especially children, to create something of their own, leading to richer lives. This is exceptionally rewarding."

CAN YOU IMAGINE FLYING AT MORE THAN FIVE TIMES THE SPEED OF SOUND?

The **SABRE Engine** by Reaction Engines



Picture courtesy of Reaction Engines

The **SABRE Engine** by Reaction Engines

Has a British company made commercial space travel a possibility and hypersonic air travel a future reality?

Reaction Engines has created an engine that overcomes the weight and air-cooling issues of current spacecraft, making a fully reusable spacecraft a possibility. Its SABRE engine (Synergetic Air Breathing Rocket Engine) can operate both within and outside of the Earth's atmosphere. What is incredible is that it could power a vehicle from a runway take-off all the way into space.

The technology in the company's SABRE engine can also be adapted to create a faster successor to Concorde that could travel at hypersonic rather than supersonic speeds.

History

The space race began in 1957 with the launch of the first Earth-orbiting satellite, Sputnik One, by the Soviet Union. NASA then developed the world's first reusable spacecraft. The space shuttle was launched in 1981 and was in use until 2011. However, for each of the 135 missions into space, Solid Rocket Boosters (SRBs) and an external tank containing liquid hydrogen and liquid oxygen were used to power the craft on take-off and during its ascent through the atmosphere. Once used, both were jettisoned from the orbiter. The SRBs were recovered from the ocean, refurbished and then reused.

The external tank was designed for single use and would disintegrate as it re-entered Earth's atmosphere. This was extremely costly NASA spent nearly $3billion on a contract for external tanks for its space shuttle fleet between 2000 and 2010.

A more effective approach would be to produce a completely reusable space vehicle. In 1982 one of the founding engineers of Reaction Engines, Alan Bond, began working on such a solution. In 1989, British company Reaction Engines was formed and development began on the SABRE engine.

THE HEAT EXCHANGER IS CAPABLE OF COOLING AIR FROM 1000°C TO -150°C IN LESS TIME THAN IT TAKES TO BLINK

Why is the SABRE Engine so special?

The SABRE engine enables the possibility of a totally reusable spaceplane. This engine will allow a space vehicle to use the air in the atmosphere for the first stage of flight, reducing the amount of liquid oxygen required and therefore negating the need for expendable hardware.

As part of the engine design, Reaction Engines produced a heat exchanger, also known as the 'pre-cooler'. It is light and powerful enough to dramatically cool the air entering the engine's compressor.

The company has also developed a 'Frost Control' system to ensure that water in the air does not form into frost and hinder engine performance.

What will the SABRE engine be used for?

So far there are two proposed uses for the technology within the engine:

Space travel
SKYLON will be a multi-use, pilotless aircraft, capable of flying into space and powered by SABRE engines.

Inside the atmosphere the aircraft will accelerate up to a hypersonic speed of Mach 5.5, more than 4,000mph.

Outside the atmosphere the craft will travel at Mach 25.

Once in space, SKYLON will be able to deposit up to 15 tonnes of cargo, such as telecoms satellites, space station supplies, and even a specially designed pod to ferry humans in and out of space.

Picture courtesy of Reaction Engines

The **SABRE Engine** by Reaction Engines

Hypersonic aeroplanes

Since the retirement of Concorde, the world has yet to benefit from a supersonic commercial aircraft. As part of an EU-funded study on hypersonic air transport, called LAPCAT (Long term Advanced Propulsion Concepts And Technologies) Reaction Engines studied the use of SABRE technology in a hypersonic aircraft, capable of a cruising speed of Mach 5. LAPCAT A2 is an aircraft designed to carry around 300 passengers. The SABRE technology will be used to develop the Scimitar engines, optimised for operations within the atmosphere.

Did you know?

- The pre-coolers in the SABRE engine house more than 2,000km of heat exchanger tubing, but they weigh less than 1.25 tonnes
- The heat exchanger tubes in the SABRE engine have a wall thickness that is thinner than a human hair
- LAPCAT A2 will have a range of 20,000km; this means it would be able to fly extended routes to avoid noise pollution over land
- LAPCAT A2 will be 66m longer than the Airbus A380

LAPCAT A2 COULD FLY FROM BRUSSELS, BELGIUM TO SYDNEY, AUSTRALIA IN 4.6 HOURS

AN AVERAGE AIRLINER CURRENTLY TAKES 21 HOURS

TIMELINE

1982
Alan Bond begins research on rocket engines

1989
Reaction Engines formed

1989
Work on SABRE engines commences

2011
European Space Agency confirms successful tests would indicate major breakthrough

2012
SABRE Pre-cooler tests successful

2014
£60million to be invested into Reaction Engines by UK Government

2017
SABRE prototype expected

2020
SABRE flight tests expected

Who makes this possible?

Reaction Engines has a highly skilled workforce, developing cutting edge technology. This includes:

Simon Feast – Technical Design Engineer

MSc Advanced Engineering Design, Oxford Brookes University
BSc (Hons) Computer-aided Mechanical Engineering, Oxford Brookes University

Simon has worked at Reaction Engines for 10 years. He is responsible for a number of engineering projects within the company, including technology development for parts of the SABRE engine and SKYLON spaceplane.

On a day to day basis Simon's role involves project coordination, engineering design and development work, as well as research into new technologies and processes, which are being implemented into Reaction Engines' hypersonic engines and spaceplane.

He loves his job because:
"Working at Reaction Engines presents many exciting challenges – I enjoy finding solutions to complex engineering problems, of which there are a lot! It is a privilege to be part of the team who are developing the technology that will create new and exciting opportunities for the future exploration and development of space."

Performance Engineer

MEng Aeronautical Engineering

Responsible for the optimisation of engine component designs and analysis of test results/ data from simulation software to improve system performance.

Design Engineer

BSc/BEng Mechanical Engineering

Responsible for turning conceptual solutions into detailed engineering drawings for manufacture using a creative approach, a lot of engineering knowledge and some amazing 3D design software!

Mechanical Technician

Apprenticeship/HNC

Responsible for the manufacture and testing of Reaction Engines' pre-cooler – the world's most powerful air conditioning unit!

Engineering Apprentice

A-Levels

Apprentices at Reaction Engines work alongside the engineering team, to gain experience in their field and learn new skills on the job, alongside a day release college course.

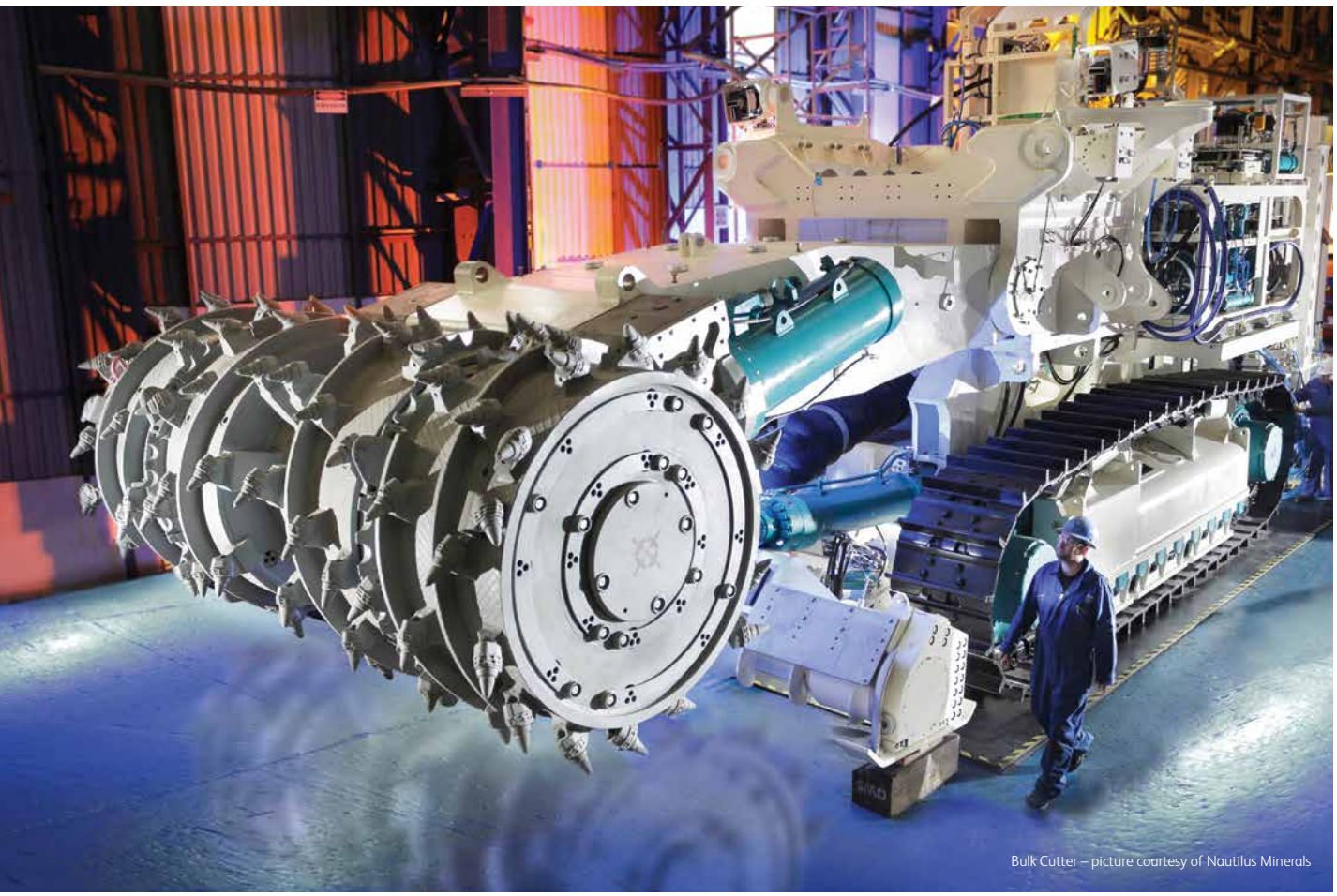
MINING UNDER THE SEA FOR PRECIOUS METALS

Seafloor Production Tools
by Soil Machine Dynamics

Are we about to embark upon the next 'gold rush' accessing untold riches in minerals and rare metals?

A Newcastle company has built the world's first machine which will be used to mine for precious metals at water depths of 1,600m – 2,500m, where large quantities of high-grade metals and minerals exist.

Our insatiable appetite for modern technology together with the growing demand from western populations and industrialisation in countries such as China and India, requires us to find new means of accessing the Earth's increasingly valuable and rare resources. Did you know that your smart phone, for example, is likely to contain metals such as gold, silver, platinum and copper?



Bulk Cutter – picture courtesy of Nautilus Minerals

Seafloor Production Tools by Soil Machine Dynamics

The next 'gold rush'

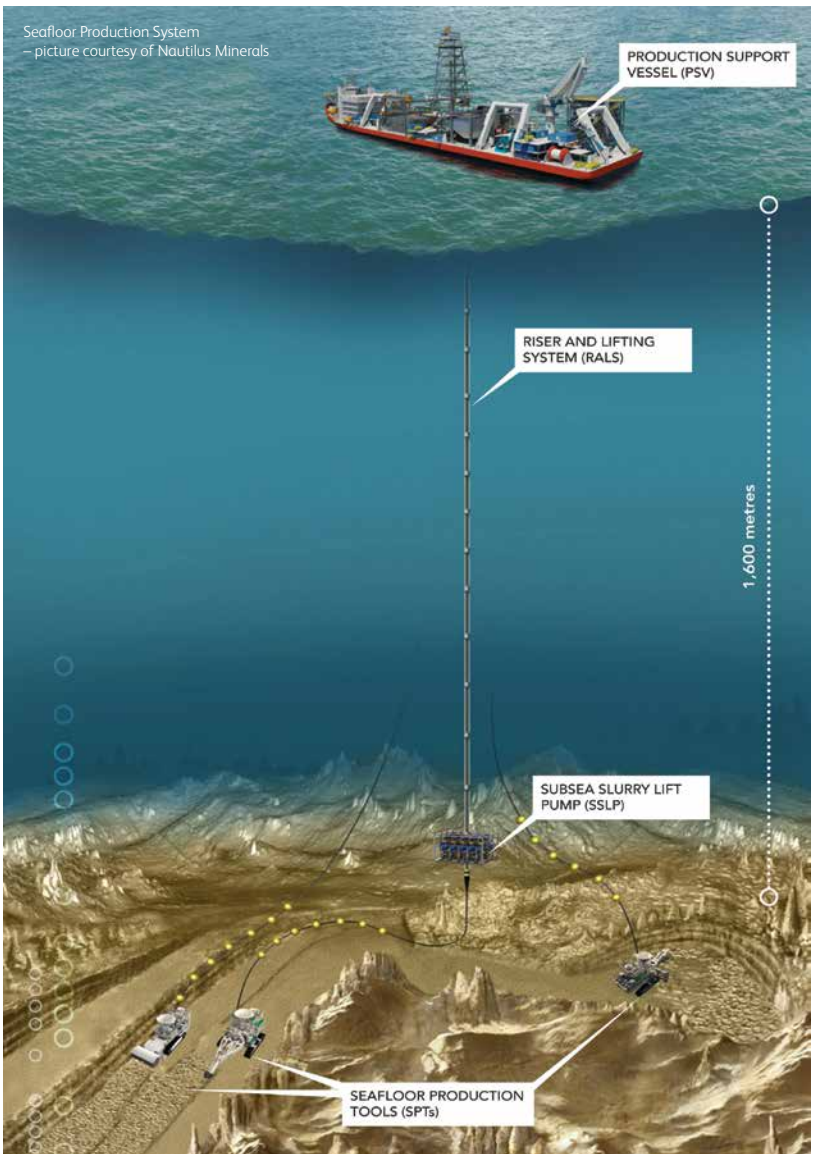
The next 'gold rush' is on its way. On 24th April 2014 the International Seabed Authority granted Canadian company Nautilus Minerals one of the few licences to mine the seabed in Papua New Guinea for precious metals. Nautilus Minerals had already chosen British company Soil Machine Dynamics (SMD), with its pedigree in manufacturing equipment suitable for the subsea environment, to develop and build the sophisticated equipment required. SMD is the world's number one designer and manufacturer of work-class and specialist subsea Remotely Operated Vehicles. SMD's work in this area has earned the company royal approval with three consecutive Queens Awards for Enterprise in 2011, 2012 and 2013.

History

Of course, mining is not new, and we are all aware of the original 'gold rush' early in 1848 in Sacramento Valley, California. However, due to depletion in supplies of easy-to-reach minerals onshore, together with high mineral prices, the idea of deep-sea mining is becoming a reality.

Mining on the seafloor is relatively new and therefore inevitably raises environmental concerns, so the challenge for those involved is to ensure that they access these resources responsibly.

THE SEAFLOOR PRODUCTION TOOLS WILL BE ABLE TO MINE AT DEPTHS OF 2.5 KM



Seafloor Production System – picture courtesy of Nautilus Minerals

What do you need to mine under the sea?

The mining system consists of 3 Seafloor Production Tools that will be able to mine at water depths of up to 2,500m: an Auxiliary Cutter, a Bulk Cutter and a Collecting Machine.

The Auxiliary Cutter prepares the seabed, flattening rugged terrain, which could include the remains of volcanic chimneys. Thereby providing a flat operating surface for the main tool, the Bulk Cutter.

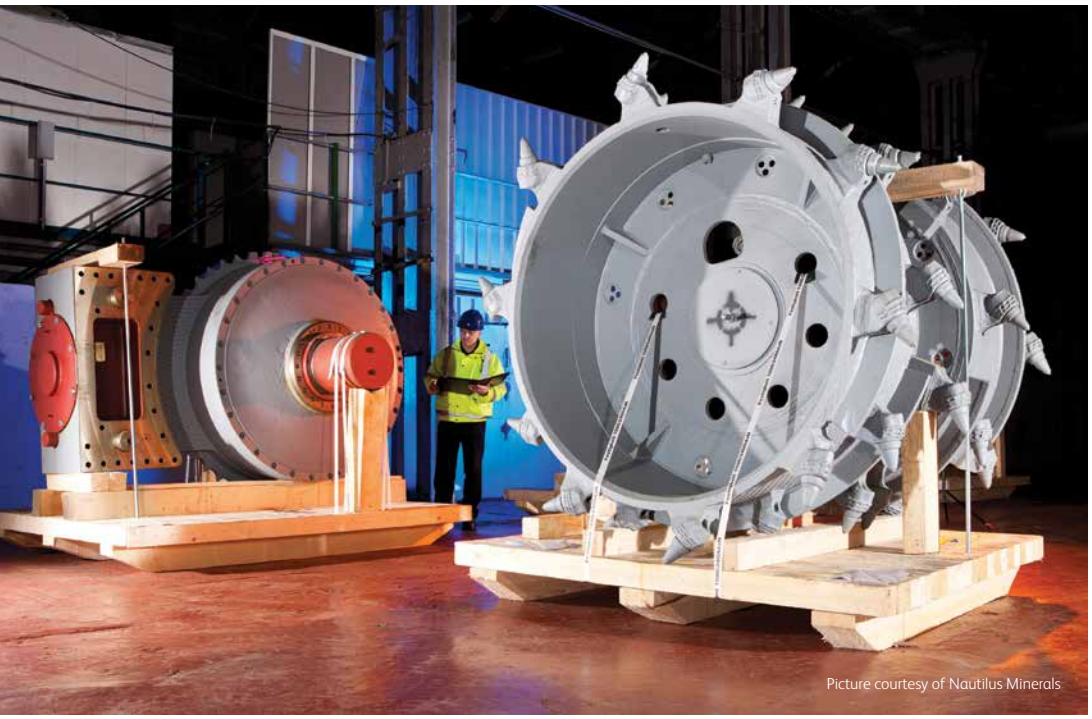
The Bulk Cutter is responsible for the majority of production. It will cut up the seafloor, before depositing rocks in a pile behind it. This is the heaviest tool weighing in at 310 tonnes. It has 4m wide cutting blades.

The Collecting Machine sucks in the cut material, left behind by the other two machines. It is harvested as seawater slurry which is sent along a pipe to a pump on the seafloor, which then pushes the material to a ship on the ocean surface. The minerals are then filtered out and the water is returned all the way down to the ocean floor.

Who will control the 3 Seafloor Production Tools?

The Seafloor Production Tools will not be manned and will instead be remotely operated. A power cable will connect them to the launch ship on the surface and they will be controlled by two pilots based on the ship.

Cameras and 3D sonar sensors will enable navigation on the seabed. 3D sonar is essential, as soot coming from vents in the ocean crust will reduce visibility.


Picture courtesy of Nautilus Minerals

Seafloor Production Tools by Soil Machine Dynamics

Did you know?

– The pressure experienced at 2.5km below the surface of the sea is similar to the weight of an elephant standing on your big toe[19]
– Going 2.5km under sea is equivalent to climbing Mount Snowdon 2 and half times

Solwara 1 deep sea mine

The Seafloor Production Tools will be used to mine Seafloor Massive Sulphide (SMS) deposits on the seafloor. The mining will occur at 1,600m water depths at a site called Solwara 1, located 30km off the west coast of New Ireland, Papua New Guinea.

SMS deposits are formed when water that has escaped through cracks in the seabed is heated by volcanic activity and rises back through the ocean floor as hot water vents. These deposits are rich in minerals.

Retaining skills in the North East

SMD has been in North East England for more than 40 years. When the shipbuilding industry in the region declined, manufacturing had to find inventive ways to retain existing skills in the region.

The workforce has grown significantly in the last 4 years and now employs more than 400 people, around half of whom are degree qualified engineers.

OCEAN WATERS ARE ESTIMATED TO HOLD 18 MILLION TONNES OF GOLD

TIMELINE

2007
Awarded Nautilus Minerals contract

2012
Production of Seafloor Production Tools begins

2013
Mining due to begin

2013
Project postponed – Nautilus negotiating with Papua New Guinea

2014
Agreement reached

2014
Bulk Cutter completed

[19]American Museum of Natural History, 'Pressure in the Deep Seas', http://www.amnh.org/education/resources/rfl/web/dsv/pressures.html, (accessed May 2014).

Who makes this possible?

SMD employs talented individuals who are passionate about engineering. The workforce is highly skilled and includes:

Cheryl Cave – Design/Project Engineer

Degree in Mechanical Engineering

Cheryl first joined SMD in 2001 and has responsibility for the mechanical and hydraulic design of Remotely Operated Vehicles (ROVs). As a Design/Project Engineer at SMD, Cheryl comes up with new concepts and ideas for ROVs. She also designs components using CAD software.

As new designs are not always right first time, Cheryl is tasked with overseeing the build of ROVs on the shop-floor to help resolve any issues that might arise at the build stage. Once the ROVs are built Cheryl is involved with their commissioning. This involves testing them in SMD's own indoor swimming pool to make sure they work correctly before going to the customer.

Cheryl loves her job because:
"I decided I wanted to be an engineer when I was about 14. Thanks to the SMD 'can do' attitude I have learnt a huge amount and have gradually taken on more responsibility".

Daniel Cunny – Graduate Engineer (Trainee Project Manager)

BTEC National Diploma in Engineering
Degree in Engineering

Daniel is responsible for ensuring ROVs are delivered on time and within budget, while meeting the customers' requirements.

Mark Cameron – Senior Production Engineer

Degree in Mechanical Engineering

Mark is tasked with managing production at SMD. This involves managing shop-floor staff, ensuring production is carried out in a safe environment, improving production methods to reduce errors and ensuring deadlines are met.

Paul Johnson – Principle Operations & Support Manager

Four year Engineering Apprenticeship

Paul provides support and advice to customers after the equipment has been delivered. This includes making sure Operations and Service Engineers are available anywhere in the world when they are needed.

Simon Prior – First Year Apprentice Engineering Technician

SMD Advanced Modern Apprenticeship Programme

Simon has spent time building ROV frames and learning about hydraulics. He is also undertaking a BTEC National Certificate and Higher Certificate in Engineering.

THE WORLD'S MOST ADVANCED BIONIC LIMB

'i-limb ultra revolution'
by Touch Bionics

Science fiction becomes fact as manufacturers turn bionic limbs into a reality.

A human hand has 34 muscles and 48 nerves allowing us to grip, control speed and movement and to carry weight. From the moment you wake up in the morning you use your hands to do everything from getting dressed, eating, writing and even communicating.

In the past those born without upper limbs or amputees could only be fitted with relatively basic artificial hands that offered a simple pincer grip. This made routine tasks difficult, if not impossible.

Picture courtesy of Touch Bionics

'i-limb ultra revolution' by Touch Bionics

Technology takes prosthetics to a new level

In recent years, the focus has been on using modern technologies to engineer prosthetic limbs to make them more functional. British company Touch Bionics has taken the development of upper limb prosthetics into the 21st century. Its initial 'i-limb' model was the first prosthetic hand to have 5 independently moving digits. Its latest model the 'i-limb ultra revolution' – can be controlled by a mobile app.

History

Prosthesis development has been around for thousands of years but really gained traction following both World Wars when demand rose as a result of the increasing number of amputees. However, the origins of Touch Bionics came from research that started in the Princess Margaret Rose Hospital, Edinburgh, in the 1960s. The challenge was to come up with prosthetic limbs suitable for children impacted by Thalidomide.

Utilising his experience as an engineer, David Gow joined the Scottish research team in the 1980s and in 2003 he was instrumental in creating a spin-off company now known as Touch Bionics. This led to the first 'i-limb' hand being developed in 2007.

The 'i-limb' range look and function much more like human hands; the digits bend naturally and can fit around almost any shape. This allows wearers to more easily undertake everyday tasks.

'I-LIMB' ALLOWS THE WEARER TO UNDERTAKE DELICATE MOVEMENTS, SUCH AS PEELING A BANANA AND TURNING A KEY IN A LOCK

Picture courtesy of Touch Bionics

'i-limb ultra revolution' by Touch Bionics

Picture courtesy of Touch Bionics

Why is the 'i-limb ultra revolution' so special?

The 'i-limb ultra revolution' is the latest of the 'i-limb' products to be launched and is the most advanced and dexterous yet. As well as having 5 independently moving digits, this model incorporates increased movement in the thumb, which can automatically rotate. In previous prosthetics, the thumb had to be moved into position manually, making certain grips and gestures more difficult.

The 'i-limb ultra revolution' is also the first upper limb prosthetic that can be controlled by a mobile app via an iPhone, iPad or iPod.[20] Remote control gives instant access to 24 different grip patterns and gestures, such as handshaking and waving.

In addition, as with the original 'i-limb', the 'i-limb ultra revolution' can be operated through muscle contraction, using extra-sensitive electrical sensors attached to the remaining portion of the user's limb. The signals are interpreted by an on-board computer, which is able to translate them and move the hand in a natural way.

It also has a feature that enables variable grip strength to be applied across each digit, allowing the user to gradually increase the strength of grip on an object. This helps with routine tasks such as tying shoelaces or opening packages. Sensors indicate when enough pressure has been applied, preventing the wearer gripping too hard and damaging what is being held.

Touch Bionics has created control software called 'biosim-i' that connects wirelessly to the device and has a built-in training mode to help wearers learn the features. It can also be used to select grip patterns or gestures and for the creation of custom movements.

THE 'I-LIMB ULTRA REVOLUTION' HAS A MAXIMUM LOAD OF 90KG EQUIVALENT TO AROUND 450 APPLES

[20]The mobile application is available for download from the Apple App Store

'i-limb ultra revolution' by Touch Bionics

Did you know?

- The 'i-limb' products are all assembled by hand in Scotland
- The 'i-limb' consists of more than 250 custom-designed components
- The prosthesis can be covered with an 'i-limb skin natural' cover, which can be individually painted to match the user's skin and features

Picture courtesy of Touch Bionics

TIMELINE

2007
'i-limb' launched

2009
'i-limb' digits introduced

2010
'i-limb' pulse developed

2011
'i-limb' ultra launched

2011
virtu-limb created

2013
'i-limb' ultra revolution introduced

Who makes this possible?

Touch Bionics designs and builds its range of bionic limbs in Livingston, Scotland. The team includes highly skilled engineers, such as:

Rob Meijer – Design Manager

MEng Mechanical Engineering

Rob is the Design Manager. He has 30 years of industry experience and has spent 2 and half of those at Touch Bionics.

As a Design Manager it is Rob's responsibility to lead a team of Mechanical and Electronic Engineers in the products department. He uses his state-of-the-art product and application knowledge to design and develop the mechanical aspects of Touch Bionics' products in line with plans agreed with the Chief Technology Officer.

Rob also has responsibility for ensuring all work carried out by the research and development team is conducted in accordance with quality standards.

Rob loves his job because:
"For anyone who has an innate desire to create and work in an environment where everyone is focused on developing new products that make a real difference to people's daily living, this job is like finding your destiny!"

Mechanical Engineer

Degree in Mechanical Engineering

Responsible for the overall product design and mechanical features, such as digits, structure and materials.

Electrical Engineer

Degree in Electrical Engineering

Responsible for the electronic components of the 'i-limb ultra revolution', including the electric motors, on-board computer and connection to electrodes.

Test Engineer

Degree in System Engineering

Responsible for ensuring that the products and all components are fully functional and performing to all established specifications.

Product Assembler

ONC/ HNC in Production

Responsible for building the prosthetic hands from their component pieces.

THE WONDER MATERIAL OF THE FUTURE

Graphene,
The University of Manchester

What's next for manufacturing? Could graphene be the material that revolutionises the sector?

It is amazing to think that graphite, one of the components of a pencil, could be the starting point for the material which could transform the manufacturing industry in the 21st century. That material is graphene.

If you imagine graphite as a pile of sheets of paper, graphene would be just one of the sheets. Almost 1 million times thinner than a human hair, it is almost completely transparent. It is a two-dimensional material that consists of a single layer of carbon atoms arranged in a honeycomb structure.

Despite its nanoscopic proportions, it has amazing and unique properties that open the door to many future applications. It is lightweight, extremely strong, a great conductor of heat and electricity, transparent and flexible.

Picture courtesy of The University of Manchester

Graphene, The University of Manchester

Global interest in this British discovery

Since its discovery, graphene has received worldwide interest. Academics and manufacturers are racing to identify further properties and production techniques, which will lead to the development of revolutionary products. To support this flourishing new industry, the £61million National Graphene Institute is to open in Manchester during 2015 and will be the UK home of graphene development. It will provide academics and industry with premises to work side by side on this wonder material, continuing the pioneering British research.

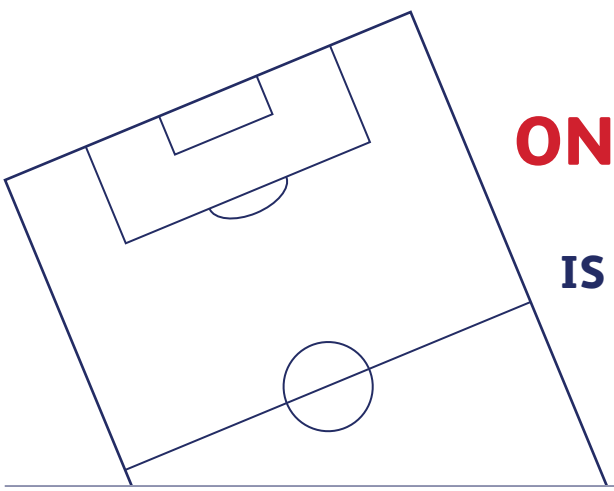
History

The concept of graphene has been studied since 1947, but it was not until 2003 that the first samples of pure graphene were produced at The University of Manchester in Britain. Andre Geim and Kostya Novoselov, based at the University, were the first to isolate the material in its free form. For this they received the 2010 Nobel Prize in Physics. Before graphene was isolated, it had been grown on other materials, but interactions with the surface on which it was grown prevented the properties of the material being accurately measured.

What makes graphene so special?

Graphene has many exciting properties that will prove beneficial in the manufacture of future products. The material is incredibly lightweight, harder than a diamond and up to 300 times stronger than steel. It is extremely elastic; it can be stretched up to 20% more than its original length and can conduct heat better than any other known material.

Graphene is also a far superior electrical conductor than copper, which is commonly used in products today. Electrons are able to pass through the material as if they carry no mass, enabling electricity to travel at 100th of the speed of light.



ONE GRAM OF GRAPHENE IS ENOUGH TO COVER AN AREA THE SIZE OF A FOOTBALL PITCH

Graphene, The University of Manchester


Picture courtesy of The University of Manchester

What could graphene be used for?

Due to its unparalleled characteristics, graphene has many potential applications and could transform future products. Potential uses include: flexible electronics, such as bendy touch-screen displays for mobile devices; lightweight composite materials that could be used in aircraft and vehicle manufacture, as well as more efficient batteries, fuel cells and solar panels.

Future development

When Geim and Novoselov first produced graphene they employed a very simple method, using sticky tape to peel layers from a solid piece of graphite. They then applied more tape to further reduce these layers until they were left with 1 atom thin graphene. Although they were successful, the method used was not very efficient. Production methods need to be refined to reduce the cost and time it takes to produce the material in large quantities and to make its use more viable to manufacturers. To achieve this, The University of Manchester is working with companies such as QinetiQ, Samsung, Johnson Matthey, AkzoNobel and Sharp, to both improve the methods of production and develop future applications for the material.

Did you know?

- Graphene is the thinnest material ever made
- It would take the weight of an elephant balanced on a needle point to produce enough pressure to break the material
- Graphene is so dense, not even the smallest atom, helium, can pass through it

TIMELINE

1984
Electrical conduction capabilities of graphene realised

1987
Graphene terminology first used to describe layers of graphite

2002
Andre Geim tasked a student to polish down graphite to produce the thinnest layer possible

2003
Graphene isolated at The University of Manchester

2004
Paper published on producing graphene

2015
National Graphene Institute to open in Manchester

NEXT 5 YEARS
Could see graphene used in flexible displays

NEXT 15-20 YEARS
Could see graphene used in electronics

Part 3

MANUFACTURING NEEDS YOU!

Terry Scuoler, CEO of EEF, Lorely Burt MP, with apprentices from MBDA UK[22]

Your career in manufacturing

You may have never considered a career in manufacturing, but look what you are missing out on...

British manufacturing employs 2.6 million people.[21] It is extremely diverse, including sectors such as aerospace, nuclear, mechanical, electronics, automotive, food & drink and renewable energy. The industry offers a wide variety of highly skilled jobs.

Opportunities in manufacturing are exceptional and could give you the chance to:

- be creative and inspiring – working with pioneering products and ideas
- make a difference – dealing with products which affect and improve the quality of lives
- have a job where every day is different and variety of work is never a rarity
- gain from continuous career development, competitive salary and rewards
- reap the benefits of working for organisations with global reach

[21] Office for National Statistics, JOBS02 Workforce jobs by industry, released May 2014.
[22] Photograph taken at EEF's Women in Manufacturing launch, May 2014 – Sponsored by Lloyds Bank.

Two apprentices from MBDA UK, a manufacturer of missiles and missile systems, explain why their journey so far has been a fulfilling one:

Jade Aspinall, age 21

Engineering Apprentice, MBDA UK

I have been an apprentice at MBDA for nearly 3 years and I love the responsibility that the job brings. Working in manufacturing has allowed me to be both creative and innovative. I have the opportunity to be involved in new and exciting projects, at the forefront of new technologies.

My apprenticeship has helped me progress personally, as well as increase my skills. I have to manage my own projects and regularly need to adapt to new environments and work with different teams.

Working within Engineering and Manufacturing is really exciting; being such a diverse subject every day is different.

Anna Schlautmann, age 21

Logistics Apprentice, MBDA UK

Even though I am an apprentice and in the early stages of my career, I am recognised as having a vital role in the business and I am treated the same as all other employees.

I am part of a team and my output is essential to the company's success and this has given me responsibility early in my career. This practical experience is also relevant to my studies and I have the advantage of being able to put theory into practice while I study for a Business Management degree.

I really enjoy the wide range of skills that an apprenticeship offers. I do everything: working on the shop-floor, project management, supply chain and logistics. This varied overview of a manufacturing environment is invaluable and I will be able to apply my experience in a future role.

An engineer from Jaguar Land Rover explains why she gets a real sense of achievement:

Verity Atkins, age 24

Project Engineer, Jaguar Land Rover
BEng Aerospace Systems Engineering

In my role as Project Engineer, no two days are the same. I have the opportunity to be involved with a product at every stage of its life cycle, from conception, into a virtual environment, right through to production. This means I am able to directly influence the way in which our products are designed and then witness them being brought to life on the production line. It gives me a real sense of achievement to follow a project through to the very end.

Part of what I enjoy about my job is the amount of problem solving I am required to undertake. I am regularly involved in devising solutions that strike a balance between functionality, cost and vehicle requirements, while giving customers a product they will love.

There are always opportunities to explore new technologies and working with such a tangible end product is very rewarding.

An engineer from McLaren GT explains the variety and challenges his job brings him:

James Dornor, age 25

GT Support Engineer, McLaren GT
BEng Automotive Engineering

I have always been fascinated with how things work and I am fortunate that I have a job that offers the opportunity to provide technical, engineering and systems support at circuits across the world for McLaren's GT race teams. It is a challenging role which requires accurate interpretation of engine data, a detailed knowledge of embedded strategies that control the GT3 car and the ability to lead customer teams in resolution of technical issues on race weekends.

At base we are constantly developing current and future cars as the requirements are different each year. We work on a range of real-life projects and find solutions based on team analysis. It's a role that keeps me inspired and motivated every day and lets me work closely with professional racing drivers, obtaining feedback and developing my skills further.

I have learnt that anything is possible regardless of the educational route taken: it's about hard work, determination and believing in your ability. For me it's an honour to work with such a great British company and a privilege to have the opportunity to do so.

Picture courtesy of McLaren GT

But how do you get involved?

With a job in the manufacturing industry, you could be designing and testing aircraft systems, developing technology for nuclear plants, working on the latest microprocessors or creating cutting edge wind turbines. The possibilities are endless.

A good starting point to ensure a fulfilling career is to achieve good results in the STEM (Science, Technology, Engineering and Mathematics) subjects at school. Your options are then limitless and there are many ways to gain the skills sets needed to take you to a high level in manufacturing:

Picture courtesy of EEF

APPRENTICESHIPS & ADVANCED APPRENTICESHIPS

Apprenticeships provide a blended learning and development opportunity – mixing on-the-job practical experience with academic study. Earn while you learn. Qualifications include NVQs plus Awards, Certificates and Diplomas.

HIGHER APPRENTICESHIPS

Blended learning to achieve higher level qualifications such as a foundation, bachelor or even a masters' degree, while obtaining work experience and getting paid.

UNIVERSITY

Start with working towards your degree by undertaking one of the many and diverse engineering courses available in Britain.

I am interested; how can I find out more?

We have picked just a few of the websites you can visit for more information on how to enter engineering and manufacturing.

EEF: Apprentices and Skills

www.apprentices.co.uk and EEF: Apprentices and Skills YouTube channel

As part of our commitment to the future of manufacturing, our website offers advice to those thinking about an apprenticeship, as well as to employers. You can find out more and understand the benefits of taking this route. The website also outlines the apprenticeships we offer through our own purpose-built EEF Apprentices and Skills Centre in Aston, Birmingham.

The Institution of Engineering and Technology (IET)

www.theiet.org

The IET promotes engineering, science and technology. Its website offers a platform for engineers looking to develop their careers, by providing them with the options, access to mentors and tools to manage continuous professional development. It also offers information for those considering a career, highlighting the diversity of the sector.

Tomorrow's Engineers

www.tomorrowsengineers.org.uk

Tomorrow's Engineers promotes the field of engineering to students, with the aim of encouraging pupils to take up jobs in the sector. Its website contains information for children as young as secondary school age, detailing the different routes available for those seeking to become an engineer. You can find out how to obtain work experience and ways to be involved in extracurricular engineering activities.

Women's Engineering Society (WES)

www.wes.org.uk

WES brings together a network of female scientists, engineers and technologists. Its website contains case studies on female students studying engineering-based subjects at university in order to inspire even younger students. There is information on courses, clubs and competitions which have a relevance to engineering and science.

About Us

EEF is dedicated to the future of manufacturing. Everything we do is designed to help manufacturing businesses evolve, innovate and compete in a fast-changing world. With our unique combination of business services, government representation and industry intelligence, no other organisation is better placed to provide the skills, knowledge and networks they need to thrive.

We work with UK's manufacturers from the largest to the smallest, to help them work better, compete harder and innovate faster. Because we understand manufacturers so well, policy makers trust our advice and welcome our involvement in their deliberations. We work with them to create policies that are in the best interests of manufacturing that encourage a high growth industry and boost its ability to make a positive contribution to the UK's real economy.

Our policy work delivers real business value for our members, giving us a unique insight into the way changing legislation will affect their business. This insight, complemented by intelligence gathered through our on-going member research and networking programmes, informs our broad portfolio of services; services that unlock business potential by creating highly productive workplaces in which innovation, creativity and competitiveness can thrive.

The EEF Information and Research Team is in a unique position to provide insight into the trends and behaviours that shape the UK manufacturing sector. The Team is able to provide invaluable research data, assisting with daily business needs while also providing the intelligence to help businesses compete, innovate and grow.

To find out more about this report, please contact:

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The Information and Research Team

Michèle Fordyce, Head of Information and Research

Michèle has been involved in Information and Research in the City for more than 25 years. Professionally qualified in information, Michèle has led information teams in both law and investment banking. She took up her position as Head of Information and Research at EEF 5 years ago. As part of the wider remit of this role, Michèle is responsible for ensuring the delivery of high-level, tailor-made information and research projects, built around clients' individual needs. With their specialist experience of the manufacturing sector, Michèle and her team can offer individual research and an integrated quality product.

Amanda Norris, Survey Manager

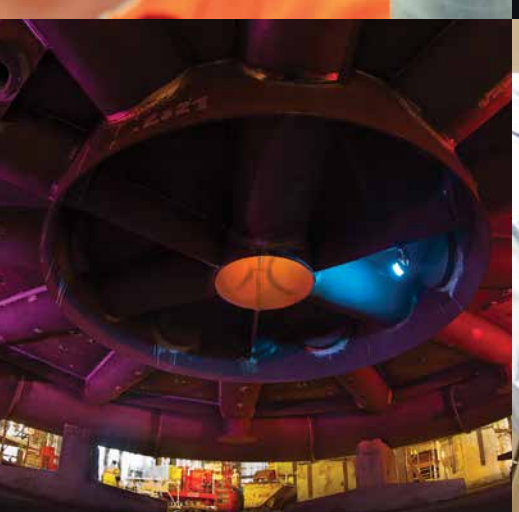
Amanda has more than 15 years' experience in the field of surveying and benchmarking, backed up by a Master's in Research. She manages all the surveys conducted by EEF, including advising on questionnaire design and the compilation of results. In addition, Amanda has experience in a range of research methods from interviewing through to case study work and has delivered high-quality projects for blue-chip clients.

Oliver Kelly, Information Specialist

Oliver joined EEF in April 2012. Prior to this he spent 3 years working in market research and economic development. He has experience across a wide range of sectors and an appreciation of numerous research techniques. Oliver works on bespoke 'intelligence' projects for clients as well as assisting in the management and processing of benchmarking and surveying.


AIRLANDER


SAMSUNG
Raspberry Pi
(c)2011.12

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www.eef.org.uk

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