AEROSPACE DESIGN & MANUFACTURING

A case study with Rolls-Royce plc.

Engineers and scientists in Rolls-Royce have been using equadratures for a while now, in the areas of (i) design space exploration, (ii) uncertainty quantification, and (iii) manufacturing assessments, led by Prof Shahrokh Shahpar. Shahrokh is the Rolls-Royce Fellow in Aerothermal System Design and an international authority on optimisation and uncertainty quantification. His team was the first to pick up equadratures and test it on various Rolls-Royce industrial problems.

> Although there are many packages for parameter-space analysis and design space exploration, equadratures is in a league of its own. Its models are fast to train, and test compared to many popular neural network models. Furthermore, it is computationally efficient — requiring only a small batch of data and finally its models are easily interpretable! This makes a fantastic tool for our engineering teams
>
> Shahrokh Shahpar.

The outcome of the relationship between the equadratures development team and Rolls-Royce has been the development of three new tools:

1. Subspace performance maps: better design space exploration tool.
2. Manufacturing envelopes: better manufacturing assessment strategy.
3. Uncertainty quantification framework: exponentially faster sampling methods.

These methods are widely viewed as pioneering— where subroutines in equadratures are used to develop application-driven demonstrators. The engagement between equadratures and Rolls-Royce has been three-fold and encompasses the following.
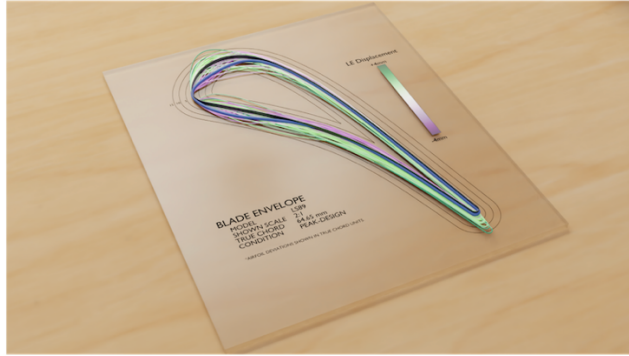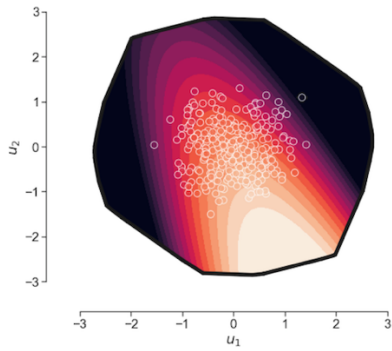
equadratures

Two tools developed with Rolls-Royce (left) subspace performance maps; (right) manufacturing envelopes.

1. A <u>strong research collaboration</u> — i.e., understanding Rolls-Royce workflows and where equadratures can fit in to solve niche but important problems.
2. Delivery and presentation of technology demonstrators such as the instant CFD and blade envelopes to the wider Rolls-Royce community.
3. <u>Periodic workshops</u> to ensure equadratures is used to maximise value-add.

The benefit to Rolls-Royce can be best summarised in two points:

1. Significant savings in engineers' time — moving away from expensive and uninterpretable models to equadratures for a variety of tasks, and
2. Greater confidence in the design & analysis strategies based on a sound understanding of the fundamental statistical and mathematical concepts.

equadratures