

## Mac Robertson Travel Scholarship - Final Report: Shahroz Khan

### About me



*Me at the famous Spanish Steps*

I am [Shahroz Khan](#), a 27 Maritime and Mechanical Design Researcher from Pakistan. Currently, I am in the second year of my PhD at the Department of Naval Architecture, Ocean and Marine Engineering (NOME), University of Strathclyde, Glasgow, United Kingdom. At NOME, I am working under the supervision of Professor Panagiotis Kakkis on Intelligent Data-Driven Design Techniques for Maritime Industry. The recent industrial and digital evaluation is transforming traditional design and fabrication techniques at an increased pace. This has brought digitalization and smartness to the contemporary design paradigm. Integrating artificial intelligence, data analytics, generative design and simulation-driven-design open innovative and more efficient ways for computational design. Despite these advancements, the maritime industry is still attached to traditional design and manufacturing techniques.

Therefore, as a part of my PhD work, I am working on the development of design systems, which integrate state-of-the-art machine learning and generative-design techniques along with disruptive simulation paradigms, to (1) Improve the efficiency of design-space exploration, (2) Reduce overall computational cost and (2) Create user/customer-centred designs by integrating human intelligence.

During the academic year 2019-2020, I was awarded with the Mac Robertson Travel Scholarship of value £3500, which gave me the privilege of working as a Visiting Researcher at the Institute of Marine Engineering (INM), Rome, Italy for three months.

### **Why did I apply for the Travel Scholarship?**

The main reason I applied to this scholarship was to enhance my research skills and to work with Dr Matheo Diez at INM. A part of my PhD project is to study and develop dimension reduction techniques which can help to minimize the computational burden during design space exploration and optimization. Dr Diez has great expertise in shape optimization and more specifically in combining these techniques with dimension reduction methods. He has published a great number of research articles on these techniques in well-reputed academic journals. Therefore, this travel award from Mac Robertson Trust gave me a fantastic opportunity to work in a multidisciplinary dynamic environment and to collaborate and learn from pioneer himself of this field.

### **Details of my visit**

I collaborated with Dr Diez and his team for three months at the Institute of Marine Engineering (Istituto di Ingegneria del Mare, INM), which is a public research institute within Department of Engineering, ICT and Technologies for Energy and Transport (Dipartimento di Ingegneria ICT e Tecnologie per l'Energia e i Trasporti DIITET) of the National Research Council (Consiglio Nazionale delle Ricerche, CNR) of Italy.



*The entrance of the Institute of Marine Engineering*

During this time I worked on a project entitled, "Data-driven Techniques for Accelerating Shape Optimisation in Maritime Engineering". The main idea was to develop a dimension reduction technique which can reduce the number of design parameters for any given problem, thereby reducing the overall computational time to perform the optimization process. To achieve this

objective, I started with an extensive literature review to study and understand the existing methods. During this time I had weekly meetings with Dr Diez and with my supervisor, Professor Kaklis, at the University of Strathclyde. During these meetings, we discussed a few of the existing technique and how we can use these techniques to achieve our objective.

After two weeks I had developed a sufficient knowledge on existing literature and along with the discussion with other members, we came up with an idea of combing two existing dimension reduction techniques, Principal Component Analysis and Active Subspace Method, to see if one can achieve better results. Afterwards, I started the implementation of this technique.

Moreover, these techniques are data-drive which require a lot of design data for testing. Creating this data wouldn't be possible during such short time, therefore we decided to use an existing data which was used previously by Dr Diez and his team for their previous work. This dataset was based on DTMB 5415 naval ship.



*DTMB 5415 Naval Ship Model which I used to test my methodology*

During this time I also received help from other lab members on setting up the computational pipeline and to integrate my code with theirs. After one and half month of implementation, we had our initial results ready to be discussed further. During this first week of my visit, I also gave a seminar on my previous work, which was a great opportunity for me to meet different people and get valuable feedback on my research.

The screenshot shows the website of the Istituto di Ingegneria del Mare (INM). The header includes the INM logo and navigation links: ABOUT, RESEARCH, NEWS, WHERE WE ARE, PEOPLE, RESOURCES. The main content area features a seminar advertisement for Shahroz Khan, titled "Geometry-based sensitivity analysis of parametric shapes using Active-Subspace Method". The advertisement includes a diagram of a ship hull cross-section with various parameters labeled, a photograph of an empty lecture hall, and text describing the seminar. The text mentions the seminar was held on Thursday 6 February 2020 (updated) at 12:00 in Sala Consiglio, INM Rome. The abstract describes the research study on the use of the Active-Subspace Method in reduced-order modelling of design spaces and global-parametric analysis to exploit the significance of design parameters based on geometric properties of free form shapes. Examples are provided.

*Screenshot of the INM's website advertising my seminar*

## Impact of the scholarship

The Mac Robertson Travel Scholarship gave me the opportunity to work in an international multidisciplinary environment and collaborate with the experts of my field. My work at INM helped me to understand the practical implication of my research work and provided me with a skill set which will be a great help to successfully complete my PhD. This has also given a chance for my professional development. The feedback and supervision I received from Dr Diez while working on this project helped me a lot and gave me a platform to not only get technical knowledge but also helped me to further polish my skills for conducting research. I would also like to say the experience I gained from the trip would not be possible without generous support from Mac Robertson Travel Scholarship.

Apart from working on the research project, it was an amazing experience to live in Rome. I must say it's a magical city. I spend most of my time exploring the city and trying amazing Italian cuisine. Moreover, it also gave me the chance to make many Italian friends and to experience Italian culture at first hand.



*Some of the pictures I took while exploring the city*

I will miss many things from this experience and my time in Rome but what I will miss the most is the Pizzarium, which is arguably the most delicious and unique Roman-style Pizza in all Italy.



*Pizzarium*

## **Acknowledgements**

I would like to pay my deepest gratitude to Professor Kaklis for arranging this collaboration and to Dr Diez for allowing me to work with him. I am also thankful to Dr Andrea Serani for helping me on using the code and setting up the test model and Riccardo Pellegrini, a fellow lab member, for showing me around the research centre. Last but not the least my Airbnb host, Andera, who was of great help in guiding me around the city.