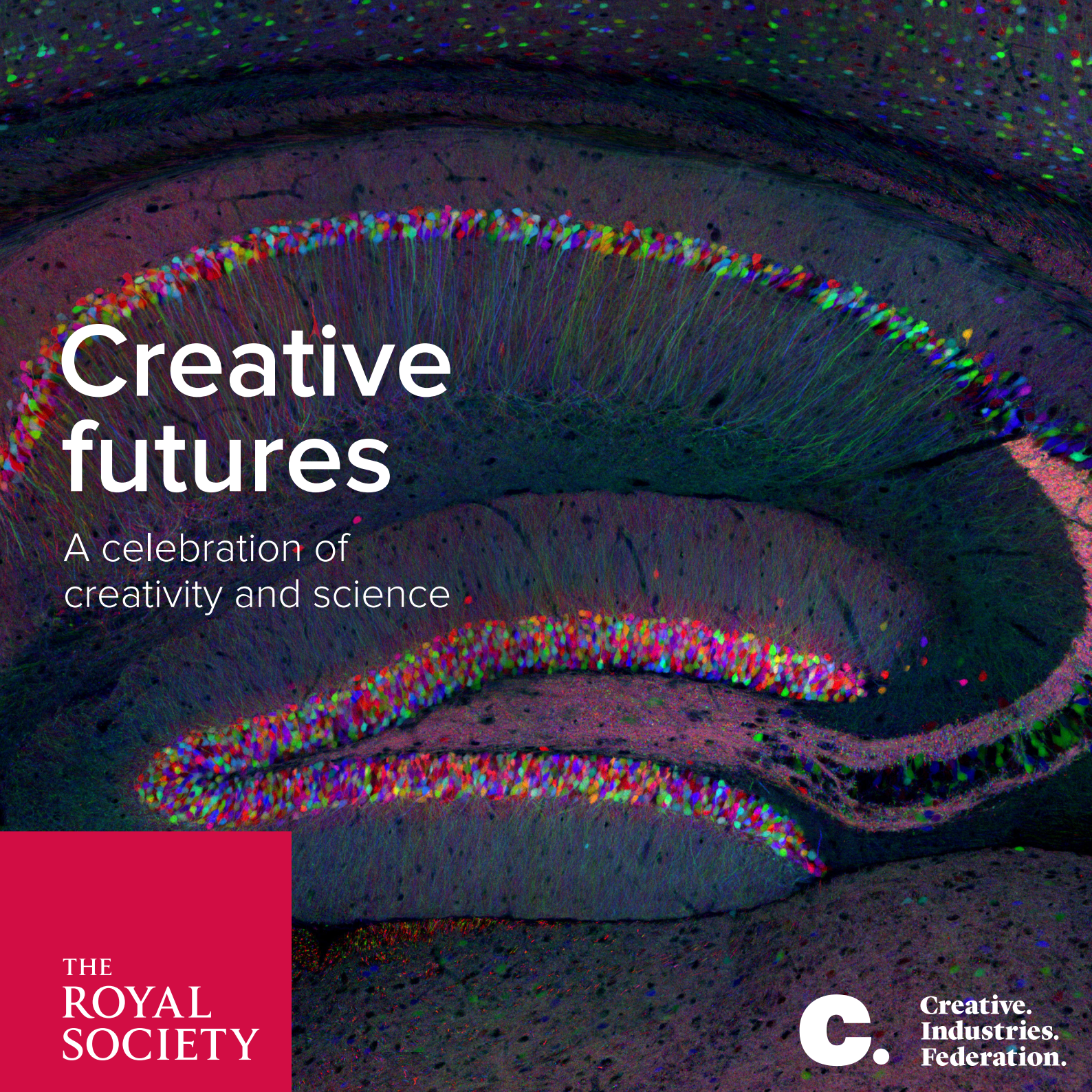


Creative futures

A celebration of creativity and science

THE ROYAL SOCIETY

Creative. Industries. Federation.

Contents

Cover image:
Hippocampus and cortex brainbow by Harvard Centre for Brain Science. © Courtesy of Professor Jeff W Lichtman, Harvard University.

Creative futures

A celebration of the interplay of creativity and science and the importance of a broad, balanced education to equip young people for the jobs of the future.

Sir Venki Ramakrishnan
President of the Royal Society

Research and innovation are vital to the long term sustainability of the UK's economy. We cannot compete on labour costs and we are not awash with natural resources, but we do have a world-leading science base. That is our competitive advantage.

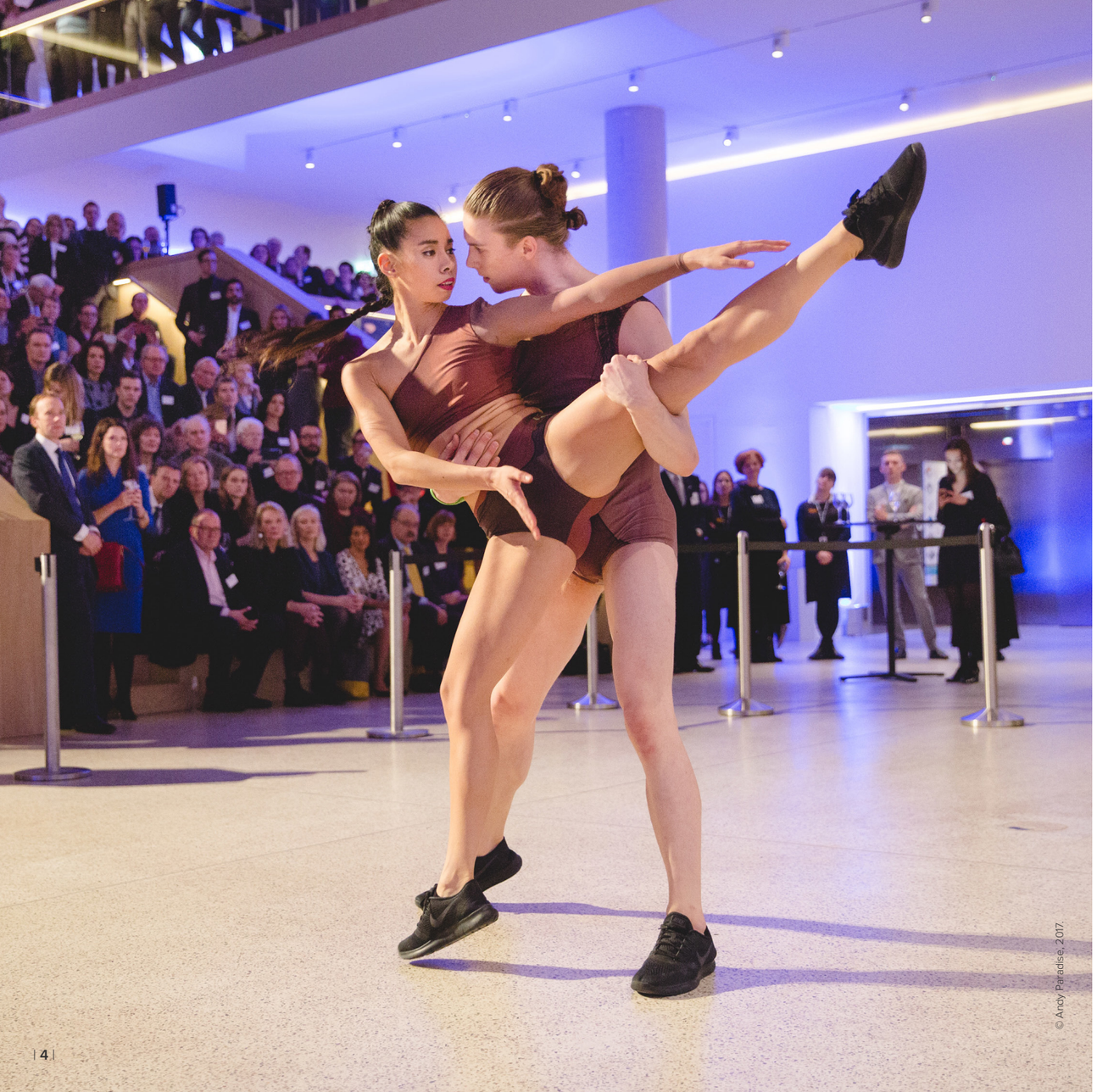
The marriage of research and entrepreneurship has long been the bedrock of our economy. If we want to maintain that, we need to ensure we have an education system that is providing young people with the skills to equip them for the modern world of work.

When it comes to jobs, the market has always changed but we are facing a new wave of change driven by technologies such as artificial intelligence. Some jobs will change, some will be lost altogether and there will be many new jobs in industries that do not even exist yet. What we do know is that they will likely require a combination of creative and scientific skills. We are seeing broadening of skills requirements across all industries.

Today, our A-level systems are among the narrowest upper secondary systems in the world and they are getting narrower. If we want our young people to be able to get good jobs, and employers to be able to hire the people they need in the future, our children must leave school with a broader range of skills. There is no one right way to end up in a certain role, and narrowing your education too far cuts off your options. Meanwhile, jobs are no longer for life and broad skills are needed to support a lifetime's career.

To deliver that requires an increasingly rounded education all the way through to the end of school. Forcing young people to narrow the range of subjects they are studying will also narrow their skills and options. This is not giving them the best start.

Creative roles involve lots of science, while scientific roles involve lots of creative skills. The case studies in this booklet will hopefully give a sense of the complex interplay of creative and scientific skills that are required in the workplace. You can see how artefact conservation needs an understanding of chemistry and materials science; visual effects combine art and computer science; physics needs visualisation; architecture needs engineering. That is the future of work and if we want to thrive, we must prepare all of our young people for it by giving them a broader, more balanced and connected education.



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Rick Haythornthwaite

Chair of the Creative Industries Federation

It may surprise you to read that the creative industries in the UK are worth more to our economy than the automotive, aerospace, life sciences and oil and gas industries combined. It is the fastest growing sector in the last decade, employs more than two million people, and the work of the sector makes a difference to the quality of life of every single person living in the UK.

Examples of collaborations between the arts and science stretch back centuries, and are as crucial as ever if we are to generate innovative responses to some of the most urgent challenges facing our world today.

Despite this success, there are tens of thousands of roles within the creative industries which are currently unfilled or which require additional skills. Faced with the dual challenges of a restrictive immigration system post-Brexit and an education system which increasingly fails to value creativity, the talent pipeline for the creative industries is under threat. Urgent action is needed to rectify this and to ensure that the creative industries have access to the talented people they need in order to thrive.

Yet, it would be misguided to suggest that creativity and creative education only benefit those who go on to work within the creative industries.

Skills developed through creative endeavour, including problem solving, good teamwork, communicating creatively and developing innovative solutions to problems, are among those most in demand by businesses and employers right across our economy. With 87% of creative roles resistant to automation, it is these creative skills that will be essential to the whole workforce of the future.

This is not a one-way street, and the important role that cross-sectoral entrepreneurship, innovation and technology plays within the growth of creative enterprises cannot be underestimated. Creative thinking is a crucial skill for scientists, and the ideas and innovations generated by scientists increasingly inform the work of our creators and creative industries. It is damaging to think of STEM as separate from arts and culture, and limiting to believe that one area can exist and thrive without the other.

The Creative Industries Federation has been vocal about the need for government to recognise the critical importance of creative education, for the sake of our young people, for our creative industries and for the economy at large.

It makes complete sense that the Royal Society and Creative Industries Federation are working closely together on this vital agenda. Examples of collaborations between the arts and science stretch back centuries, and are as crucial as ever if we are to generate innovative responses to some of the most urgent challenges facing our world today.

Dr Muyiwa Akintoye

Head of Research and Development, Quorn

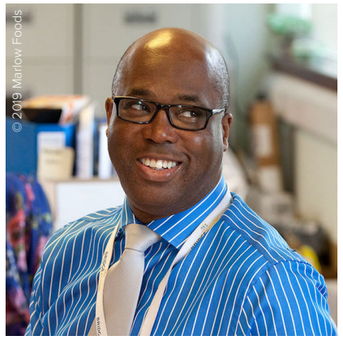
My job involves looking for new ways to make meat-free food. What I do is not very different to what most people do in their kitchen at home: our 'kitchen' is just on a much bigger scale. My team researches new ingredients and processes to combine them with mycoprotein to make Quorn products. Quorn is now developing more vegan foods: replacing egg white with plant protein, while maintaining the texture, is not easy.

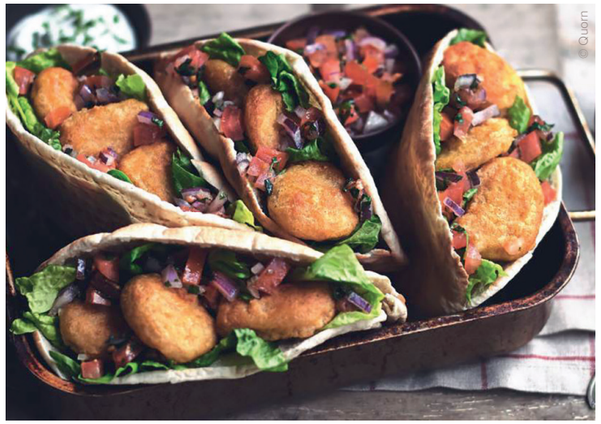
It's important that what we do positively impacts people's lives and the planet. Meat production is one of the biggest greenhouse gas contributors, but replacing meat is challenging because eating meat is cultural and the human body can draw nutrients from it. We want to make it easy for people to reduce their meat consumption without compromising on the meals they eat. There's recognition that we need to change something to reduce long term damage to the planet. If we can work together to solve meat overconsumption, and unsustainable usage of land, water and raw materials, everyone wins.

We use science to make Quorn products and our teams have several trained food technologists, biotechnologists (making mycoprotein) and engineers (designing and building manufacturing plants). Product development is particularly creative – there's a creative leap to get mycoprotein's 'toothpaste' texture to chew like meat. You have to step outside your comfort zone and we are constantly trying new ideas. The invention of mycoprotein came from an outside-the-box idea to use microorganisms to create protein. We are where we are today because of someone's creative idea 50 years ago.

At school in Nigeria I faced a dilemma. My favourite subjects were chemistry and literature, but I had to choose between arts and sciences. My entire career has revolved around food, and I pretty much always knew what I wanted to do. I studied Food Technology at the University of Ibadan in Nigeria, then did an MSc and PhD in food. Before being employed by Quorn, I worked at a breakfast cereal company in the UK.

One of my projects was to evaluate raw materials, so tracking the effect of raw ingredients on the finished product was right up my street. As part of my degree I spent three to six months in industry every year. This was a great opportunity to try out different sectors. Friends from my course have done all sorts of jobs, so your degree doesn't restrict your options. Learning scientific method is useful, and you can always retrain.





"Food research and development is creative and you have to step outside your comfort zone to try outside-the-box ideas. Quorn is where it is now because of someone's creative idea 50 years ago."

Oliver James
Chief Scientist at DNEG

I make visual effects (VFX) for movies including Interstellar and Harry Potter. Unlike special effects, like explosions, VFX are created during post-production using a computer. My role is to build software used by artists to create unique VFX and to research new technologies.

I've always been into photography, computing and physics, and teaching myself to code helped me get an internship with IBM before university. I read physics at Oxford and was always interested in how light is created and propagates through space. Having done sciences at A-level and university, I wanted to try something else. My first job was as an apprentice in a photographic studio. I had fun and learned a lot, but missed maths and physics. Luckily, I found an industry that combined computing and film. The industry is constantly changing, so I'd advise people to study core sciences or fine art for a solid grounding that equips them for the future.

VFX combines science and art to tell powerful stories. Writing code to do this requires software engineering, science and maths and I am lucky to be learning all the time. When we made Interstellar, we worked with Nobel Prize winner Kip Thorne to bring ideas in theoretical physics to the screen. I hope we've set a precedent for getting more science into film. We released some scientific papers after Interstellar, but the real impact was to whet the public appetite for black hole science. If we can connect audiences with science using film, it feels like we're doing something really worthwhile.

Creativity isn't limited to the visual arts: every profession has an opportunity to be creative. Everything you learn builds your arsenal of techniques to solve a problem; the larger that arsenal, the more creative you can be in joining your ideas together. At DNEG it's important to be able to communicate those ideas to colleagues who may be artists and have a very different training to you.

One aim of software development today is to expand the scale of VFX without increasing our energy use. We do this by designing more efficient algorithms and ways for our artists to work. VFX is now mostly digital, but 30 years ago it was crafted in photographic studios. Computers were primitive when I started and we were constrained by processing power, but now we're constrained by our ingenuity.

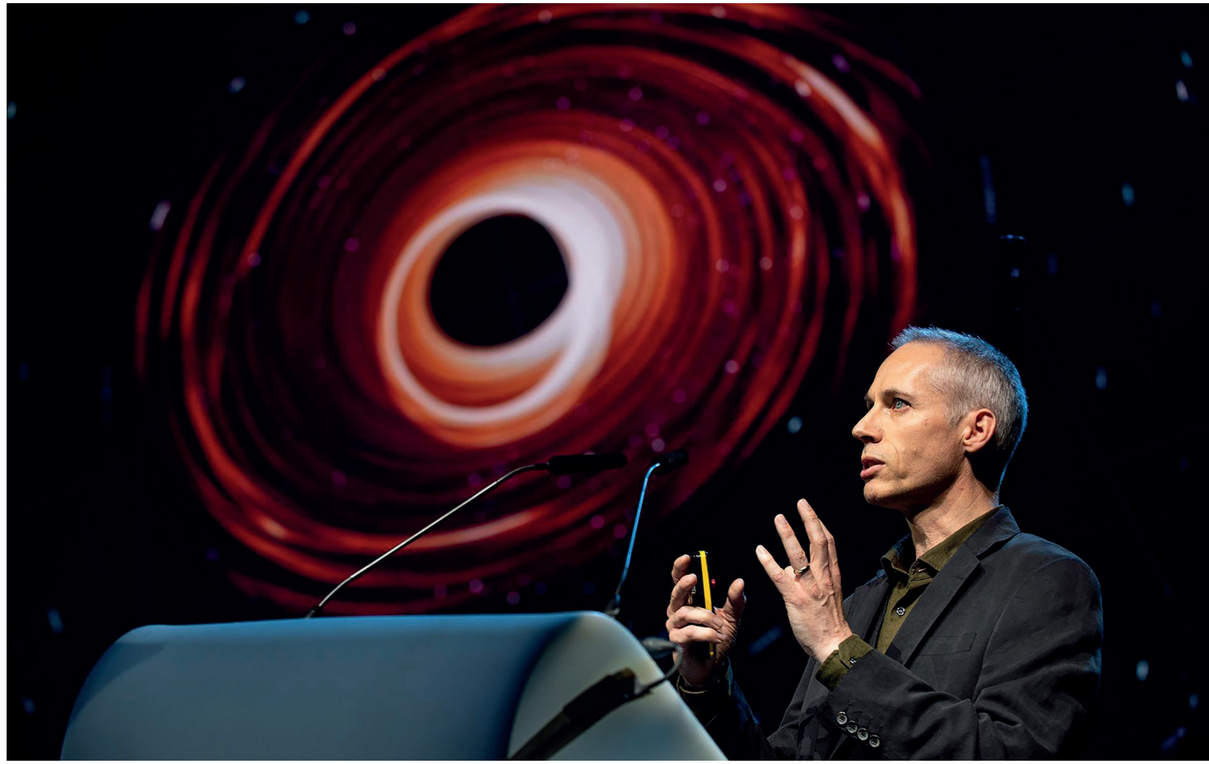


Image credit: Max Alexander Starmus

"Creativity isn't limited to the visual arts. Every profession has an opportunity to be creative – it's about using your imagination to see what might be possible. Everything you've ever done builds your arsenal of skills and experience to solve a problem, and the larger that arsenal the more creative you can be."

Josephine Vermilye

Zero Plastic Waste Consultant and Sustainability YouTube Influencer

I run a sustainability YouTube channel with a viewership of half a million people and have helped institutions including London's Natural History Museum and Kew Gardens reduce their single-use plastic. YouTube gave me autonomy to be my own boss when I was in school. My video, 'ten tips to reduce your waste', went viral, launching my work as a sustainability consultant.

I hope to help build a bridge between the scientific world and the public, and to share scientists' work, giving them space to be creative.

Creative skills in PR and communication help me talk to consumers. What if we could use the same techniques that persuade people to buy things to help them cut down on plastic? Making plastic 'unsexy' would be the best thing.

Developing a successful campaign is a scientific process requiring research, test groups and methodical thought. Using Google Analytics, we've seen that 'health', unlike 'sustainability', has remained important across many years, so changed our communications to focus on plastics' impact on human health. More 'green' jobs will appear, and we'll need a more nuanced understanding of building an audience.

"Science is like a language you have to learn and it's a level of academia that can be quite inaccessible. I made myself read a lot of research papers to understand the conversations around me. Now, I'm looking into studying Earth Sciences to fill the gap in my skills."

My parents taught me to be a self-starter: taking charge of your own learning is so important. I went to school in Switzerland where arts are taught differently in the International Baccalaureate, so at 16 I took my education into my own hands and moved to a school in the UK.

The frivolity of fashion is inherently unsustainable, and during my gap year I realised that by studying the fashion industry I could change it. I studied Fashion PR and Communication at the London College of Fashion. While my formal education focused on the arts, I was fortunate to grow up around scientists. My school encouraged me to apply for arts degrees, but I now know I could have studied Earth or Materials Science to learn more about the science I was trying to teach myself. Now, I'm retraining in Earth Sciences and studied at Stanford for a summer.

The model of getting a degree to do one job for the rest of your life doesn't hold anymore. I didn't know what to do after school, but embracing the unknown allowed me to pursue entrepreneurship. I've hit lots of dead ends: those are major learning points. In Silicon Valley they have graveyard parties to work out why apps failed, and I do the same for my videos.

William Tunstall-Pedoe FREng

British entrepreneur focused on Artificial Intelligence and deep tech

I'm best known for founding Evi, originally True Knowledge, the AI start-up that developed much of the artificial intelligence technology behind Amazon Alexa.

Founding Evi, I wanted to tackle a really big problem: making computers understand language was the biggest problem I could find. Every bit of technology has a different user interface, but voice is the most intuitive. It is how people interact, and everything we expect technology to do can be described using language. I care that my work has a positive impact and am proud to have created a product used by tens of millions of families. Since 2016 I've focused on mentoring and angel investing to help support the next generation of founders, and have a new start-up.

There's a vision of the future where all technology responds to voice. If it doesn't, you'll think it's broken. However, voice technology has a long way to go. Developing natural conversation will depend on technological advances and people with a combination of skills in technology, business and product. Building successful products requires more than pure science. You need technological understanding to make it a reality, and creativity and understanding of product to design something valuable to users.

My education was heavily influenced by being able to play with computers aged 13 when my family moved from South London to Scotland. My school, the High School of Dundee, was next door to the Dundee Institute of Technology. In a friendly gesture to the local school they made us accounts on their mainframe computer, helping educate the community. I taught myself to code in all sorts of languages that don't exist anymore. In those days, writing computer software was a cottage industry and my teacher, Michael Ryan, had a small business with schoolchildren writing the software during break times. It gave me a very decent income for a child.

One advantage of the Scottish system is you do more subjects later. Instead of specialising for A-levels, I did six Scottish Highers exams. During my gap year I worked for GEC and did programming in the US. I did the first ever three-year Computer Science degree at Cambridge University and have stayed in software engineering ever since. Outside my formal education I did courses on start-ups, and through my teacher's software company was immersed in business throughout my early education. Those threads – technology, business and product – have been with me throughout.

> "The difference between science fiction and reality is engineering. The reason we haven't seen voice controlled computers until recently is that the engineering is really difficult, for example there are often literally millions of ways of phrasing a single question."

Professor Aviva Burnstock

Head of the Department for Conservation and Technology, The Courtauld Institute of Art

I study and conserve paintings from the 12th Century onwards and teach students to investigate their history, materials and the techniques used to make them. My work bridges history of art, conservation and science. I enjoy seeing the incredibly skilful things people made and stories behind them.

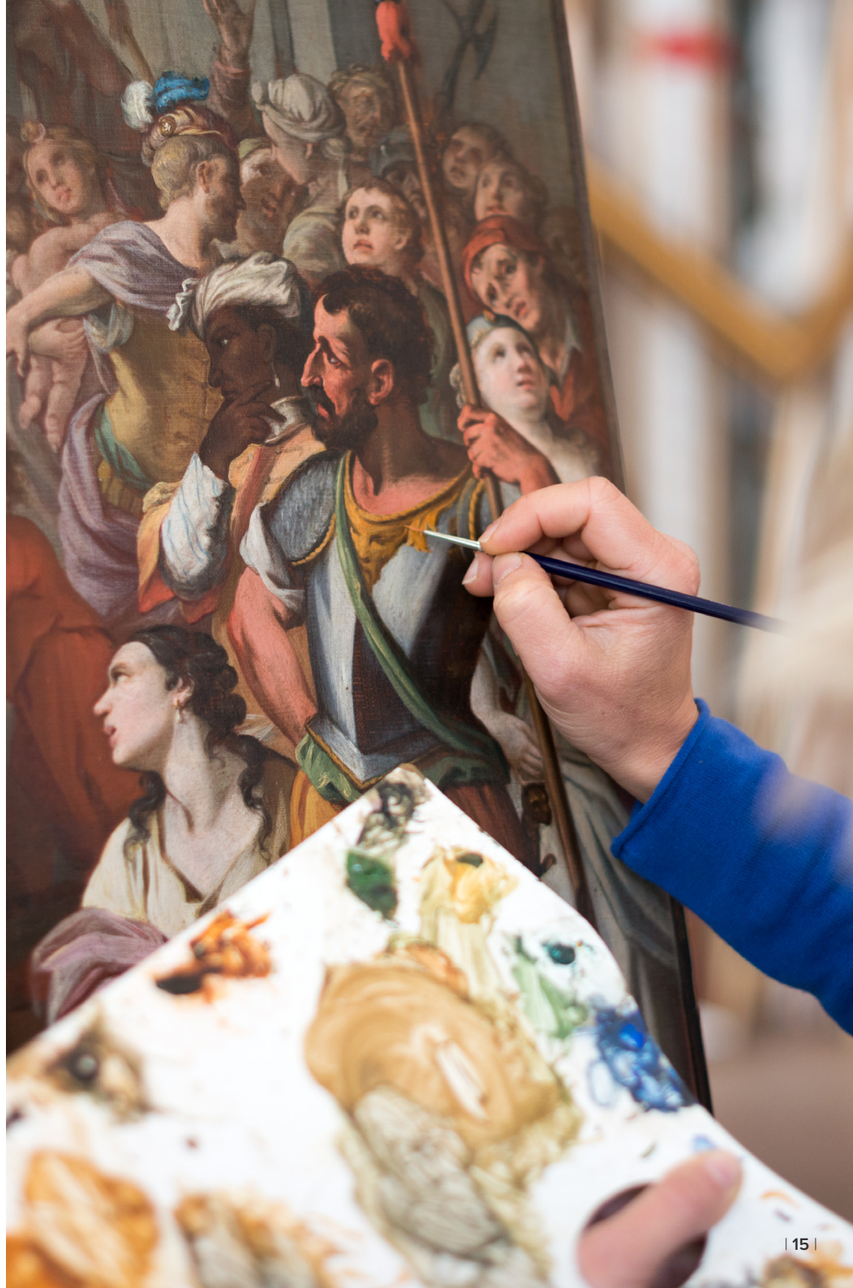
Conservators combine knowledge about science and art to interpret how a painting might have looked when it was made, before deciding how to conserve it. This requires understanding of history, materials and how they were used by artists. Use of particular painting materials might indicate where and when a painting was created. Old paintings have gone through many lives and we need to understand which scientific techniques could reveal their history. Techniques found in medicine, including X-radiography and microscopy, are used to examine paintings. My students learn basic and applied science to understand analytical methods and how materials change with time.

In the future, the way we preserve art might be affected by regulations in environmental control. If we can control exposure to light and moisture, we can delay the deterioration of materials. However, future priorities for the use and cost of energy and resources may necessitate compromises. Modern art combines diverse materials that require different approaches to conservation, and the materials available to artists will continue changing. We must also consider how to preserve new, internet-based art.

Before moving to England from Australia at aged 16, I had an alternative education and didn't have to go to lessons. At Camden School for Girls, then a grammar school in London, I struggled to settle in and bunked everything except maths and choir. I was in the bottom set for most subjects and moved down a year. My parents moved me to a smaller school, King Alfred, where I did lots of art and loved watching seedlings grow in biology, but was clueless about what to do next.

I studied Neurobiology at the University of Sussex. It was what my father thought I should do but I loved the mixture of maths, biology and psychology. Hoping to combine science with my interest in art, I completed the Courtauld's postgraduate diploma in Conservation of Easel Paintings. During an internship as regional galleries conservator for New South Wales, I realised I still had much to learn and returned to the Courtauld for my PhD exploring the use of scanning electron microscopy to study paintings. I then worked in the National Gallery's scientific department before joining the Courtauld as a Lecturer.

"Learning history of art after my science degree was at first like learning a foreign language. Still, every day, I'm learning on the job. Some of the paintings I work on have been there for hundreds of years and I'm a very small intervention, so it's important to respect them."



Professor Jim Al-Khalili OBE FRS

Professor of Theoretical Physics and Chair in the Public Engagement in Science at the University of Surrey, author and broadcaster

I'm a theoretical physicist specialising in nuclear physics, and try to translate physics into language that someone without years of specialist study can appreciate.

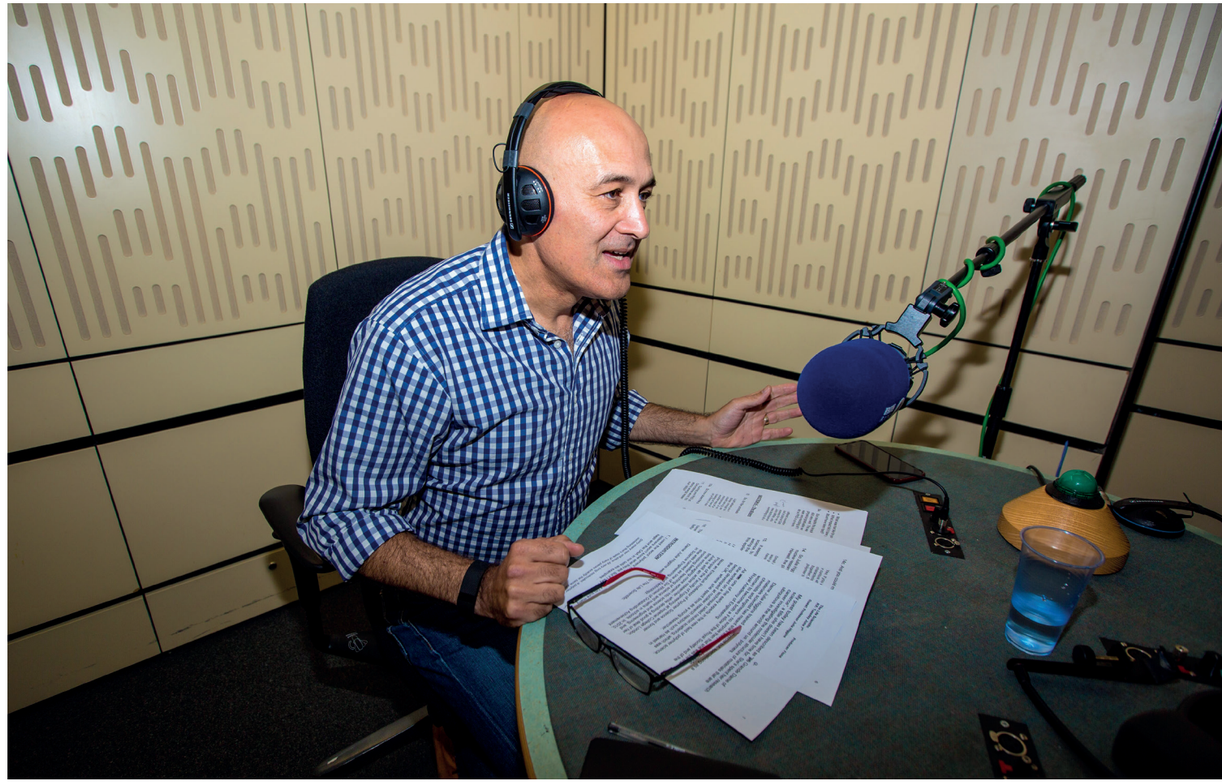
Finding a way to explain a complicated concept that makes someone say "oh! I get it!" gives me as much pleasure as when I 'get it' myself. I now carry out research in the new field of quantum biology, and write books and broadcast on radio and TV to get people excited about science.

On one hand, theoretical physicists think of the maths necessary to solve a problem: Greek symbols, computer code and graphs. Mathematical equations are abstract but to a theoretical physicist they are aesthetically pleasing, and seeing messy algebra that can be simplified to one line is very beautiful, like looking at a work of art or listening to music.

On the other hand, physicists need imagination to visualise something simply. We think in terms of pictures – they may not be accurate, but form guiding principles to help us understand what the maths tells us about the world. I think that in a decade or two, we'll see theoretical physicists becoming experts in using AI and machine learning to solve problems and model complex systems too difficult to study with the human mind.

At 16, I came to the UK from Iraq to start A-levels. I wanted to do computer science O-level alongside my subjects, but was persuaded into A-level chemistry instead. I hadn't even done O-level and, unsurprisingly, failed. I also had to retake maths because I turned up late to the exam and panicked. Until around age 14 I wanted to be a footballer, a popstar, and thought brain surgery sounded clever. Then I discovered that physics came easily to me: it was common sense about how the world works. I appreciated that physics would help me answer deep philosophical questions, like how big is the Universe? what does time mean? I'm still trying to answer these questions now!

I've been very lucky. My physics undergraduate degree and PhD at the University of Surrey led to a research postdoctoral fellowship at UCL, before returning to Surrey. After this, I did some temporary lecturing and another research fellowship. In the mid-90s I became interested in communicating science to the public. Senior colleagues warned me that it would damage my academic reputation, but now it's much more established to do both research and outreach.



"Scientists get very cross when people say that creativity has to come from the arts, when there has to be just as much creativity in science. In the same way, artists get very cross if they're accused of not being rigorous or thinking deeply about how they are representing the world. Artists are doing science as well, and thinking like a scientist is a very broad definition that includes the whole methodology."

Amanda Levete

Founder and architect, AL_A

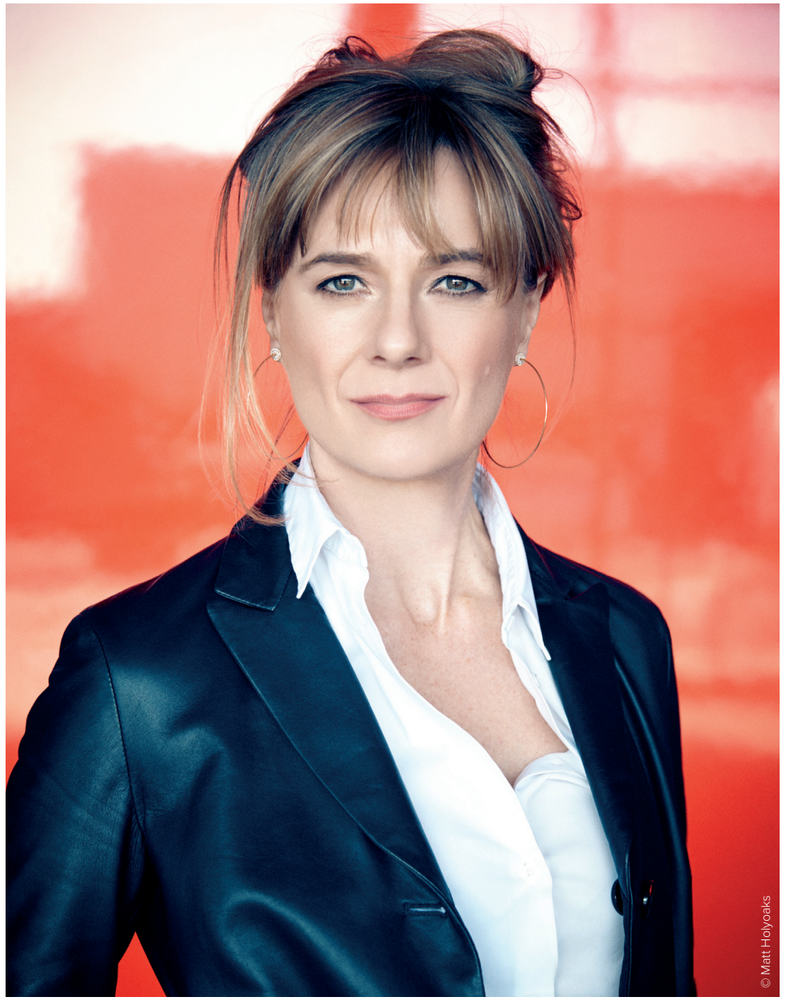
As an architect I have to consider many aspects of life: politics, identity, history, what the future might be. Designing buildings is both artistic and scientific and what is most interesting for me is where the two intersect. Everyone lives, works and socialises in buildings, and their architecture affects your behaviour and mood. Through my work I hope, in some small way, to make the world a better place.

There is a growing awareness of the fragility of our planet and sustainability is hugely important in architecture. Demolishing a building is very energy intensive and polluting, so instead of constructing new buildings, we try to repurpose them. Sometimes the most radical thing is not to build.

Architects need a creative sensibility and imagination. You need to immerse yourself in research and to understand the community you are designing for. There's also science behind architecture. You make technical drawings and structural analyses, research new materials, and you need a feel for engineering to understand what makes a building stand up. It requires a cast of thousands to make a building and it's essential to understand the perspectives of people from all over the world. And you need to be able to communicate ideas with passion.

I went to a very academic school and loved art and English, but that was it, so I left school at 16 to go to the Hammersmith College of Art and Building (now the Chelsea College of Art and Design). Through reading about history of art, I discovered architecture. It attracted me because it allows you to push boundaries and I went on to study at the Architectural Association School of Architecture.

Spending a year at an architect's office during my degree gave me a taste of real life. I think you absorb things faster when learning on the job and there is certainly a place for apprenticeships in architecture. There is no one right way to do anything and you do take wrong turns: you need resilience while finding the path that suits you best.



© Matt Holyoaks

"Architecture crosses many disciplines, both creative and scientific. I think you can be creative in any field. In life, we need the arts as much as science – and both need intuition."

Isis Shiffer

Industrial Designer and Founder, Spitfire Industry

I'm an industrial designer and run a studio called Spitfire Industry in Brooklyn, New York. We design everything from Dutch ovens to buses. I think it's the most interesting job in the world.

I prefer designing things to have a direct positive impact on people's lives. For example, our Ecohelmet is designed to cost a fraction of a regular bike helmet and fold up to the size of a banana. I hope that having a convenient, inexpensive helmet option will get more people riding bikes, which is both healthy and good for the environment.

Industrial design falls between art and science, and a good designer can do both to an extent. An average project requires that I strategise, draw, prototype, CAD, 3D print and prepare files for production. It's important to be able to communicate well with electrical and mechanical engineers and others in the technical world. I need to have a working understanding of material science, fabrication and production so I can make myself understood and understand the feedback I receive.

I was homeschooled and got an odd 19th Century education – poetry, fencing, music, Latin – which on the surface wasn't too practical. However, the underlying skills have proved extraordinarily useful over the years. I struggled with maths and chemistry and would cram for tests then forget everything, but loved languages, literature and natural sciences.

Wanting to be a sculptor, I got my Bachelor of Fine Arts at the Pennsylvania Academy of the Fine Arts/UPenn. One changes a great deal between 18 and 22, and I knew when I graduated that I was not going to be an artist. It took me a while to realise that instead of a regrettable waste of time, the aesthetic and 3D skills I learned in art school laid a wonderful foundation for a design career. Later I got a Masters of Industrial Design at Pratt Institute in Brooklyn, with a year abroad in Tokyo and London.

After university I spent three years as a metalworker building bicycles. I learned about materials, production and how exciting it is to create a functional, beautiful thing. Everyone interested in design should work in a workshop, at least for a little while.

It's important to see design as solving problems rather than just creating physical things. Solutions can be physical or digital, and we need to constantly absorb new ideas, software and skills in addition to a strong aesthetic foundation.

Image credit: Dyson

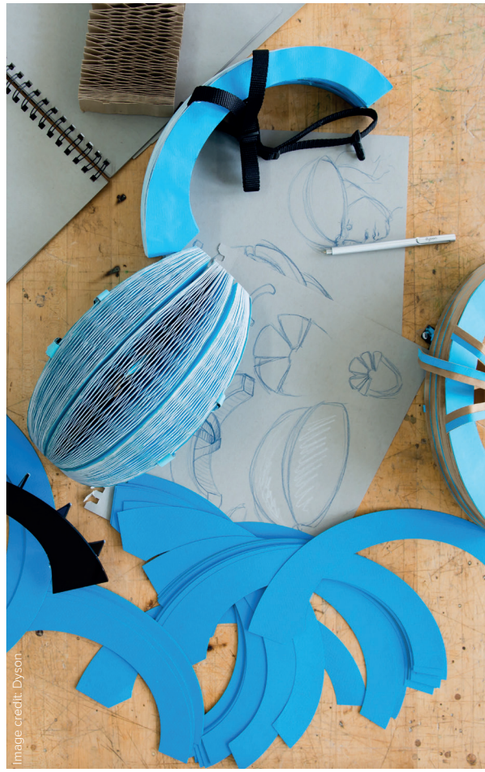


Image credit: Dyson

"Industrial design falls right between art and science, and a good designer can operate to an extent in both."

Tom Mitchell

Lecturer in Computer Music, Associate Professor in the Department of Computer Sciences and Creative Technologies, University of the West of England, Royal Society APEX Award Winner 2018

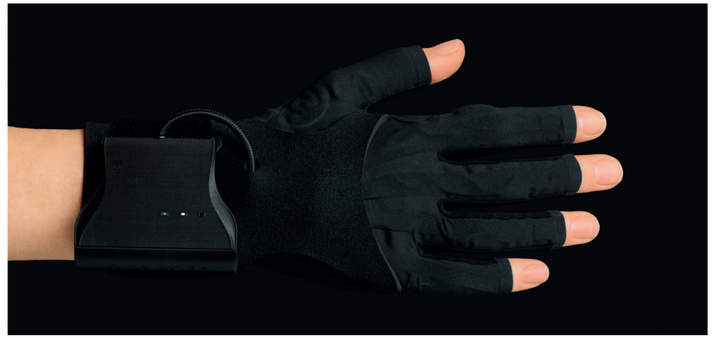
I'm a computer scientist specialising in human computer interaction and audio. Humans are multi-sensory beings: we see, hear and feel our way around the world.

My work involves developing ways of interacting with technology that engage a wide range of senses, and in particular hearing. One aspect of this work is music performance using gestures rather than traditional instruments. I created the MI.MU gloves along with Imogen Heap, which enable musicians to make music with hand gestures using motion tracking and AI techniques. Another aspect of my research is 'sonification': the use of non-speech audio to enhance visual representations of data. This helps scientists extract information they might otherwise miss with their eyes alone. I am currently helping molecular scientists design drugs by creating immersive sonification algorithms for VR on a project called ISOMORPH.

My science and engineering training has always fed my creative interests. As a teenager I wanted to be a musician, but with an aptitude for technology I spent most of my time programming tools and algorithms that support music making rather than actually making music. I went to a comprehensive in Essex and I loved art but gave it up because the syllabus was so traditional, with no connection to technology. I think learning programming in the context of art would really motivate students to learn to code, I can't understand why these subjects are always separated.

Over the years I've worked on lots of cross-disciplinary projects and learned a great deal from artists and musicians who take a practice-based approach to research. It's a fun challenge getting to grips with other disciplines, working collaboratively to satisfy creative and scientific aims. For example, there have been so many complications to overcome in the MI.MU project relating to performance, music, textiles, choreography, engineering and software.

In the same meetings we are often discussing interconnected issues relating to e-textiles, machine learning and wireless connectivity. It can be stressful at times but seeing musicians express their creative ideas so fluidly is enough to keep me motivated.



I studied Electronic Engineering at university, including a placement year at an audio engineering company that made me realise I wanted to develop my software skills. After graduating, I worked briefly as an embedded software engineer before returning to university to study for a PhD, where I developed AI techniques to evolve synthesisers that mimic instrumental sounds. I then got a Lectureship at the University of the West of England, Bristol where I've been since, progressing to Senior Lecturer and now Associate Professor.

"I focused on science and technology throughout my education but always had a passion for music. Now I'm able to combine these domains, creating the technology that connects these worlds."

Professor Nicola Clayton FRS

Professor of Comparative Cognition in the Department of Psychology, University of Cambridge

I am fascinated by birds' memories and mannerisms as well as how humans think with and without words. In psychology, comparative cognition means comparing nonhuman animals to humans. I study birds from the corvid (crow) family and pre-verbal children to understand how, without words, they can remember the past and imagine the future – a concept known as 'mental time travel'.

My other passion is dance, which I explore as a form of non-verbal communication with choreographer Mark Baldwin OBE. I am the first Scientist in Residence at the dance company Rambert, and my dance background helps me devise experiments based on movement. I also collaborate with artist and writer Professor Clive Wilkins on The Captured Thought to explore communication without words through dance and art, and to demonstrate cognitive roadblocks that lead to illusion using magic.

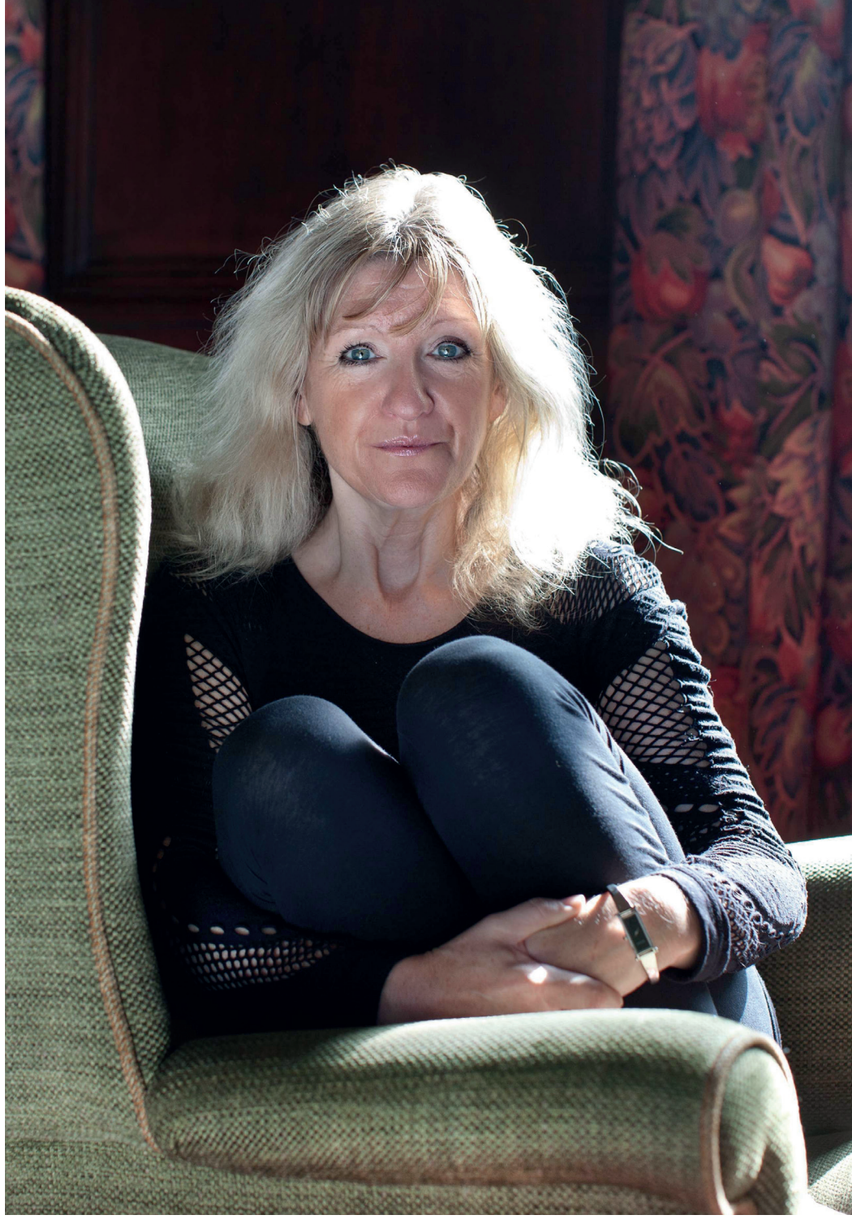
To study behaviour and cognition you need to know your animal really well. The scientific part is thinking up hypotheses and what to measure, for example observing where birds store and search for food. The creative part is designing experiments that tap into birds' cognitive talents through their natural behaviours, and finding questions that birds' natural behaviour can answer directly.

To study subjective memory in animals in the absence of words, you can't ask them if they had a good day. You have to think about what you could test to engage those cognitive processes. Transferrable skills are the most important thing. By combining two really different fields, like psychology and dance, you realise new ways to present material and ask questions.

I went to Montgomery High School, a comprehensive in Blackpool, and was always interested in sciences and arts. Public speaking competitions taught me to communicate with confidence, and I've danced salsa, tango and ballet throughout my life.

My school suggested I apply to Oxford but nobody in my family had been to Oxford or Cambridge. I had no idea what colleges to apply for so looked for those that might have something to do with birds. I read Zoology but also attended Psychology lectures, and my research project was on memory interference – much more psychology than zoology. At the University of St Andrews, I did a PhD in zebra finch birdsong before returning to Oxford as a post-doc, then to University California Davis for my first permanent job. In 2000, I was invited to apply for the job in Cambridge and the rest is history.

"When you become an 'expert' over ten or more years, you become very focussed. This is great for detail but you can struggle to explain it to a broader audience. Collaborations with artists provide inspiration and help you regain the big picture."



Lucinda Bruce-Gardyne

Founder of Genius Foods and Royal Society Entrepreneur in Residence

I founded Genius Foods in 2009 when my son, aged three, was diagnosed with severe gluten intolerance and gluten-free bread was poor quality and hard to find.

Having studied Physiology before training and working as a chef I had an unusual skillset in science and cookery and decided to solve this family problem by developing tasty gluten free bread in my kitchen at home. Today we sell over 45 gluten-free products around the world. Bread is the ultimate convenience food and we have made a great difference to people avoiding gluten.

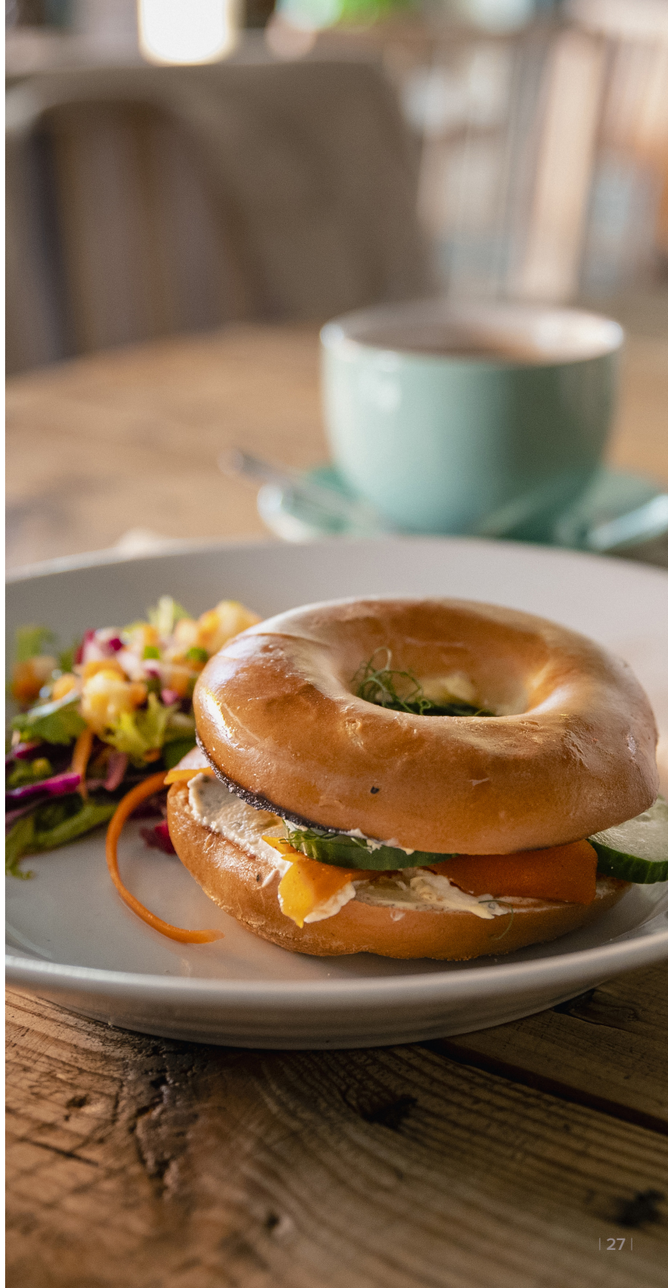
The science of free-from food and ingredient innovation is developing fast. Gluten-free bakery is a nascent sector, and pioneering products and processes is in Genius's DNA. While scientists remove gluten from wheat grain using genetics, and develop gluten intolerance vaccinations, we are optimising the nutritional value of our products by adding prebiotics, protein and fibre. Our next challenge is to replace egg with vegetable proteins to successfully set the structure of our bakery products.

To deepen our knowledge of ingredient functionality and interactions in our formulations we collaborate with scientists, and my science background helps me understand their perspective. The physics and chemistry is fascinating as we learn to create stable bubble structures without gluten. Every product type brings its own structural challenges and creativity and lateral thinking are key to finding solutions.

My A-levels mixed arts and sciences and I didn't leave school with a firm view of what to do. Studying Physiology at Queen Mary University of London, I wanted to do something that helped society but realised medicine wasn't for me.

After my degree, I trained as a chef at Leiths School of Food and Wine. My family advised against food as a career, but I worked as a chef in a Michelin star restaurant before going back to teach at Leiths, then wrote two books on the science of cooking. However, it wasn't until I turned 35 that my mission became clear, when my sons were diagnosed with allergies. I have taken a winding path, but each job taught me more about myself and what I wanted to do.

"Every job you have helps you get to where you want to be in the end. Every experience is valuable and I would never have known that with a physiology degree, training, working and teaching as a chef, I would end up creating a global gluten-free bakery business."



The Royal Society

The Royal Society is a self-governing Fellowship of many of the world's most distinguished scientists drawn from all areas of science, engineering, and medicine. The Society's fundamental purpose, as it has been since its foundation in 1660, is to recognise, promote, and support excellence in science and to encourage the development and use of science for the benefit of humanity.

The Society's strategic priorities emphasise its commitment to the highest quality science, to curiosity-driven research, and to the development and use of science for the benefit of society. These priorities are:

- Promoting excellence in science
- Supporting international collaboration
- Demonstrating the importance of science to everyone

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The Creative Industries Federation

The Creative Industries Federation is the independent body which represents, champions and supports the prosperity of the UK's creative industries. Through our unique network of member organisations, our influential policy and advocacy work and our UK-wide events programme we bring together the many sectors that comprise our world-leading creative industries. Through the combined expertise of our members we ensure that our sector is at the heart of political, economic and social decision-making.

In September 2019 the Creative Industries Federation and Creative England announced their intention to formally unite, recognising that they will be able to make a greater difference together than would be possible alone. The Federation's history of bringing together UK-wide networks and championing the sector will combine with Creative England's significant experience uncovering, investing and growing creative businesses outside of London.

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