2022_74_Dyson_Cardin: Data-Driven Optimisation of Electric Airport Systems for Better Climate Sustainability and Resilience

Supervisors: Michel-Alexandre Cardin (mailto:m.cardin@imperial.ac.uk); Antonio del Rio Chanona, Department of Chemical Engineering; Joeri Rogelj, Centre for Environmental Policy, Grantham Institute

Department: Dyson School of Design Engineering

Short-haul flights are currently responsible for up to 50% of all emissions produced by the airline industry, contributing significantly to greenhouse gas emissions and climate change (Roland Berger, 2020). There are, however, significant efforts across the industry to achieve net zero emissions before 2040. Indeed, as of 2020, several start-up companies analysing infrastructure design for Urban Air Mobility (UAM) have accounted for up to $907 million in venture funding, with 42% of current electric aircraft design in production being for UAM usage (Hader, Baur et al., 2020). While there has been extensive research in electrification of aircraft design, there has been comparatively less efforts on the design of airports, heliports, and vertiports systems that will accommodate future UAM. This was highlighted by Uber as the “greatest operational barriers to deploying UAM in cities” (Uber Elevate, 2016).

To address this important challenge, in this project you will use machine learning and data analytics to develop a data-driven model that will enable analysing the design of future UAM infrastructure systems. Your model will enable optimising the design of such systems considering economic and engineering aspects, as well as potential impacts on emissions and climate change. You will account for inherent uncertainties in the airline sector (i.e., passenger flows), but also consider possible disruptions to the sector, such as recently experienced through the COVID pandemic.

To deal with uncertainty, you will exploit the concept of Flexibility in Design – also known as Real Options – to enable the system to adapt, reconfigure, and evolve as uncertainty unfolds. Using techniques from deep reinforcement learning, you will identify optimal policies for business and governments to design, deploy and operate such systems in a multi-stakeholder setting. This is important, since such airports may be operated by independent organisations working towards a common goal (i.e., fulfilling demand for short-haul flights), while satisfying economic and operational constraints. In doing so, you will contribute to the body of knowledge in the field of reinforcement learning, where little work has been done to investigate multi-agent interactions in real systems.

The project will help you develop a multidisciplinary skill set in future airport design, systems engineering, climate modeling, economic analysis, as well as deep reinforcement learning, data science, uncertainty modeling, and policy-making. You will synthesize your findings to provide concrete recommendations to policy-makers and business leaders in this nascent industry that promises to have a huge impact on future transportation systems. You will quantify the impact of your recommendations on emission and climate abatement policies, keeping an eye on enabling better policies for climate sustainability and resilience.

For more information on how to apply to us please visit: https://www.imperial.ac.uk/grantham/education