InFoMM
Industrially Focused Mathematical Modelling

UNIVERSITY OF OXFORD

Ian Roper

I graduated with a first class degree in Natural Sciences from the University of Nottingham. My degree was equally split between the chemistry department and the mathematics department until the final year when I specialised almost entirely in mathematics. I knew I wanted to do a PhD but was not sure about working in academia afterwards. I found out about InFoMM at a postgraduate open day in Oxford and saw the balance between academic mathematical research and mathematics in industry very suited to my aspirations.

My multi-disciplinary undergraduate degree put me in a great position for this CDT since I found I was able to apply my chemistry knowledge to modelling challenges and tackle problems from a more applied mindset. I felt particularly well prepared for the Maths for Energy course, where the mathematics behind solar panels, geoscience and water heating was introduced and explained. However, I also enjoyed expanding my mathematical knowledge in areas I had not seen in my undergraduate degree, for example, in the Data Analytics and Contemporary Numerical Techniques courses. While learning this new mathematical content at a high pace was challenging, the benefits seen in the tasks set in the first year, and the projects since, have been undoubtable.

I enjoyed the large amount of interaction with industry during the first year, as this gave me a first-hand look at how maths is used in industry and how research can impact the wider community. Company-delivered courses given on team work and project management also particularly interested me as this is not something I had ever seen before.

I thoroughly enjoyed the cohort structure of the course and the many opportunities to work in groups to solve problems through weekly challenges. I took on the role of Cohort Representative which involves organising the members of the cohort for events and being the main connection between the CDT management and the students in cohort 2. I have really enjoyed taking a lead role in the cohort and seeing how the CDT is organised and run from the inside.

There were several research projects that interested me at project day. When the cohort came together to have a first attempt at project allocation, it became clear that several of the cohort were also very interested in these projects. To solve this conflict, I opted to try a mini-project with Tesco on data science which was a new area for me but also led to a research project so that I had some security.

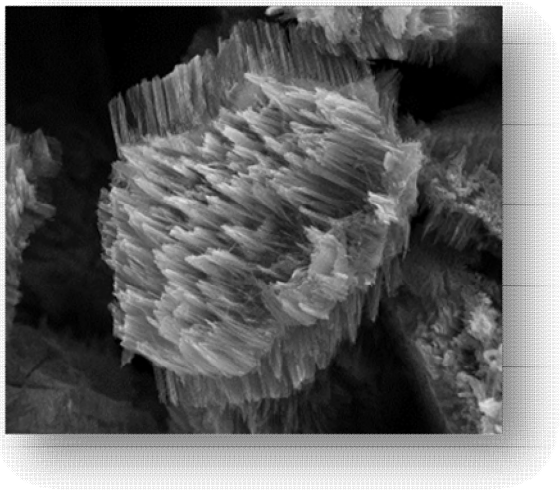
Ian presenting his mini-project results

Ian problem solving with other students

EPSRC
Engineering and Physical Sciences Research Council

In this mini-project, entitled “Short Heuristics Applied To Purchasing Decisions”, I used probability and data science techniques to model how sub-conscious decisions (heuristics) affected customers' purchase choices. This was a fantastic chance to put what I had learnt from the first year of the CDT into practice. I was also invited by Tesco to work in their head office in Welwyn Garden City for two weeks during this mini-project time and I found interacting with the rest of the online product team and finding out how Tesco operates a brilliant experience.

While I undertook my first mini-project, the CDT team searched for an alternative project in which I could combine my previous interests in electrochemistry with my new skills in modelling and computation. The CDT team talked to some new companies they hoped to associate with the CDT that work in this area and a small materials company called Nexeon who make materials for Lithium-ion batteries was interested. I was involved in meetings to discuss the projects and scope the scientific content to ensure this was a project I was very interested in doing. Thankfully, the SME bursary scheme enabled the projects to go ahead and my second mini-project was with Nexeon, entitled “Stress Distributions in Silicon Electrodes During Lithiation”. I was based with Nexeon for this project, which involved modelling the expansion of silicon anodes during lithiation and my preliminary solid mechanics model formulated in the mini-project produced results that compare well with the experimental results obtained by Nexeon.



Silicon microparticle produced by Nexeon

I chose to do the associated research project with Nexeon, entitled “Silicon Anodes in Lithium Batteries”, which started in October 2016. The benefit for Nexeon will be seen through being able to model the expansion of new novel anode designs mathematically before attempting to produce prototypes and thus saving on time and money. Lastly, I am hoping to propose novel anode designs himself through techniques such as shape optimisation and hopefully improve on designs that are currently in production at Nexeon.

I has enjoyed the transition from the more-structured first year of the CDT to the first year of the research project. More freedom in my research and more opportunities to attend seminars and gain experience in teaching has allowed me to continue to broaden my mathematical knowledge. The more in-depth interactions with Nexeon means I am now very involved in the company and have regular meetings with my industrial supervisor to share updates from the company and academic sides of the project. Lastly, I have found the skills sessions and the feedback from academics and students at CDT group meetings useful for progressing my research ideas.