Interview

Dr Roger Highfield, Science Director, Science Museum, London

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On 12 June 2024, I was fortunate enough to meet Dr Roger Highfield, Science Director of the Science Museum in London, for an in-person interview regarding his early career in research and later moving on to science journalism and authorship. He has a rich experience with promotional engagement activities as the Science Director of the Science Museum, and also has written 10 popular books in recent years. With his rich wealth of knowledge and experience in the scientific academia field, I thought he would be the best person to pass on his words of wisdom and advice to prospective students who might be interested in venturing into this career field. I first met Roger in the New Scientist Live event 2023 held in Excel, London where he was conducting a talk on the concept of digital twins and its application in the medical research field, based on his new book, *Virtual You*. I found this concept extremely enlightening and innovative, and so I thought I would explore it and open your eyes to this exciting new concept through this interview.

Can you briefly introduce yourself and your scientific background – including your education in university and careers thereafter – can you share some experience about your education and work, and perhaps some anecdotes?

I undertook my doctorate in Chemistry at Oxford, where I conducted experiments on bouncing neutrons off soap bubbles. A lot of my downtime in university was spent undertaking student journalism posts. Upon the end of my doctorate, there were not that many jobs out there in science, due to Margaret Thatcher's government reducing funding for scientific research during the early 1980s. As part of her broader economic policies, which focused on reducing public spending and promoting free-market reforms, there were cuts to various areas of government funding. There were few opportunities available in academia. As I enjoyed getting involved with student journalism in university, I was encouraged by my supervisor at university to apply for a journalistic career, and I started out working for Pulse and freelancing for the *Economist* and the *Guardian*.

An interesting story to share occurred on 28 April 1986. I was working for the journal *Nuclear Engineering International* and visiting a nuclear power plant in Forsmark, in Sweden, just before the Swedes were to open a new nuclear repository under the sea. All of a sudden, the plant's radiation alarms went off – they all thought there was a leak on site – and we were confined in the canteen. However, following analysis of the radionuclides, it was found that the source was likely a Soviet graphite moderated nuclear reactor, the RMBK 1000.

The Swedish pressured the Soviet Union to provide an explanation. Under this pressure, the Soviet state news agency TASS issued a brief statement acknowledging an accident at Chernobyl, but it downplayed the severity. Sweden demanded for more transparency from the Soviet Union, which was echoed by other European nations. It was not until later that the true extent of the Chernobyl disaster was officially declared to have occurred at the Chernobyl Nuclear Power Plant in Ukraine, publicly acknowledged by the Soviet Union, and full details of the event and leakage were finally revealed. This happened to be the same time when the *Telegraph* was looking for a new science and technology correspondent – I, as the first British journalist to witness the Chernobyl disaster, was invited to take on the new position and I started in September 1986. I worked for the *Telegraph* on Fleet Street, which was then well known for its exhaustive news coverage, before moving later to Canary Wharf and then Victoria, for a total of 22 years. My work as a journalist was diverse, ranging from science news and features, to editing special supplements and the science page, organising science writing and photography competitions, parties, mass engagement experiments and more. I later became the editor of the New Scientist journal, having worked there from 2008–2011. Following then, since December 2011, I have been working in the Science Museum here in London where I was first appointed as the Director of External Affairs where I was in charge of Press and Marketing before becoming the Science Director, which is my current position. I hold responsibility across a group of four additional museums under the Science Museum Group apart from the Science Museum London, including the Science and Industry Museum in Manchester; the National Railway Museum in York; the Locomotion railway museum in Durham; and the National Science and Media Museum, Bradford. I help colleagues develop exhibitions, galleries and events, making sure the scientific content is both suitable for a target audience and accurate too. The aim is to explain things to a very broad audience group which range in age, academic backgrounds, and life experiences. For example, we had to explain Stephen Hawking's work on black holes – and his discovery that they glow – in simple terms in an animation aimed at museum visitors, which range from families with young children to adults.

What are your special interests in science? Out of all the written works you've produced, what aspects excite you most, can you name a few?

I'm into many aspects of science, ranging from cosmology and the Apollo Moon programme to gene therapy. One of my favourite topics is reproductive medicine, as there is so much to offer on that field – apart from the hot topics of cloning and IVF, there are multiple spin-out technologies, involving mitochondrial donation, cloning, pre-implantation genetic diagnosis, stem cell research etc. And with so many people now benefitting from IVF technology – about 10 million people on the planet – it has so much potential for the future. I wrote two books on that area – *The Dance of Life and After Dolly*. My other books *The Science of Harry Potter and The Physics of Christmas* explore the exciting quirky aspects of science that most people don't know about. I am a science generalist but particularly like subjects that are quirky or with mysterious twists and turns!

The books that you have written seem very interesting – can you tell us a bit more about these and perhaps some interesting facts from these books which people might not know about?
(For your reference, these books are: *The Private Lives of Albert Einstein, Can Reindeer Fly? The Science of Christmas, The Science of Harry Potter: How Magic Really Works, After Dolly: The Uses and Misuses of Human Cloning* – very interesting titles!)

The book about Albert Einstein, *The Private Lives of Albert Einstein*, was the first Einstein biography that incorporated letters from his younger years, which painted an image of Einstein as a handsome, funny and charismatic figure in his 20s–30s. The Einstein Papers Project was a key information source. We also conducted interviews, not least with Evelyn Einstein, Albert Einstein's granddaughter, who gave us access to the love letters that Einstein wrote to Mileva Mariç, his ex-wife.

Gasps: Wow, that's so cool.

I was amazed by the number of scientists – a hundred something – who were happy to help me with the my book *The Science of Harry Potter: How Magic Really Works*. It got really popular and was published in lots of foreign editions, featured in several literature festivals/Festival of Ideas. The first half of book discusses on some magical 'muggle' topics, such as how to make an invisibility cloak, how does flu powder work, how do potions work. The second half of the book explains magic in a rational and scientific way – it is about the human brain, superstition and how the brain can mislead us via visual illusions, and why things appear to be magical to us.

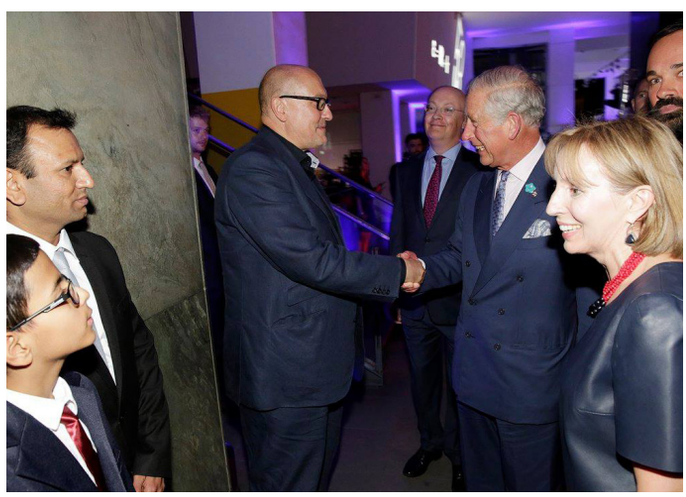
How do you actually make an invisibility cloak then?

Today, you can probably use metamaterials to make an invisibility cloak; metamaterials are artificially engineered materials with unique structures that can control electromagnetic waves. You can create an invisibility cloak by manipulating light, making it flow around an object – in theory at least!

Another interesting story to share involves my encounter with Dolly the sheep. She was a big character and my impressions of her was that she was a prima donna diva. She eventually passed away by catching an infection that triggered lung tumours, which was commonplace for sheep. There were also discussions about if the cloning process had caused her to die young but I am not convinced by this.

I saw that you are a fellow of the Academy of Medical Sciences (FMedSci), and a member of the UKRI- Medical Research Council. What area of medical sciences are you most involved in?

I have not got a medical background but am on the council of the Medical Research Council (MRC). As a kind of 'trustee' of the organisation, I take part in meetings four times a year to discuss big issues. As the medical council is spending £800–900 million pounds on medical research, it is important that the public understands how their tax money is being spent (eg on COVID research). We discuss all kinds of issues, from the way research is managed to key research areas to ethics and how to present and communicate research in a way that is relevant to the public, even involving the public in setting the research agenda.

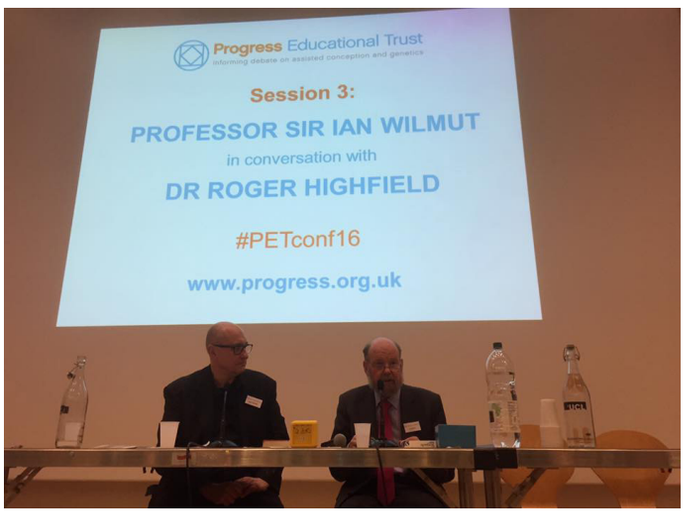


About your recent book *Virtual You* (which I got a signed copy of) can you share with us and readers about the digital twin concept and how the idea first came about?

Glad to hear you have a copy of *Virtual You*, which is the third book I have coauthored with Peter Coveney of UCL! In a hand-waving way, *Virtual You* follows on from themes we explored in our two previous books, from the power of theory to complexity and computer simulation. This time, however, we focus on Peter's research and how to fix the shortcomings of the current 'one size fits all medicine', which is based on past data gathered on people of different genetic makeups and in different circumstances to you, so it often does not work and sometimes produces harmful side effects. That is if it works at all, of course. Look at the years and billions wasted on drug development. Moreover, those who are biologically female, or from minority ethnic groups, have been relatively neglected by medical research over past decades so that, if you train an AI on current medical data, for example, it will be biased in favour of white, male medicine. Unlike AI trained on population data, digital twins offer the prospect of truly personalised medicine.

Just as a weather model that runs in a powerful computer can produce forecasts of flood, droughts and storms, so these digital twins can produce 'healthcasts' of how the body will respond to a disease or a treatment, whether drug, implant or surgery. The amount of data and the sophistication of the model depends on whether you are modelling the whole body, an organ or a molecular subsystem, and what questions you ask of it: to use an analogy, if you goal is to navigate around London then a high-resolution satellite image of the city is helpful but nowhere near as practical as a simple tube map. Digital twins are special examples of computer models which

are updated in real time with data from the body – the constant interaction between the virtual and real you produce a virtuous circle in which the model is honed by reality to produce ever better healthcasts and so on.



We list many examples in *Virtual You* where simulations are already producing reliable forecasts of biological reality. We cover a vast number of computer models and digital twins, from simulating bacteria and cancers to screening heart drugs and planning epilepsy surgery. *Virtual You* simulations are based on actual understandings of human biology, unlike AI, which blindly seeks correlations. That is good news in two ways: if your model predicts how a heart beats in novel circumstances, then you know it works, and how. If its predictions are wrong, then you know you need new chemistry and physics, and a model, supported by experiments, is the best way to explore these possibilities. Perhaps the easiest way to express how much progress has been made is to say that regulators, such as the FDA, now accept simulations, and a plethora of commercial companies are working in this domain. This effort is now shifting out of the laboratory into the company and clinic.

As one dramatic example, accurate digital twins of the human heart already exist – bioengineer Dr Jazmín Aguado Sierra of the Barcelona Supercomputing Center created a twin of her own heart, based on the Alya Red heart model and her own data, which is now beating in the Science Museum, London. (more here: https://www.sciencemuseum.org.uk/about-us/press-office/first-engineer-model-their-own-heart-reveals-simulation-science-museum). And there are already companies that offer digital twin technology, such as Twinomics (acute myeloid leukaemia) and ELEMBio, along with others that use this approach in medical device design and implementation, such as ANSYS and Dassault Systèmes.

What do you think is the biggest medical breakthrough/ innovation in this era of Artificial Intelligence and Big Data?

We see Big Data and AI as complementing digital twin efforts and of all the AI out there, I am most impressed by AlphaFold, which has the ability to predict protein structures, and was not surprised it earned a Nobel Prize. This could prove important to biology and medicine, from developing vaccines and drugs to diagnostics. Many other challenges, like finding ways to break down industrial waste, are also tied to understanding proteins, notably enzymes, which are proteins that can accelerate chemical reactions. However, Peter Coveney and I are concerned that AI should be made more scientific (and we have just written an editorial for a journal about this) and that people do not see a blend of AI and Big Data as a replacement for theory and understanding, the subject of another piece we wrote together.

What does the "One Health" concept mean to you?

It is not a term I use very much, I must confess, though I do appreciate the importance of integrating knowledge about individuals with that about the environment. Here, I am sure digital twin research can help. As a practical first step, however, I do think we need to join up the parallel UN COP (Conference of the Parties) processes to avert dangerous climate change and ecosystem destruction: ecosystem collapse and climate change are two sides of the same coin.

What are some of the key skills you'd like to share for students aspiring to go into academia- what can they do during their time at university to enhance their skill set?

Just remember that university is much more than a course and a degree. You make friends for life as a student and you can try all sorts of other things, from amateur dramatics to sport, music and more. When I comes to my own experience, I studied chemistry but ended up in journalism because of my experiences on student radio and on the university paper. Bottom line: being a student is not just about enhancing your skill set – it is also about having fun with a view to seeing if a passion could turn into something more serious!

Can you share some tips about scientific journal editorial work mainly for students with scientific or medical background who would like to pursue such roles? Will it be difficult to balance time if you're not a full-time editor – especially those who need to balance clinical work?

Communicating clearly is a really useful skill for lots of professions – if you can't write clearly, you're not thinking clearly, as Bill Bryson once told me. And it makes your life a lot easier when it comes to winning grants, impressing your peers or wowing VIP visitors and ministers. Try to get some experience at university doing student radio, blogs, podcasts, videos, magazines or whatever, so you can demonstrate some real interest in editorial work. Ditto work experience and attachments. When I was the Science Editor of the *Daily Telegraph*, I would get a lot of job applications for correspondent jobs I advertised but found that, when I excluded all the people with no experience of any kind, the longlist shrank by more than 90 per cent. Rolling up your sleeves and having a go at editorial work sends out a strong message that you are keen. And, of course, you learn a huge amount along the way.

Photos kindly provided by Roger Highfield