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Features

Career interview: Business development manager − Smith Institute

by Marianne Freiberger

BOOKMARK

Pure beginnings

Claudia in Canada.

"At school I had two passions: mathematics and languages," says Claudia, "So when it came to choosing my degree, I thought let's do maths and keep the languages as a hobby." A good choice, it turns out, as the maths degree has led Claudia to an interesting and varied career, with lots of opportunity to travel and perfect her language skills.

Claudia Centazzo is from Italy and did her degree in maths at the University of Trieste. "The pure maths courses in Trieste were far more developed than the applied ones; there were more options. Because of this and out of personal interest I chose a fairly pure path for my degree." Claudia's mathematical interests were pure indeed. She soon acquired a taste for *category theory*, an area of maths that seeks to encode all of mathematics in one all−encompassing abstract system. "The beauty of category theory is that it allows you to describe all of maths in one language. It gives you a way of looking at maths from above, from a higher level of abstraction. In a sense it's the foundation of all mathematics." At the end of her degree, which resulted in a dissertation on category theory, Claudia had the chance to meet one of its founders Saunders Mac Lane at the University of Coimbra in Portugal, and the experience made up her mind: research in category theory is what she wanted to do.

Claudia's university supervisor advised her to join an exchange programme with the University of Dalhousie in Nova Scotia, Canada, for a Masters. "I really enjoyed my year in Canada, and they also offered me a PhD place, but I felt that I wanted to come back to Europe. It was a personal decision, not a professional one; it was about the differences in life style between Europe and North America." There is a large and active research group working in category theory at the University of Louvain−la−Neuve in Belgium, and Claudia successfully applied for a PhD place there. In September 2000 she was back in Europe.

During her PhD Claudia was an assistant lecturer, teaching five groups of around twenty students. The job was a rewarding one, partly because of the challenge of teaching in French, but also because she was given ample opportunity to participate in the creation and assessment of the courses she was teaching. "I really enjoyed the job, particularly the relationship with my students. Some of them, especially those on other sciences courses, find mathematics hard, and it's very rewarding to think of ways of making the subject more interesting and getting the students involved."

Lots of pure maths, but still smiling: Claudia during her PhD in Belgium.

Claudia enjoyed her research work immensely. After she finished her PhD in December 2004, she stayed on in a teaching position for a year. But then she was faced with a problem common in academia: before securing a permanent position as a lecturer, researchers often have to go through a string of one− or two−year postdoctoral positions at universities all around the world. "I really didn't like the idea of continuing to hop from one place to another. As an undergraduate, I had already spent six months in Spain [as part of the *Socrates−Erasmus* exchange programme], after that it was Canada, then Belgium I had no regrets, but I felt I had done my bit of travelling. So although I had been offered a temporary postdoctoral position in Portugal, I took the big decision to leave the academic world and settle down."

The place she chose to settle down wasn't her native Italy though for personal reasons Claudia decided to go to the UK in June 2006 and started looking for a job there. "I really wanted to continue doing mathematics, so one of the options would have been to go and work in the City to do financial maths." What put her off, though, were the long hours that often come with a career in finance. "I don't consider myself lazy, but I think that you do need a balance in life. Moreover, I like living in Oxford." She started sending her CV to a variety of other places, and eventually it landed on the desk of Robert Leese, the director of the Smith Institute for Industrial Mathematics and System Engineering.

Penguin eggs and ice cream bubbles

The Smith Institute is a private not−for−profit organisation that uses mathematics to solve real−life problems all kinds of problems. Unknown to many business people, and even some mathematicians, there is a huge range of applications of mathematics that can make a real difference in business success and lead to innovation. The Smith Institute actively seeks industrial problems to tackle and offers companies several ways to access mathematical expertise. It operates both in the private sector, as a mathematical consultancy, and in the public sector, where it manages the Knowledge Transfer Network for Industrial Mathematics (KTN).

The Industrial Mathematics KTN is funded by the Technology Strategy Board (TSB) as part of the Department for Universities, Innovation and Skills, and aims to help businesses benefit optimally from academic expertise in mathematics. This involves advising the TSB on business priorities, identifying what kind of mathematical research would help businesses and helping companies access funding so that it can be carried out. But most importantly it's about putting the people with the problems in contact with the academics that can help solve them. An exciting example of this are the study groups with industry. At these week−long events, companies pay a fee to present the problems they need to solve not next year or next month, but right now. A group of mathematicians then descends on the problems, brainstorming their way to a solution, or at least close to one. Regular study group visitors include the food and home care giant Unilever and the global aerospace and defence company BAE Systems.

Most mathematicians like nothing more than attacking tricky problems by sitting around chatting and bouncing ideas off each other (usually consuming vast amounts of coffee in the process), and to them the study groups are a week of fun and games. Their expertise is so invaluable because of the versatile nature of maths: once you've phrased and solved a problem in abstract terms, you can often use the same approach to solve problems from completely different areas, even problems that at first glance don't seem mathematical at all.

Why do African penguins rotate their eggs? Fluid dynamics can provide an answer.

An example comes from a question posed by Bristol Zoo Gardens at a study group in 2003. The zoo is involved in captive breeding programmes of endangered species, in particular the African penguin. One of the strategies the zoo uses is to remove eggs from the penguin's nest soon after they are laid and to place them into artificial incubators. The mother will usually lay more eggs to make up for the loss, so as long as the artificial incubators do their job well, the zoo ends up with more chicks than the mother alone could produce. To be maximally efficient, the artificial incubators need to mimic natural conditions as closely as possible, and this is where the difficulty lies: penguins, like many other birds, periodically rotate their eggs around their long axis, and no−one knows exactly why they do it. If you don't know why something happens, it's hard to replicate it effectively, and without the rotations the chicks won't hatch.

The study group was asked to investigate this problem by looking at the fluid dynamics within the egg. An initial idea was that the rotation ensures a uniform temperature of 37° throughout the egg, but the study group's mathematical model, based on the equations of fluid dynamics, showed that the effects of rotation on temperature are minimal. They had more luck with a second theory: their model showed that the rotations produced the necessary mixing within the egg, ensuring that nutrients are distributed uniformly and waste is dispersed. The model describes the turning and churning within the egg in detail and provides a theoretical basis to help with programming artificial incubators, not only for penguins but also for other species of bird. The group also recommended what type of further research would be necessary to improve their model. (You can find out more about the model on the KTN website.)

Selling maths

Penguin egg rotation is by no means the strangest problem in the Industrial Mathematics KTN's archives. Air bubbles in ice cream, the perfect bread crust and artificial feet for shoe−testing all make an appearance. It's exactly this surprisingly wide range of applications of maths that Claudia's role at the Smith Institute is about. Her job is to go out and persuade businesses that maths can benefit them she's selling maths.

"My job title is business development manager. As part of my tasks I go to conferences and workshops and network in order to find people that could use our services both the publicly funded KTN services and the private consultancy services we offer." This year, for example, the Smith Institute decided to try and find clients from the retail sector and Claudia attended a conference on efficient consumer response in Milan.

As with penguin eggs and artificial feet, it's not immediately obvious what maths can do for retail, apart from helping to sort out companies' finances. But an example comes again from the study groups with industry. In 2004 a study group investigated mathematical models for consumer behaviour that take account of psychological and sociological aspects, for example that people will be influenced by the buying behaviour of their friends. In one such model consumers are visualised as particles moving in *quality space*. Products are imagined as sources of attractive potentials, the degree of their attractiveness depending on their characteristics. An individual consumer's psychology is reflected in how much his or her "particle mass" is affected by the attractive potentials, and sociology is modelled as a form of particle−particle interaction. Models like these are used to simulate and forecast consumer behaviour and give companies ideas on how to brand their products.

But how easy is it to persuade someone from a non−mathematical sector like retail to consider using maths? "It's not as straight−forward as selling a cup of tea," says Claudia, "Often people don't immediately see the relevance of maths and some conversations end rather quickly." Claudia has found that previous success stories involving well−known companies are much more effective than maths itself when it comes to catching people's initial interest. "But having said that, there are a lot of people who understand the value of maths and the fact that the job they are doing can be made much more efficient using maths. After all, we are not selling category theory, but ways of solving commercial problems."

Claudia in Venice.

When Claudia has managed to spark some interest with a company, they can either work with mathematicians through the Industrial Mathematics KTN, or hire the Smith Institute as a consultancy. The latter usually happens when the company prefers to keep its operations confidential. (This confidentiality, incidentally, is also the reason why she can't tell us much about her recent retail successes.) Claudia's job is to oversee the process from beginning to end. "First we arrange a meeting that will include technical experts from the Smith Institute to make sure that we understand the problem in depth. We move on from there with a rough idea of what we can do, and then bring together our internal expertise to put together a proposal. The proposals have to be highly detailed and technical to convince the client that we can solve the problem. My job is to make sure that the proposal is written, that it is signed and accepted by the client, that the client is still happy at the end, and finally to maintain a future dialogue with the client."

Much of Claudia's job is about human interaction and networking, but she never strays far from the hard maths. When looking for clients she has to have a keen eye for the type of problems that could be solved mathematically. She also proof−reads the technical proposals and the mathematical reports that result from the study groups, so she constantly sees mathematical problem−solving in action. And while her engagement with maths now is very different from what it was during her time as a research mathematician, it's no less fascinating. "I read about so many different and interesting applications of maths all the time, and this really keeps me motivated. I have no regrets about leaving research, and I can see myself staying where I am for some time to come."

About the author

Marianne Freiberger is Co−Editor of *Plus*.

Plus is part of the family of activities in the Millennium Mathematics Project, which also includes the NRICH and MOTIVATE sites.