

UROP: Undergraduate Research Opportunities Programme

A Personal Perspective by John Paul Alexander

John Paul had just completed the second year of an undergraduate degree in mathematics, and embarked on an UROP research experience in the summer of 2015 under the supervision of Dr Demetrios Papageorgiou (Department of Mathematics).

Placement Title: The effect of an electric field on a dielectric fluid-fluid interface

When I initially heard of the UROP (Undergraduate Research Opportunities Program) I was a bit dubious as to what part I could play in some complicated mathematics where I would have to learn so much before I could be of any use. As time went on, and I went to different meetings on the UROP, I came to realize that most projects would not be like this but look more specifically at a certain system or area of mathematics which, although being difficult, would be attainable at my level with guidance. From that point forth I was very keen to find a suitable supervisor and an intriguing project.

I looked at the UROP as a great way to spend a summer putting to good use what I had learnt in the previous year. Obviously no one wants to lose their summer completely so I was glad when I realised I had a month free after my project had finished. I was, and still am, fascinated by the scope and variety of different fields that the subject of Mathematics covers. This program was a way to study and research a small, but hopefully representative, part of one of these fields and determine if I would like to delve further into this field by taking a full lecture course (or more) later on.

Research is also a new idea to the average undergraduate and also to me. How this method of learning and exploring works practically and with a purpose didn't seem very clear and I hoped this research program would help me understand and give an indication as to whether I would like to continue in research after my undergraduate degree has finished.

With such a wide range of fields and topics to do a project on, I started by looking at the lecture courses I had already taken and the ones in the coming second term. These I knew well and had some inkling as to where furthering these subjects would take me. With some research over the Christmas period and the start of the second term, I had decided on some area in fluid dynamics. I have always been inspired and awed by airplanes and formula one cars which use mathematical shapes and geometries to achieve lift and low drag, and the complex mathematical equations that govern the motion of the air. These equations are tough to solve and are mainly done numerically. Fluid dynamics is similar but as we are generally handling incompressible fluids the equations are more amenable equations.

Happily in my second term we studied a non-linear waves course which is an introduction for more in-depth fluid dynamics. I really liked the lecturer's enthusiasm and style of teaching, how we were being taught exploratory way. This course quickly became my favourite and so the lecturer was my first choice for a UROP supervisor. I spoke to him after a lecture, quite early on in the term, and he told me to email him. After an email full of my enthusiasm, he replied that he wouldn't take anyone else on which would exclude me. I was excited but also a little bit apprehensive as to the project which seemed a long way ahead; as I had arranged my supervisor quite early due to not wanting to miss the opportunity. Around the middle of term we handed in the appropriate forms and started to discuss how I should prepare for the UROP.

To prepare for my UROP I went through the material in the non-linear waves course especially the latter part considering how to take it further and completing some of the harder problems given to us. I ensured I knew the techniques we had been taught but as at this point we didn't know which direction the project would take us, it was hard to do more.

At the commencement of my UROP we reviewed the possibilities for the project. There were several options available: to read papers then understand and review the material covered in them, to use a numerical method to approach a specific problem covered in some paper or to consider a problem and, using several papers as a guide, solve or gain an insight into its behaviours. We looked at some papers and problems, finding one suitable to the last option. I decided to go ahead with this choice because I find that a more hands-on approach leads to more understanding and satisfaction. So I wasn't really trained at the start of the project but in reading through the paper, I understood what was expected of me.

Throughout my project I encountered several hiccups and various problems which, after a suitable time of me trying different techniques, were sorted through meeting with my supervisor or by email. Summer is the time of year where many conferences happen, as the lecturers are not teaching, and as a result after a couple of weeks of working directly with my supervisor, he introduced me to one of his PhD students and I worked with him while my supervisor was away. This arrangement worked well and the PhD student was very approachable and understanding.

The main skills enhanced through this experience were how to work independently, how to approach a problem and time management when the time scales are days and weeks. This project means you are working alone generally with one or two checks with a supervisor a week and so you naturally establish a routine, and set goals to achieve for each meeting. I can be very focused and like to complete a section in one go but you begin to see that the tasks need to be split up so you can manage them all in the long run. I really enjoyed the experience and have learned a lot from it (not just mathematically), I think this will definitely influence my future plans and I will be taking a couple of courses in this area too.

The best thing about my research experience was starting from the equations deriving a relation which corresponds directly with other papers and then exploring the properties of the system numerically using this relation.