



How (not) to Build an Expert

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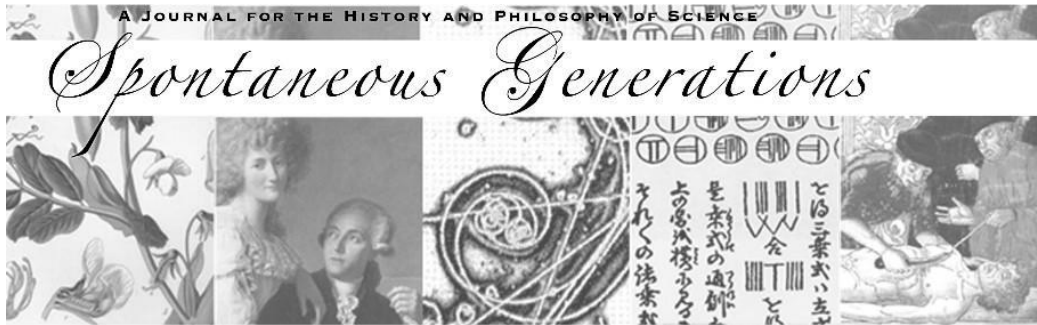
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How (not) to Build an Expert: Personal Reflections on a Terminated Physics Career

Robert Naylor

Abstract The social contributors to the formation of expertise are often a taboo subject when practitioner communities interact with outsiders, making the exploration of these inputs a difficult endeavour. When exploring scientific communities, one resource that many STS and HSTM scholars can draw from is their personal experience as students of science – experts in waiting. I will draw on my personal experience as a physics student at a Russell Group university from 2014 to 2018, with a year abroad at a US institution. The UK physics course instilled in me an image of physics expertise that is hyper-specialised, apolitical, and ‘pure’. This was achieved through the choice of curriculum, the content of internal displays, and the culture of the department as mediated by informal interactions. This vision of expertise resonates with corporate entities whose interests are in experts that can function as stable commodities, rather than volatile political actors.

How does one become a physicist? Plenty of answers to this question can be found in biographies or online YouTube videos.¹ However, much of this can be boiled down to “I was good at physics”. Of course, it is in the interest of physics practitioners to portray the process as straightforward and objective, detached from social constructions and input. However, Haraway’s consequential work on situated knowledges challenges this complacency, arguing that all knowledge producers should acknowledge their social position and context, and therefore the contestability of their knowledge claims.² This short paper attempts to illuminate the sociocultural context of physicists, by recalling the perspectives of someone who did not become a physicist, but experienced some of the institutionalisation to which the discipline subjects its future experts. Understanding the formation of experts informs topical scholarly debates surrounding the intersection of scientific expertise and politics, especially regarding the behaviour of experts in political settings.³ In relaying this narrative, I break down the socially detached image that physicists present to the public,

¹For example, Nottinghamscience, “How to Become a Professor,” 2009. <https://www.youtube.com/watch?v=ThgJHeDKsxA>

² Donna Haraway, “Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective,” *Feminist Studies* 14, no. 3 (1988): 575–99.

³ Paul Cairney, “The UK Government’s COVID-19 Policy: What Does ‘Guided by the Science’ Mean in Practice?” *Frontiers in Political Science* 3 (2021).

exploring the important role that institutionally mediated social interaction (or lack thereof) plays in forming a physics graduate.

In the UK, the institutionalisation of a physicist begins long before they enter a university physics department. The most common requirements for entrance to a UK university physics course are A-Levels - school leaving qualifications - in physics, mathematics, and one other science. Since the average number of A-Levels taken by UK students is three, this restricts the breadth of study for prospective physicists in their final two years of secondary education. Physics and mathematics A-Levels are almost completely exam-based so students are very much rewarded for memorisation and 'learning the exam'. There is also a formulaic rigidity in how to obtain the highest grades, with students not being encouraged to find methods beyond the set syllabus. In summary, many physics students enter higher education having spent two years without writing an essay or offering any sort of critical analysis. Moreover, students are often exposed to media that downplays the importance of social critique. Many popular books and TV programs written by physicists, avidly consumed by prospective students, reflect a similar belief that squabbles between humans are childish and unimportant when contextualised by the grandness of cosmic questions. Physics is portrayed as an activity that transcends (but also fundamentally determines) society – a problematic image that is reinforced once the student enters university.⁴

I arrived at the physics department determined to become an expert and completely trusting of the physics establishment to make this so. Each student was assigned a personal tutor to guide them through choosing modules. On the second year of study, the range of options increased, and I expressed an interest in a history of science module that was being offered outside the department. My tutor, thirty years my senior, brushed this aside 'There's no reason for you to do a history module.' he said, 'It will be difficult for you to continue in physics if you take modules like that.' I did not protest. At the same time, my core physics courses were largely devoid of social context, at most occasionally brushing over some real-world applications in the first lecture. Any focus on real-world application was relegated to optional units, and even during these modules social implications were discussed minimally. As general rules, breadth of expertise was devalued and specialisation was encouraged, 'pure' science was prioritised over the applied, and when applications were discussed social implications were often glossed over.

My lab reports were criticised for including too much 'unnecessary information' regarding the social importance or utility of the subject matter, reflecting the highly reductionist style of writing that we were strongly

⁴ Most famously: Carl Sagan, *Pale Blue Dot: A Vision of the Human Future in Space* (New York: Ballantine Books, 1997). Other examples with similar themes: Brian Cox, *Wonders of the Universe*, Documentary (British Broadcasting Corporation (BBC), 2011); Fred Hoyle, *The Black Cloud* (William Heinemann Ltd, 1957); Richard P. Feynman, *Surely You're Joking Mr Feynman: Adventures of a Curious Character as Told to Ralph Leighton* (W.W. Norton, 1985); Robert Zubrin, *Mars on Earth: The Adventures of Space Pioneers in the High Arctic* (New York: Jeremy P. Tarcher, 2003).

encouraged to use. In this style of writing, the individual is suppressed in order to create the impression of objectivity. It is interesting to note that this style of writing is a relatively recent phenomenon – pre-war physics papers were often full of anecdotes.⁵ When it came to academic referencing, there were two somewhat contradictory schools of thought that were transmitted to us through instruction and marking. On the one hand, there was a fetishization of historic papers by famous physicists – the foundational texts by the founding fathers – that we would be praised for referencing directly in lab reports. On the other hand, especially when it came to research, we were encouraged to reference peer reviewed articles from the last ten years, the newer the better. Glancing at a physics bibliography gives the impression that physics is a dynamic subject that ‘advances’ against the unknown, but in reality the recentness of references is often just a reflection of training. Indeed, it is sometimes difficult to question the recent consensus when you are trained to only draw knowledge from that recent consensus. I remember feeling that this was all very oppressive, that I was losing part of myself by spending so much time writing in a clinical manner, but that it was worth it to become an expert. When I was an expert, I reasoned, I could write in a way that engaged with society again – I just needed to have a better grasp of my subject matter in order to earn that position. On reflection, I feel that this is a normal way to think within a conservative social dynamic – internalising shortfalls and trusting in the system.

This disconnect from society was reflected by the version of history we were taught in the department. Our program induction lecture listed Nobel Prize winners (all white and male), demonstrating the esteemed lineage that we were supposed to uphold. The department was extremely lucky to have its own dedicated building, the internal decoration of which reinforced this history devoid of social context. A bust of Sir Arthur Schuster, arguably the founder of the department, lists all of his post-nominal letters, but tells us nothing about his struggle to be recognised and accepted by a prejudiced society as a German-born British physicist during the First World War.⁶ Another bust in the main lecture theatre portrays Ernest Rutherford, the esteemed splitter of the atom, but nowhere in the department could a student find evidence of his founding presidency of the Academic Assistance Council, an organisation that assisted scholars fleeing from the Nazis.⁷ Most notably, a sombre painting of Patrick Blackett hangs in the library. Blackett was arguably one of the most politically engaged physicists of the last century, a nuclear abolitionist whose views exercised strong influence over post-war Labour governments.⁸ There was no

⁵ E.g. J. N. Lockyer and Arthur Schuster, “Report on the Total Solar Eclipse of April 6, 1875,” *Philosophical Transactions of the Royal Society of London* 169 (1878): 139–54.

⁶ George Clarke Simpson, “Sir Arthur Schuster, 1851-1934,” *Obituary Notices of Fellows of the Royal Society* 1, no. 4 (1935): 421–22.

⁷ David Zimmerman, “The Society for the Protection of Science and Learning and the Politicization of British Science in the 1930s,” *Minerva* 44, no. 1 (March 2006): 25–45.

⁸ Alfred Charles Bernard Lovell, “Patrick Maynard Stuart Blackett, Baron Blackett, of Chelsea, 18 November 1897 - 13 July 1974,” *Biographical Memoirs of Fellows of the Royal Society* 21 (1975): 1–115.

evidence of this in the physics department in which he worked. The history of the department has been sanitised, with its progenitors losing their identities as victims and propagators of political change. The department does engage extensively with its history - there is a large display conveying an internalist hagiography of Schuster that uses original letters and photographs - but most of the department's history pulls apart the physics from the humans who practiced it and the society in which they lived.⁹

However, the department did provide one umbilical cord to society, and this was in the context of employment. On a regular basis, weapons manufacturers would set up bright coloured stalls in the department atrium. This was reflected by the regular newsletter sent out to students: 'BAE systems are currently recruiting students from the University of [...] for their graduate, industrial placement and internship schemes. They're taking on [...] students in particular for a range of roles with healthy salaries. Since they recruit on a rolling basis it would be advisable to get your application in as soon as possible!' One compulsory course on the physics curriculum stood out from the crowd – it was called 'Professional Skills', and was run by representatives from various sectors over several sessions, teaching us how to write CVs and resonate with a corporate environment. Diverse sectors were indeed very interested in us – our skills in numeracy, data analysis and coding crossed the pure/applied divide when it came to solving technical problems. The effort that the department puts into its professional skills course contrasted strongly with the level of ethics education that it provided. Students were required to take an online ethics module, that covered, as written in the course syllabus: 'plagiarism (briefly) and academic good practice, honesty and data integrity, ethical issues for physicists (for example the potential sociological or environmental impact of new technologies weapons, nuclear power and nuclear weapons) and whistle-blowing.' However, the content of the module did not match the description given in the syllabus. One student, who took the course in 2011, told me that the ethics part was 'completely useless' and that the course leader did not deal with many ethics issues due to their background in theoretical physics. For me, the unit consisted of a few online presentations, and was assessed through an online questionnaire of thirteen multiple-choice questions, only two of which covered ethical issues outside of academic malpractice. The two questions were 'What is a deontological ethical framework?' and 'There is always a clear and correct single solution for any ethical issue which arises in a professional situation. True or False?' The second question demonstrates the problematic nature of the

⁹ With this being said, there is a display illustrating the first women to join the department that contains many inspiring quotes from these pioneers. However, there does not seem to be any acknowledgement on this display that the department still has a long way to go in order to achieve a better gender balance in its student intake and (especially) its staff. There are also only a couple of brief mentions of the institutional challenges these women faced (women were not allowed to take engineering courses due to concerns that their skirts would become caught in the machinery, and one of these trailblazers was encouraged by a professor to take science honours instead of physics due to science honours being more applicable to teaching). This display felt like a story of past triumphs as opposed to current struggle, reflecting a conservative notion that equality has already been largely achieved.

course. Instead of encouraging students to reflect on and discuss ethical issues, developing their ability to critically assess a range of possible solutions to ethical problems, the course reduced its assessment of ethics understanding down to a true/false binary. The questionnaire could be retaken *ad infinitum* to get a passing mark – many students skipped much of the content on such online modules and spammed the assessment until the passing grade was met.

The department's online ethics module felt like inadequate signalling to cover a much wider problem that required more fundamental changes. Both implicitly and explicitly, physics and physicists should not be portrayed as separate from society, but as socially intertwined and as a 'society' in itself. Only by doing this can physics institutions start to tackle some of the discipline's glaring issues, such as an outstanding gender and race imbalance when compared to many other sciences,¹⁰ and some more subtle but no less important issues, like the fact that physics courses do not equip their students with the critical skills necessary to evaluate the activities that they may be asked to undertake once out of higher education. Even within academic physics, ethical decisions are not trivial, and there appears to be a worrying pattern emerging where physicists only make token concessions to local communities that protest against large scientific projects.¹¹ Of course, this is to say nothing of military physics-orientated projects such as nuclear weapons, which raise the political and ethical stakes to a new level. Sometimes, the attitudes of senior physicists demonstrate an alarming disconnect with even the most basic considerations of society and ethics, a recent example being Alessandro Strumia's outrageous comments that women are inherently less capable at physics research than men.¹²

I decided I had to leave physics when the façade that I believed in came crashing down once I entered research. I spent the third year of my degree at a US university, and I immediately dove into research, as is usual on undergraduate programmes in that particular university system. Although I personally had a positive experience, I quickly learned that physics was not a panacea of progress that I had believed, and that social and political forces are as important in physics

¹⁰ Luke Holman, Devi Stuart-Fox, and Cindy E. Hauser, "The Gender Gap in Science: How Long until Women Are Equally Represented?," *PLOS Biology* 16, no. 4 (April 19, 2018); Summer Sewell, "'Discomfort Can Break Ground': Physicist Stephon Alexander on the Value of Difference," *the Guardian*, September 1, 2021, <http://www.theguardian.com/us-news/2021/sep/01/stephon-alexander-physics-science-brown-university>.

¹¹ Michelle Broder Van Dyke, "'A New Hawaiian Renaissance': How a Telescope Protest Became a Movement," *the Guardian*, August 17, 2019, <http://www.theguardian.com/us-news/2019/aug/16/hawaii-telescope-protest-mauna-kea>; Amitabh Sinha, "Behind Tragedy of a Death, Story of a Remarkable Scientific Experiment," *The Indian Express* (blog), April 3, 2018, <https://indianexpress.com/article/explained/neutrino-observatory-behind-tragedy-of-a-death-story-of-a-remarkable-scientific-experiment-5121117/>; Sarah Wild, "In South Africa, Opposition Flares against Giant SKA Radio Telescope," *Scientific American*, June 22, 2016, <https://www.scientificamerican.com/article/in-south-africa-opposition-flares-against-giant-ska-radio-telescope/>.

¹² Valerie Jamieson, "Women in Physics: Why There's a Problem and How We Can Solve It," *New Scientist*, November 7, 2018, <https://www.newscientist.com/article/mg24032031-900-women-in-physics-why-theres-a-problem-and-how-we-can-solve-it/>.

as they are in any other human activity. Fellow researchers told me stories of professors using students as ‘battering rams’ when submitting a controversial theory to *Nature* to give them plausible deniability, of how ‘pure’ physics programmes functioned as vehicles for national prestige, of how the physics community sometimes shunned individuals that did not follow a party line. Perhaps I was naïve, but this was not what I had imagined from the outside. Once I got back to the UK there was one experience that confirmed my misgivings. One week, I noticed the mental wellbeing of one of my housemates decline. When I asked what the problem was, he told me that his dissertation supervisor had given him a week to make a calculation that he just could not decipher. The week passed, and it turned out that my housemate had been tasked with making a calculation that no-one had done before, information that his supervisor, who found the situation funny, had withheld from him. It suddenly became clear to me that physics was very much a society with a culture, and that this culture had problems. My housemate’s supervisor was only thinking about ‘the physics’, not the human being who was doing it. As ever, the human aspect was being repressed. Needless to say, there were individuals within the department staff who went against the picture I have painted, who were emotionally supportive and active in engaging with and discussing social issues during meetings in their office, but I think many of the issues with physics pedagogy are systemic and can only be resolved on a systemic basis.

Throughout my physics career, I felt that I was being shaped on a production line to solve technical problems. Not only was I discouraged from taking courses that would broaden my perspective, but I was not given essential ethical tools to make my own decisions regarding my function in wider society. Whether course leaders were conscious of it or not, the department seemed geared towards manufacturing experts that function as stable, valuable commodities rather than free-thinking individuals. Some of the problems are immediately fixable – the department’s ethics course should fulfil what it advertises in the syllabus. Other problems are deep-rooted – the department should engage with society critically in most of its courses, and allow students to write in a way that reflects their unique perspectives as conscientious human beings. Physicists often employ reductionism in an attempt to understand the world, but this mentality need not extend to how physics students are shaped. As is, the way that physics students are educated by the my former physics department only suits the interests of large corporations, whose interests are in graduates who are technically proficient but socially disengaged, representing the ultimate commodification of higher education. The push towards ‘pure’ physics helps with this drive - while commercially valuable skills such as numeracy, data analysis and coding cross the pure/applied divide, a focus on ‘pure’ physics produces commodified graduates who do not engage with social context or ethical issues to an even greater degree. Of course, many academics in the department (as in the rest of the university) are very aware of the commodification of higher education. However, they see this as a corruption of scientific education. I believe instead that the commodification process is not a corruption, but was often integral to the way that physics was taught to me. There were indeed aspects of commodification that were ‘bolted on’ to the

course such as the extensive compulsory professional skills module that made us resonate with corporate culture, but other aspects, such as the writing style that leaves little room for social critique, are integral to the way that physics is performed both within the department and more widely.

Since I left physics and entered the history of science, gaining a broader view of science in the process, I have become ever less comfortable with my experience as a student of science. I have been told by my own undergraduate students that there are similar issues in biology and chemistry. It would appear that undergraduate science just does not engage with social issues, and the main beneficiaries of this disengagement are multinational corporations of questionable moral standing – the graduate schemes of BAE Systems and Goldman Sachs are always open. During a casual meeting since leaving the department, I was told by a physics lecturer that the lack of engagement with wider issues was ‘because we have so much content to get through.’ I found this unpersuasive – there are always choices to be made as to what content is important. During another casual chat with a biology lecturer, I was told how they had been made ‘the token scientist’ on environmental regulation boards, being there for show rather than substance. ‘It’s quite depressing if you think about it too hard.’ they said, as I wondered why they had not resigned from such meaningless positions. Recently, I was struck when watching one of Boris Johnson’s press conferences on COVID, where Johnson was able to prevent one of his scientific advisors from answering a ‘political’ question.¹³ I could not help but wonder if that advisor was acting consciously in complying, or whether his instinct to ‘obey the boss’ was born in an undergraduate science department a long time ago.

¹³ Chris Tighe et al., “Boris Johnson Stops Advisers Commenting on Dominic Cummings’ Lockdown Trips,” *Financial Times*, May 28, 2020, <https://www.ft.com/content/28cc2693-99be-4394-86fb-20dfa541dc48>.

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