

Rolls Royce Deutschland – Non-Technical Report

Berlin, Germany

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Like every Sunday I am sitting in ‘The Barn’ - one of many Berlin’s specialised coffee roasteries. The sour taste of freshly brewed coffee compliments the mellow beats of electronic music that can be heard throughout the city.

Principally, I applied to CaMPUS because I wanted to work with metals after attending lectures on ‘Metals and Alloys’ as a part 1B Material Science course. Thanks to help from Material Science department, Rolls Royce, as well as Armourers & Brasiers company, a couple of months later I could be in the Rolls-Royce office in Berlin working on the multiaxial fatigue behaviour of material Allvac718Plus in order to increase the accuracy of predicting lives until failure of turbine discs in jet engines.

I started my journey in Berlin like every other journey - lost – both in the city and in the work. And when you’re lost you need to explore. So that’s what I did. In the mornings, I was studying the construction of Jet Engines, the specifics of internal Finite Element software SC03 and about multiaxial fatigue. In the afternoons, I just walked around Berlin, trying to observe and see as much as I possibly could. It was difficult because everything was new and I was alone. Coming back to my apartment was a bit lonely but it was very useful experience and made me more confident about who I am.

In work, I wanted to do something extra, and not just study standard content. Therefore, while learning SC03, I also asked some colleges to teach me how to automate things and hence I learned the local scripting language. This allowed me to start writing programs that could make the process of extracting data faster. Automation took a bit more time initially but with each next task it became significantly faster and eventually I was doing it at previously unattainable speeds.

In the city, I found a beautiful library, where I sat after work and read papers on multiaxial fatigue. When I was tired or bored, I went outside and sat next to Bode’s museum. There was always a guitarist there that played some modification of flamenco music and always smiled which made me rest particularly well there. It was probably my favourite place in Berlin. In the night, it transformed into an open air dance floor – playing Tango, and Swing, and Jazz. I often came there just to watch people dance and twice I even managed to ask someone to dance with me. I loved that - except the Valse. Being the only one who can’t dance you always try to find a little square for yourself. Valse has different rules – it seems that there is no little squares and everybody pushes you in all directions. It feels a bit like having around a herd of wildebeest running, while being stuck in the centre.



Figure 1 Me dancing Valse among people who can dance Valse. Original photo. Circa 2019.

The more time I spent, the more everything seemed to fit into places. In work, I knew what to do and when to do it. My ability to script in the local language quickly paid off. Short programs that I wrote were useful enough and so I decided, together with my Supervisor, to write something that wasn't written before. I wrote a script that was able to evaluate life using different lifting criteria (Fatemi Socie, Findley,...). This was done on each space point of the digital copy, each plane orientation and for different loading cases. Doing this is quite complex due to the number of parameters involved, the large number of time points and the tensorial nature of stresses. The program was written in Python and required more than 3000 lines of code.

Software allowed me to take the array of loads and number of cycles and see what the residual error is when life is predicted using different models. Doing this, I evaluated more than 50 different loading cases and managed to evaluate more than 10 different life models, which gave me a good basis of comparison of currently used model in Rolls Royce with other models present in literature. This also allowed me to evaluate live giving different internal empirical coefficients, and re-fit the coefficient for material Allvac718Plus. More details on that can be found in the technical report. I also found a really nice coffeeshop which I started to go to after work. It was called the Barn, and it indeed looked like one. I made good friends with baristas there – one was a student at University of Bath and the other was a peanut butter Entrepreneur all the way from New Zealand. I think everything changes, when there are people knowing your name around town, and it made me feel that Berlin became a place where I lived at the time, and not just visited.



Figure 2. My colleague, my supervisor and me on the trip to Potsdam.



Figure 3. Chamber music session at my supervisor's house.

One concert that I will definitely remember was the 9th Symphony of Beethoven played by Berliner Philharmoniker under the Brandenburg gate. Berlin was also a very important place to me from the

My supervisor was a great help in discussing with me all the ideas and teaching me about the nature of fatigue from time to time. Working in Rolls-Royce Deutschland (RRD) meant also learning a lot about jet engines. My supervisor often took me to talks on new manufacturing methods, showed me the principles of working of a jet engine and taught me a great deal on mechanical engineering. It was also possible for me to see the assembly of jet engines, which was also very insightful. But other than that my supervisor also was a friend. He invited me a couple of times to play chamber music with him (me, him and one more CaMPUS alumni from 8 years ago). We played *Trio in G* by Haydn and *Liebesleid* by Kreisler. He also often spoke to me in German which was very helpful in recovering my ability to speak it. Furthermore, he taught me a lot about classical music, its culture and theory. This was something I will remember and it will definitely have an impact on my life. It made me fall in love with classical music again. I saw three different concerts, in both Berlin's concert house and Philharmony.

family history point of view. Part of my family is German, and so the Berlin wall was always associated in my family with a separation.

At home I started to cook, which is something that I never did before. Financial help from Magdalene College, Armourers & Brasiers and Rolls-Royce meant that I could be completely financially independent from my parents. This required me cooking, and living a more austere life, but this experience makes me more confident that I can manage in my future life. It also gives me a feeling of security, which I hope will benefit me in my future study.

At the end of the research I had a breakdown. I just realised that most of the research I did was done for single mean tensile stress value. This has a significant effect on the results and I thought I won't have enough time to fix it. However, the program and method developed allowed me to repeat most of the research for the next 229 uniaxial data, incorporating different values of tensile mean stress in a very short time. The results of my research put into question the current fit for Allvac718Plus, and if applied by Rolls-Royce can lead to the significant improvement of accuracy of the life prediction. For the last week, I also moved in with my friend living in one of the most trendy areas of Berlin – Kreuzberg. People I was living with then, were environmental activists, and most of their time they spend organising different marches and protests. Sometimes coming back from work I was drawn into discussions on society, and I think it was also good to have their perspective, while working in a big company. It was particularly interesting at the time, as it was just before the Friday for Future.

So, I am here now, sitting in the Barn and looking back at placement, being extremely grateful. The placement had big impact on both my academic as well as non-academic life. I would definitely recommend it to anyone, but also I want to express my gratitude to everyone who made this placement possible including Material Science and Metallurgy Department in University of Cambridge, Rolls-Royce Deutschland and Worshipful Company of Armourers and Brasiers. As an outcome statement, I was deeply torn between what to study next year – whether to do Physics or Material Science. I told myself I will decide at the end of the placement, and probably thanks to the summer work I decided to continue my further education with a Material Science degree.



Figure 4. Me cooking some risotto.

