Chapter 1: Expanding AI
Maja Pantić

Like in every industrial revolution, we will have some jobs which will become obsolete. But there will be tens of new kinds of jobs which will get created exactly by the fact that AI is there. I'm Maja Pantić and I'm a Chief AI Research Officer in NatWest Group and a Professor of AI at Imperial College London. I grew up in Serbia. I'm born in Belgrade. My undergraduate was in Computer Science and Artificial Intelligence. My Master's in AI, my PhD in AI. Before working for NatWest, I was working for Meta, leading their generative AI efforts. In NatWest, as a Chief AI Research Officer, I'm working on bringing AI to the financial domain, including how financial advice could be given to everybody. And we are giving it through conversational AI. Conversational AI is how you will converse with AI so that it is the same as you are conversing with a person. “Hi, I'm wondering if I should start overpaying my mortgage.” “Hi, John, welcome back. I can help with that. One moment.”

So, what you're seeing here is totally generated by AI. This includes the deep fake video of myself, as well as the whole interface that is presented in this video is generated on the fly while we are conversing with the customer. “The green line shows... If I start overpaying, can I stop later if I need the money for something else? Good question. Yes. Overpayments...” No human can hold all this information at all times in their head. So that's a great plus of AI. When we currently go for this kind of advice, we usually go to the branch. If you can ask, you can interrupt," Oh, I didn't mean that." And in order to do that with AI, you then need this full conversational AI.

Also, there are these moments in life when we have the time, but there is no availability inside of a branch with the humans. So this is why we think this is a better option. I came into this because I always was fascinated by how human brain works. And I was thinking that it would be amazing if we can build something that we can use some ways of how humans learn and then build that on a much larger scale within the machines. AI, as it is now, can only learn from human knowledge. It cannot create new knowledge. So, we can replicate stuff within AI, but we cannot create a true new things as the humans can do. So, creativity is, in my opinion, extremely important.

Chapter 2: Pushing Computer Boundaries
Winfried Hensinger

I was the first person in the world that made an atom move forward and backward simultaneously. So, imagine you park your car and rather than just hitting the car in front of you as you're trying to park your car, you simultaneously hit the car in front of you and the car behind you. I'm Winfried Hensinger, Professor of Quantum Technologies at the University of Sussex. So, a quantum computer is a machine that can solve certain problems where even the fastest supercomputer may take billions of years to solve, a

quantum computer might be able to solve that problem in a few hours. The quantum computers won't replace your laptop, but some things are just really hard on a conventional computer. Now what are these problems? For example, you can create new pharmaceuticals and finance. For example, for portfolio optimisation. In medicine, make a diagnosis quicker using pattern recognition. All the quantum computers that are available, none of them actually can solve any really useful problems.

Instead of having a thousand quantum bits, we developed technology here at the University of Sussex that can host millions of quantum bits. And that means we can really tackle these really, really important challenges that will change the way we work and live. My physics career actually started in primary school. I watched Star Trek Enterprise and I really wanted to make that technology a reality. So, I asked my mum, what do you need to study to kind of develop warp drive, teleportation, all these cool things. And so my mum answered, hey, you probably need to study physics or astronomy. That's how it started. And so after my PhD, I decided I'm going to build a quantum computer.

And so I travelled the world two and a half times, visited all these research groups and I took the job here in Brighton. Twenty years later now, I'm happier than ever. So, this is one of the quantum computing prototypes that we're using in this lab. We've overtaken some of the most prestigious universities in the world. And what you see on this table is a completely unique thing that has been done nowhere else in the world like that. And using this technology, we've broken a world record that was previously held at the University of Oxford. And we haven't just broken a world record a little bit here at Sussex. We broke it by a million. So, this technology can now be used right now to build a million-qubit quantum computer.

People told me before, you shouldn't do this, that whatever you do, don't do this. And I love going exactly there. Exploring the unexplored, going where nobody's gone before. There's so many unanswered questions that we need to solve and we need the very brightest minds and the keenest minds to come here and say, oh, I'm just going to literally do this. I'm going to change this. I'm going to make this happen. We have all these amazing diverse scientists come and really help us construct some of the world's most powerful and most important machines, while at the same time, truly understanding the very fabric of reality. So, really doing the coolest job you could possibly imagine.

Chapter 3: Decoding Data
Arjun Panesar

When I was 16, I went to America and was unfortunate enough to be held at gunpoint by six police officers as I was simply the wrong colour. And that really sparked an interest in prejudice and bias, which can manifest and does manifest in data, AI and in healthcare. My name is Arjun Panesar. I am the founding CEO of a company called DDM Health, which stands for Data-Driven Medicine, and we use data to improve people's lives. My

ambition really is to ensure that regardless of the colour of your skin, your religion, your ethnicity, how much money you make and where you live, you're able to use these technologies and get the same benefit and impact from them, regardless of any of your characteristics.

It was 23 years ago when I started my undergrad master's degree at Imperial, and that was in computer science and artificial intelligence. In the autumn term of that year, my grandfather unfortunately had a quadruple heart bypass and was diagnosed with type 2 diabetes. And we did a quick Google and had a look, and he was told to eat toast in the morning, for instance, and actually he was eating chapatis in the morning. And so, you know, it wasn't quite appropriate for him. And so it was at that point we realised maybe we need to do something ourselves. So, our technology supports people in their daily lives by optimising the decisions they make in that day. So, we have an app and it collects a lot of data with respect to what people are doing, and we use that data in order to help people make better decisions. The app can be used for type 2 diabetes, for weight management, essentially any condition that is related to cardio metabolic health. The data that we collect, for instance, in a food diary, we might know what people eat over the course of a few months. And we can then nudge them to eat healthier foods by showing them recipes that suit their particular eating profile, macro and micronutrients, their culture. But more importantly, we can engage them when the time is right. So, for instance, if we know that people eat their lunch at, say, one o'clock from previous entries, we might prompt them 30 minutes beforehand in order to have a healthier meal or a lighter snack if, for instance, they were going to do some exercise or activity.

Now we have the data to make things artificially intelligent, which you didn't have 20 years ago. So, we are working on algorithms that can detect if you have type 2 diabetes or if you don't. And the application of that is really exciting, as type 2 diabetes normally takes between five to seven years to diagnose. I would state that I would like to enter my cough and then cough and the AI will begin analysing that data and will then give me a prediction. As far as we're aware, it's one of the first of its kind. And we're hoping that we will be able to scale it globally, hopefully in the next two to three years. If there was someone looking to consider what they should do in the future, I would say, follow your passion and don't look back. When I was younger, I had absolutely no idea what I would be doing, and so I think really I've lived a life from miracle to miracle. I'd like to support 100 million people with obesity across the world using our services. We're doing something that medication technically cannot, medication cannot reverse your diabetes, but behaviour change can. And to be able to support that in a very new area of innovation is a dream come true, really.

Chapter 4: Understanding the Brain
Hamied Haroon

One surprising thing about me is that I did a bungee jump while I was at university 180 foot up in the air. It stopped buses on the main road and got my picture into

newspapers. My name is Hamied Haroon. I'm a research fellow in neuroimaging in the School of Health Sciences at the University of Manchester. I work with Magnetic Resonance Images, MRI images. The pictures you get from an MRI scanner are so exquisite. They're so beautiful. It's like you've taken a knife and cut someone open and look inside, but you haven't touched them. The brain is where all the control for the body and for its functions and for movement are controlled by your brain. This is probably one of the only ways where we can really find out what is going on inside the brain. Because I wear metal callipers and I sit in a wheelchair made of metal. I can't go anywhere near the scanner because I would be stuck to it forever.

I've always been disabled. I was born with my condition called Charcot-Marie-Tooth. It's named after three neurologists who've got nothing to do with my teeth which are pristine. It affects the peripheral nerves in my body, so in my arms and my legs. My fingers don't move, don't do anything. As a kid, I always wanted to become a doctor, but at high school I was kind of put off the idea of going into medicine as a disabled person. It's like how are you going to do medicine? Being in a wheelchair, being disabled, but I kept following my passion for science and while doing my Masters in Medical Physics, I found out about magnetic resonance imaging. So, what we have here is our PET MR scanner. So, the doughnut shape here contains the superconducting coils. As that current is flowing around it generates a very high magnetic field. They take that signal that the computer generates that then we can look at and be able to understand what's going on. My specialism is called diffusion MRIs.

So, with that we're looking at the really kind of minute microscopic changes going on in the brain to help pinpoint those really early stages of changes happening in the brain that can then lead on to Alzheimer's disease and dementias of other kinds. The support that I've needed to do what I do has come from all sorts of directions, and you can never do all of this by yourself. You can bring your strengths and if you find those barriers work with people to break those down. I love working with so many amazing people getting to do like exciting science as a team with those people, driving discovery, innovation, new methods. It's that common passion for science that brings people together across borders, across languages, across different cultures and backgrounds and people. It's exciting that one day we may find a cure that can help stop the spread of dementia.

Chapter 5: Advancing Medicine
Toluwani Alade

When you know the experience that someone goes through, it's a bit easier to relate and put more effort into trying to fix that. My name is Toluwani Alade. I work in the Cell and Gene Therapy, Catapult and I'm a laboratory scientist apprentice. Cell and gene therapy is our way of using your own body to help correct any disorders or genetic diseases that you may have like cystic fibrosis or sickle cell anaemia, cancers like leukaemia. Yeah, I always wanted to go into something sciencey, but I didn't know what exactly I wanted to do. I spent a lot of time in the hospital with sickle cell anaemia. So, I saw a lot of research behind treatments for sickle cell, which was in cell and gene therapies. I

thought, okay, I can do something here to kind of help myself and other people around me. I struggled a lot with the exam aspect of school. I wanted to be a bit more hands-on and I managed to see an apprenticeship scheme for cell and gene therapies. We study the cells in a very, very small way. We'll look right into the heart of the cells, specifically in the genes. We can then infer stuff like what type of gene it is.

We look for changes in the cells. There's a lot of information that we can infer that helps us then develop the medicines later on down the line. These are human stem cells. The cells are quite invisible. So, what I want to do is I want to separate the cells from the media that was going in. And now the centrifuge is spinning. With the separation we've got a large white pellet there is all the cells that we have. This has all the information I need to get all my data. Can seem like magic. We then clean it multiple times so that it gets rid of any impurities that might mess up our analysis of the cells. We can then treat it with some dyes so that the machine can then analyse anything that we can't see with the naked eye within these cells. My favourite part of the whole process is probably when I get the data. You can kind of infer a lot from that and I'm quite a curious person, so it's quite fun to do, to be honest. So, from my results, each individual dot here in the graphs is one single cell. So, you could tell there was quite a lot of cells within the media. From here, we can understand the movement and the behaviour of the cell. With more understanding of the behaviour of the cell when it grows, you can understand it more when it's in us as well.

I would really advise young people to get into science and this kind of area of work because it might not seem something that you would want to do right now, but once you're in it, you gain the passion and the interest to kind of learn and make an impact on the world as well. Cell and gene therapies is still a relatively new medicine, but we have medicines out there now that we've developed in the last couple of years, emerging place for us to develop new medicines. It's definitely exciting to be a part of that because I know within five or ten years, I'll look back and be like," Oh, that was all the work that I put in to then have things that are out there in the real world." Me being in this industry, I can see that there's a lot of work being put into things like this, so I think the work that we do is definitely going to help find that cure for sickle cell.

Chapter 6: Nurturing Nature
Sophia Cunningham

If I could shrink down and be inside a tree for a day and measure what's actually going on inside a tree, we would find out of how they really function and how each different species functions differently. That would just be pretty incredible. My name is Sophia Cunningham. I'm a PhD student at the University of Sheffield and the Centre of Ecology and Hydrology, researching urban trees to understand how different tree species are functioning within an urban environment and then how they're going to respond to climate change. I suppose I didn't have the typical route into academia. When I finished my GCSEs, I wasn't too sure what I wanted to go into. I was always interested in science and the outdoors and the environment and nature, but I didn't really think that there

were any jobs in it. So, I ended up going travelling. I loved that, but you actually realise the damage that we've been doing. So that was a huge eye-opening moment for me. I realised that I kind of wanted to make a bit of a difference. I then decided to go to university, which is when I applied to do environmental science. I soon realised that I really loved plants. I wanted to know how plants work on a physiological level. So, I got into remote sensing and urban trees.

The aim is to ultimately try and understand how different tree species are functioning, like their health, how much carbon they're taking in and how they're utilising that carbon, what happens when the temperatures are quite extreme, so that I can see how it responds to the environment and also then how it's going to respond under a future climate when those conditions are going to change. I have sensors on the trees which are monitoring sap flow and the growth of the tree. So, I'm going to be downloading the data from my sap flow sensor. So, it takes a measurement every hour. From that, I can understand water use of the tree, understand how much the tree is cooling our cities. Although urban planners are wanting to plant trees, we still don't currently know exactly which ones are going to be the best.

And that's kind of one of the things that I'm trying to understand. Sheffield is the perfect place to study urban trees because we're one of the greenest cities in the UK and Europe. Like one fifth of the city is covered in trees. There's roughly 4.5 million trees in Sheffield, seven trees for every person who lives in Sheffield. Because the urban environment is such a kind of complicated environment, each tree is under so many different pressures that no two trees in a city are the same. So, it's great that I have such a huge choice of trees. If you're interested in something, don't be scared of it. Even if you may find it a little bit difficult, as long as you've got that curiosity, that's what makes a scientist. So, follow your passion because at the end of the day, we do this because we love it.

Chapter 6: Nurturing Nature
Charlie Foster

Best thing about my job, there's too many things. I guess just working in the environment, it's the best thing in the world, really. I mean, look at it. It's amazing. My name's Charlie, I'm a horticulturist and I work at the Royal Botanic Gardens, Kew. So, horticulture is, in simple terms, gardening. But it's quite a wide range, really. It could be anything from doing something as simple as pruning or sowing seed, creating little pockets of ecosystems for wildlife, to going in the depths of science where you're crossbreeding species or deep diving into genes of plants.

Caring for plants is just a bit like looking after a pet. Every plant has a different need of care. Some plants like to be watered more, some like to be watered less. Some like specific soils, some like shade, some like sunlight. Everything is so unique, so you need to understand how each plant works and how they like to be kept to keep them happy and keep them going. The reason why I'm cutting this back is because when bulbs die

back, the benefit from cutting back the herbaceous growth on top helps restore the energy into this section here, so it has more energy to grow back the following year. I had no idea what I wanted to do. I was bouncing between jobs. I always had a bit of green thumb, so I was sort of prompted to go for the Kew apprenticeship. Later down the line, I ended up getting the job here and now I'm living the dream.

Kew is very special. Kew is like a museum for plants. Thousands of plants from all over the world, all with scientific importance. We have plants that are almost extinct that are only here at Kew, to things that you'll find everywhere. Working in a place like this, you really realise how important nature is. Our climate itself is changing. We're heading to a more Mediterranean state climate. So, our native plants that are used to those very wet, cold, long winters and still mild summers, where we're getting exclusively hotter, our plants are starting to die out. What we're doing to combat climate change is that we're looking at species of plants, especially trees within the same families, that can still benefit us and give us what those plants give us today, but thrive for that future climate in our country, but also across the planet. As a young person, finding a career in something that you enjoy, if it's in horticulture or anything else, go for it, because knowing myself that I'm making not only a major contribution to the environment and helping with those problems like climate change, but also feeling so privileged to be in a place like I am today, there is no better feeling of that joy and proudness that you are making a difference and doing something that you truly love.

Chapter 7: Protecting Animals
Jenny Linden

I was in South Africa working. One time I was just driving back home and there was just a pack of wild dogs relaxing at the side of the road, and they all came over to the car and they were looking right in at me through the window. Really quite magical. My name is Jenny Linden. I'm a PhD researcher at the University of Oxford and the Zoological Society of London. I'm studying African wild dogs and how they might be affected by climate change in the future. I'm looking at mostly wild dog body temperature and seeing how that is influenced by their activity which is mostly their hunting activities which requires a lot of energy and what that would mean for how much behaviour they are able to do when it's getting hotter and hotter under climate change.

The other sort of side of what I'm doing is looking at how climate change is likely to shape wild dog habitats. And we're hoping to use that knowledge to be able to work on their conservation in the future. So, I went to South Africa for my PhD field work to find wild dogs, put sort of tracking collars on the wild dogs. So, with that, you know where they are but also what they're doing at the time because it measures their activity a bit like a Fitbit or a smartwatch. From that kind of data, you can put together maps that look a bit like this.

So, this is one pack of wild dogs but with multiple individuals collared on there. But the important part for my research is looking at that activity data. The different panels here

just show you that this is when a dog is inactive. So, it's resting. This is a dog walking, trotting and running. So, in Africa, we're expecting the continent as a whole to experience increasingly high temperatures going forward in the future. Addressing some of the more tangible threats that wild dogs face, you kind of buffer them to this bigger threat of climate change.

I grew up definitely with a love of animals. And then my dad is actually from South Africa. And so when I was quite young, I went on a trip over to see my dad's family and we also went out on safari. And so that was my first time really kind of appreciating nature on that sort of, that scale. So, I sort of followed this path purely based on knowing that I love nature and wildlife. And as an extension of that, biology was sort of my favourite subject at school. And it was only doing my undergraduate degree that I started to realise that this whole research career was even an option. For me, it's always felt sort of an obligation of something that we have to do because most of the problems facing these species are ultimately caused by humans.

The effects that climate change might have on a wild dog could seem really distant and therefore people might not care about it, but everything in nature is interlinked. It feels like a great privilege and a really exciting thing to be involved in. The most important thing that you can do is to follow your passions. It requires some bravery to follow what might be a bit of an uncertain path, but sort of just trusting in what you know you care about and what you know that you are sort of driven by and interested in can take you along the right path to a career in something really fulfilling.

Chapter 8: Supporting the Environment
Tina van de Flierdt

The first time to Antarctica, that moment you step out of the aeroplane onto the ice and you see this wide horizon of nothingness, it's the most amazing thing and you get a very different relationship and appreciation of nature out there. My name is Tina van de Flierdt and I'm head of department of Earth Science and Engineering at Imperial College London and I'm also a professor in this department. I'm a trained geologist so it's a lot about being in the outdoors and looking at rocks in their natural habitat. Then I'm actually a geochemist so I take the material to the lab and analyse the chemical fingerprint to learn some things about Earth's history.

So what I really do with studying the rocks is taking that archive our planet Earth has produced which tells us what environmental conditions looked like in the past when it was 1, 2 or 3 degrees warmer and transform it now into the future so we can feed it into computer models which predict what the world will look like going forward 1, 2 or 3 degrees warmer. I always thought I would go and study geography. I grew up on a dairy farm in the middle of nowhere in Germany so I feel really really passionate about learning how our planet Earth works, how it functions, how it worked in the past and

what we might do with that to predict our own future. So, when we go down to Antarctica our goal in that really remote location is to get a core of 200 metres of sediment from below the seafloor which goes back in time and tells us about the stability of the Antarctic ice sheet in the past.

Nobody has done this before so we're trying to do something quite unique which is drill in the middle of nowhere through 600 metres of ice. Below that is 50 metres of ocean and then below that is the seafloor, so that's where we want to drill in and we want to get 200 metres of sediment core to give us that history back in time. The material that comes to the surface there no human being has ever seen before so we just pack it up send it back home and then most of the research happens in the home laboratories. When we think about how the world now changes with global warming the question what happens in 50 or 100 years is very relevant for you, for me, for our children but as Earth scientists we bring the capability to play the longer game.

For big parts of my career, I actually never thought about my gender which I think is credit to the places I worked at and how they build a very inclusive environment. We didn't have a woman head of department in the Royal School of Mines before. I feel it's a real privilege so I hold it now and I really try to do it justice because I didn't reflect a lot on it before. So, when we go to Antarctica there's people from all walks of life in there. There's engineers out there but we need a cook, we need a medic, a mechanic, an electrician. What unites all of us when we're out there is that we signed up for something we believe in and we want to achieve together. The problems we're trying to solve now in science, they're the big ones left, the easy things have been done. We just need all expertise we can get. You can learn all skills in life but what you can't learn is to be passionate about something, so it has to come from within.

Chapter 9: Feeding the World
Richard Gill

There are 250 different species of bee just in the UK alone, 25,000 different species of bee across the planet. You need that diversity to have a healthy ecosystem. I'm Dr Richard Gill, I'm an Associate Professor of Evolutionary and Experimental Ecology. I work at the Silwood Park campus of Imperial College London University and I'm very interested in insects. A lot of what I do is research, I'm very interested in understanding how some of the important insects across the globe are coping and being threatened by certain stresses in the environment.

The interaction between changing temperatures into climate change and the frequent encounter that beneficial insects, particularly bees, have with pesticides in the environment, how those two things interact and how it affects the pollination service they provide. Getting that balance right is really important for food security, human health and the ecosystem that we live in. To be honest I started off actually being really interested in birds. I was a proper twitcher when I was young, but as I developed my

interest and got to understand the world of insects, I eventually did my PhD and became a doctor on understanding more about insects and then finally developed into my passion for bees. By bringing these bees into this controlled environment facility, we can control the temperature, exposure to certain pesticides that we might be concerned about and then we can take those bees and we can look at their behaviour, how they might move and their locomotion. Here we go.

She might get going, there we go. And essentially you understand how temperature interacts with the effects that pesticides have on the bees and determine what risks to their behaviours and their pollination service they might have. What we've been finding is that if you expose bumblebees to certain pesticides with particular cold conditions they're not able to warm themselves up and worryingly at very hot conditions they're not actually able to cool themselves down and so they overheat. And that affects their ability to fly which underpins how well they can forage, what they're visiting and what they're pollinating. Pesticides are really important. The food that you buy from your supermarket, if you did not apply certain crop protection strategies, a lot of that, the yield, the food that is in those supermarkets would not be there.

But on the flip side, if you did not have the pollinators that actually pollinated the plants that produce that food, you also wouldn't have the food that's there. It's estimated the contribution to the agricultural market is around about $200 billion every single year and it's around about $250 million just to the UK. If we can figure out where those risks are and we can provide the evidence that is needed to make those decisions, hopefully we're going to live in a more chemical free world. Having an inquisitive nature will really get you into science. Everyone thinks a bit differently. So, whatever you study you will always discover something that is different to what someone else is discovering. Some of the biggest, revolutionary or transformative steps in health, in ecology, in medicine, they all come from scientific understanding and scientific discoveries.

Chapter 9: Feeding the World
Rebecca Lee

I think there's something really nice about being outside collecting the data and it's just being in the fresh air with the environment around you and it's just really uplifting and it's a really good environment to work in. I'm Rebecca Lee and I work at the John Innes Centre as a Crop Technician. I assist JIC research, so the scientists come to us and ask us to grow certain things and put into trials. So, we grow these throughout the year, look after them, put fertiliser sprays on them and then get lots of data for these trials, and then at the end of the year we give the data back to the scientists.

So, the passion for agriculture came from growing up on a family farm. I was very torn between agriculture route and the childcare route and I kind of followed my friends and went down the childcare route. This job then came up so I applied for it. They put me through a foundation basis course, which is kind of like a foundation agronomy course. Agronomy covers sprays, fertilisers, everything like that so it's the field management,

which gave me the basics of everything. So, we're putting the seed in the cone, which then releases the seed through to the pipes which then goes down into the coulters, which make slits in the ground, so the seeds then go into and then the followers behind the drill cover the seed over.

The main pull here at the John Innes Centre was having the data side of things, having the conversations with the researchers and seeing whether a trial worked this year and why it didn't work or how they're going to kind of improve it for the next time. At the moment, the millers will add in extra zinc, extra fibre into bread for example. So, we're trying to produce something, which has everything already in it to try and get everything that we need daily from the grain itself. It's sharing that sense of achievement when something's gone well with someone who's worked on this variety for however many years prior to us getting it. This seed, the thousand grain weight is 41.44 grams, the germination is 100%. We'd expect the germination to be good, but you don't get many that are 100% germination. It's just that sense of you know this has worked and it's amazing.

The John Innes Centre is very inclusive and there's so many different roles within the centre like Crop Technicians. We've got a team of us who work out in the field but then you go down to the main site and you've got people who are more lab based and then you've got the researchers and the scientists, PhDs, postdocs. So, you don't need to have a PhD, go to university and have a degree to be able to do something like this. I think the thing I'm most proud of over the last 10 years is actually getting to where I am now. It's taken slightly longer to get here but I love doing what I do and being a part of the science and the impact that it will have on the farming community and the world around us. It's really incredible.

Chapter 10: Generating Clean Energy
Kate Osborn

We have an energy crisis at the moment, the demand's only increasing and fusion energy could plug that gap and eventually even take over from traditional fossil fuels. My name is Kate Osborn and I work as an experimental operations technician for First Light Fusion. We are trying to solve fusion by the simplest means necessary. Ultimately our goal is that we'd like fusion energy to be the main energy source for the UK, providing electricity to your homes. Fusion energy is a complex puzzle we have to solve.

To put it really simply though, we are compressing and heating fuel to make the atoms fuse together and release energy that we can then harness to power the world. Science wasn't something that gripped me at a young age. At school I actually wasn't very good at it and in particular physics, funnily enough. I preferred the more sort of hands-on topics. I got into the fusion industry almost by chance I'd say. I saw the job advert for my current job and it specified that they were looking for people with instrumentation

background which is exactly what I did on the gas network. So, I applied, not necessarily expecting much but yeah, got offered the job and haven't looked back really. What we do is implement the experiments that the scientists have come up with, the engineers have designed and we come and essentially doing the fun way I think. We're blowing things up using big guns and high energy pulsed power machines. We have two main machines here, one called Machine 3 which is a pulsed power machine that delivers electricity to a target which then implodes and creates fusion energy.

And the other machine is what we call the BFG, the Big Friendly Gun, which is a two-stage light gas gun. This is a projectile. We load this into the launch tube of the gun and it's ultimately what hits the target at the other end. That lets off a huge amount of energy and the target itself is essentially evaporated at that point and our instrumentation such as neutron detectors will pick up exactly what's happened. Whether we got a fusion reaction out of it, we can measure the speed, we can measure the pressure to tell us how successful that shot has been. Because I wasn't from a scientific background at all, it was quite daunting at first. I came in and there's so much interesting equipment here. I think I've turned that around into being a positive because I'm very keen to learn as much as I can.

I think with all the different issues in our world at the moment, we really need people getting into science and encouraging young people to do so especially is important. It's not just scientists doing it, it's not just engineers, it's people with my sort of background. I didn't even go to university. I don't need to be that particular role, I can do something else to contribute. That's kind of the way I see it, like I'm not personally about to solve fusion energy, but if I can play some small role, that's really great.

Chapter 11: Designing New Materials
Florence Huynh

Globally, we produce now more than 400 million tons of plastic. Not all of it is recycled. Almost 32% of plastic packaging will end up in a natural environment. Hello, I'm Dr Florence Huynh. I'm a Vice President of Innovation at Polymateria. We develop biodegradable materials to help tackle the plastic pollution problem. Specifically, we develop a technology that you can put in certain type of plastics. This cup, for example, is made of polypropylene, and people would be able to put our technology in this type of products. And if these cups then end up in a natural environment, it would fully biodegrade on land. There weren't many people knowledgeable in the field that knew how to do the testing. And so I had to work with a lot of different scientists around the globe to find the right partner to test our materials. And then to acquire a gigantic and enormous set of data proving that it's biodegradable in soil, that it works across the globe.

My parents immigrated to France, and actually my dad was fleeing from the Vietnam War. They had no proper education, and so they did a basic job. They were always saying," You need to study really hard and become a doctor, so you don't struggle like

us." That's why I focus on science. I actually remember when I was about 11 or 12 and was mixing candies with random things like water, soap. The colour disappeared and then reappeared as I added on something. And then I was like," Oh, what just happened? I want to understand it." So, I joined a science club and then I made soap, toothbrush, lip balm. When I was 16, 17, I joined a fabulous programme that was for children coming from low-income families to discover science. And that's where I did internships in research labs, and I discovered that I could actually do chemistry as studies. So here we had placed two different products in South Florida outside for three months, one without our technology and one with our technology. And after three months, the one that is without our technology has not really changed.

And here you had the one that contained our technology. And you can see structurally, it looks like a powder. And I can show you now the difference by heating them. So the standard plastic hasn't done much, just stuck to the bottom. But here, if I do the same and turn it upside down... Here the wax flows a little bit like a candle. When this is in soil, the bacteria and fungi in soil will fully digest this wax and therefore fully biodegrade it. Science is about asking questions and trying to work out why something happens. And as you try to answer the question, you're going to learn new things. And that's basically science. We're all just working on something and then discovering new things. And along the path, we make scientific discoveries. If I hadn't been curious, I wouldn't have joined the Science Club. That programme for children from low-income families. Also just take the leap of faith joining this company when I had no background in plastic. Well, I wouldn't be where I am.

Chapter 11: Designing New Materials
Thomas Warr

I remember the first time I was in EI and I was like wow, so taken back by the robot. Every day I still feel the same way almost, it's like how am I in control of this robot? I'm Thomas Warr and I'm a Composites Technician at the NCC and my day-to-day involves operating the robot to create composite parts. We've worked with many different other companies, they may come to us wishing for a part to be stronger or lightweight for a certain application so what we can do is we can go through the different materials and manufacturing processes and help work with them, create a part that sustains their needs. So my job role in that is I help to create those parts and that's why I use the ATL-AFP robot to produce these parts for them to then test.

When I was younger I wasn't really too sure on like going into any job role in all honesty. My grandfather used to have like scale model trains and I thought it was cool to like kind of see him tinkering with them and like creating things, it was like I'd like to do that. I finished off my GCSEs, I realised that I didn't want to go on to doing A-levels and more theory based stuff, I wanted to get that practical hands-on experience so I looked for apprenticeships and I found the NCC. It was local to me and I applied and after doing a bit of research I found that like this was something I could actually see myself doing and

enjoy. The sciences has allowed me to have a broad spectrum of like opportunity and the past three years have been really good doing the apprenticeship and to now like have the opportunity to run this equipment and be the main operator to create these parts for such big customers and projects that I never would have thought I was going to be a part of like when I first started.

Composite materials are used in many different applications across many different industries, in the automotive industry for car body parts and in the aerospace for some wings and also in the renewable sector to create wind turbine blades. What we're testing here is we're laying up a composite panel. Down here is where like all the kind of magic stuff happens. So here we're using a carbon fibre uni-directional twill to build up the strength of our part in different orientations that you can see here. They're made up of two parts, a fibre and a resin. We put these two together to overall enhance the properties of one of those materials by themselves and as we layer it up, we're applying the strength in the zero degree so we also need to apply strength in the 90 degree to create a part that has balanced strength. I would highly recommend an apprenticeship to anyone like even considering it. I think it's such a great way to learn and it's proper like experience, like hands-on experience. I like to kind of see it by eye and shadow like these experienced technicians that have worked here in the industry for god knows how long. It was just a better way for me to learn and also gets you into that work life sooner I suppose. What we're doing is making an impact to improve the future for this industry. It's quite good to be a part of that.

Chapter 12: Understanding the Universe
Julia Stawarz

NASA and European Space Agency missions are fundamentally large international collaborations. So, one of the cool things that I get to do is to work with people from all sorts of different countries around the world. My name is Julia Stawarz. I'm Associate Professor and Royal Society University research fellow at Northumbria University. So, I do research on space plasma physics to understand the interaction between the Sun and the Earth that's caused by this kind of gas of charged particles that we call a plasma that is blown off of the Sun and interacts with Earth's magnetic field. Part of the reason we care about this is because it has an impact on understanding space weather events. It can kind of impact power grids and cause blackouts, for example. The radiation can have impacts on the satellites that are in space. I always was really interested in space growing up. In high school and stuff, I thought physics was quite cool so that's kind of what led me to pursue physics in university.

I guess my mum pushed me to kind of talk to professors and see if there's any way to get involved in space research and I was able to really early on which is kind of unique about my career journey. I was able to start doing research the summer after my first year of undergrad and during undergrad I published a couple of papers. So, I use measurements from spacecraft so data that we collect from satellites that we send up

into space and these have lots of measurement instruments probes that are able to measure different properties of the plasma that's around Earth. So, this is data from a spacecraft called the magnetospheric multi-scale mission. So, this is four spacecraft that are orbiting Earth and measuring the plasma environment around Earth. Plasma you can think of it like a gas like the air in this room. The Sun itself is a plasma. What you're seeing when you look at a flame this is a plasma. If you think about the northern lights or aurora this is all caused by plasma interactions with Earth's magnetic field.

We can use our near-Earth plasma environment as a laboratory for trying to understand the fundamental things that are going on in lots of different plasmas throughout the universe. We're going out into nature and actually measuring what the universe is throwing at us. We're really trying to kind of push forward the frontiers of science to expand our basic understanding of physics. This is one of the kind of big endeavours of humankind is to try to push forward our understanding of the universe. In science in general collaboration is really important because you know we need to be able to exchange ideas with other people. Some of the best work that we can do comes from being able to exchange knowledge from other people and get different perspectives on problems.