InFoMM
Industrially Focused Mathematical Modelling

UNIVERSITY OF OXFORD

Raquel González -Fariña

I graduated with a BSc degree in Mathematics from the University of La Laguna, Tenerife, before deciding to move to the United Kingdom, where I studied at the University of Bath for a Master's Degree in Modern Applications of Mathematics. In my undergraduate studies, I focused on pure maths, while my MSc afforded me the opportunity to learn more about applied mathematics, and to write a dissertation in collaboration with a company. The success of this work motivated me to pursue further studies in industrial mathematics, and by extension, to apply to InFoMM. One of the benefits of InFoMM, and the thing that singled it out amongst other courses, is the large number of industrial partners affiliated with the programme and the range of projects offered in collaboration with them. This, added to the possibility of combining elements of both academia and industry, led me to decide InFoMM was the route I wanted to take.

The first year of the CDT entailed a well-structured and demanding programme that equipped me with a broad array of skills, covering numerical methods, mathematical modelling, scientific computing, and several other areas. A particular highlight was the mathematical modelling courses, in which we modelled a series of fascinating real-world phenomena such as the mechanisms behind the steering of buses in the Oxford city centre, or how beer behaves when spilled.

I also enjoyed the case studies, in which we were split into teams and worked for an entire fortnight on an industrial challenge. Some of the many topics I worked on included microfluidics, tumour growth, and even building a translator using neural networks. The year was a great chance for my cohort to get to know each another well, improving our teamwork and commercial skills alongside our mathematical abilities, as well as benefiting from skills sessions delivered by academics and industrialists. Various industrialists taught us during the industrial enrichment programme of the CDT. During this programme, we met industry experts and even visited some companies where we were briefed about particular mathematical challenges that they face.

Raquel measuring her cornea at Lein Applied Diagnostics

After the taught part of the first year came two ten-week miniprojects with companies, where we put in practice what we had learned in the classroom. One of the miniprojects I chose was based in Reading, where I worked with Lein Applied Diagnostics on improving the accuracy of their measurements of corneal thickness, vital for the detection of glaucoma. Their prototype instrument for measuring corneal thickness is based on confocal optics and on the detection of two intensity peaks coming from the reflection of the outer and inner corneal layers. I applied signal processing techniques to enhance the signal and reduce the noise, and proposed a different algorithm to detect the peaks. It was a very interesting project, in which I was even able to use data from my own cornea! My approach was successful, and Lein implemented the changes into their prototype, as it had greater measurement accuracy in practice than their previous approach.

Raquel (right) touring a silicon furnace in Kristiansand, Norway

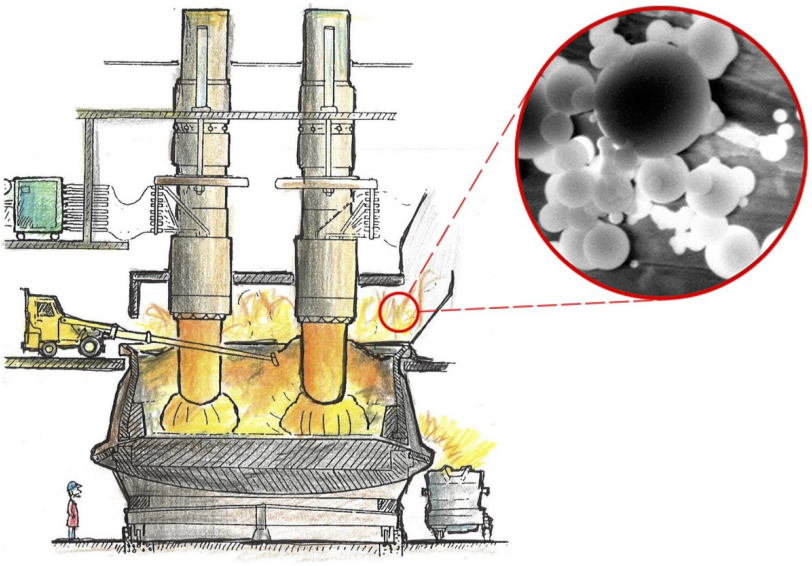
My second miniproject, which was the precursor to my DPhil research project, was on an altogether different subject and in a

EPSRC
Engineering and Physical Sciences Research Council

different area of mathematics. I worked with Elkem on modelling the formation and growth of microsilica particles inside silicon furnaces. I lived in Norway for most of the project and was able to see for myself what silicon furnaces are like. Being close to the company's infrastructure, and working day-to-day with their scientists and wider team, was essential in order to mathematically model the creation of microsilica particles in the silicon furnace hood in a realistic way.

During the second year of InFoMM, I have made substantial progress on the project, and I have been able to predict particle size distributions, temperature profiles, and chemical concentrations at different locations in the furnace hood. This model can be used by Elkem to determine the furnace conditions which are optimal for microsilica formation and growth, and how these affect the particle size distribution and the formation of aggregates. This is essential, since microsilica is sold worldwide to many customers for various applications that require strict material specifications and quality controls. I made multiple visits during the year to Elkem, which were helpful for validating the results of the model, and afforded me the opportunity to give regular presentations and updates to the Elkem team in person. These are an important feedback mechanism for the development of both my research and for developing my wider commercial and interpersonal skills.

There has been a marked transition between the first and second years of the InFoMM programme, with the second year bringing a greater emphasis on individual work and academic freedom, with the possibility of attending weekly seminars and broadening my knowledge of different areas of applied maths. During this year, I've also worked as a teaching assistant in several courses, including Mathematical Biology, and Waves and Compressible Flow. I attended the British Applied Mathematical Colloquium where I presented a poster; this was a fantastic way of meeting other academics and students, and gaining insights into current research in the wider applied mathematics community in the UK. I also attended the European Study group with Industry, where I worked for a week in a group of students and academics in collaboration with PepsiCo, modelling the process of frying a potato crisp. We made a huge amount of progress in a week, as well as consuming a large proportion of the crisps we were modelling! My favourite event of this year to date was InFoMM's Annual Meeting, which was attended by representatives from many of InFoMM's industrial partners. Each student from cohorts one, two, and three showcased a piece of research in a presentation or poster.



Location of microsilica particle formation inside a silicon furnace. Reproduced from *The Si Process Drawings* (T. Hanneson)

After InFoMM, I am considering postdoctoral study, although I may explore options within industry. Through the programme to date, I have been able to experience how maths can be applied to a range of contexts and industries, and how these applications can help to predict and solve problems that had initially seemed intractable.