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## Joaquim R R A Martins

*University of Michigan, USA*

### Aircraft design via numerical optimization

Wing shape is a crucial aircraft component that has a large impact performance. Wing design optimization has been an active area of research for several decades, but achieving practical designs has been a challenge. One of the main challenges is the wing flexibility, which requires the consideration of both aerodynamics and structures. To address this, we proposed the simultaneous optimization of the outer mold line of a wing and its structural sizing. The solution of such design optimization problems is made possible by a framework for high-fidelity aerostructural optimization that uses state-of-the-art numerical methods. This framework combines a three-dimensional CFD solver, a finite-element structural model of the wing box, a geometry modeler and a gradient-based optimizer. This framework computes the flying shape of a wing and is able to optimize aircraft configurations with respect to hundreds of aerodynamic shape and internal structural sizes. The theoretical developments include coupled-adjoint sensitivity analysis and an automatic differentiation adjoint approach. The algorithms resulting from these developments are all implemented to take advantage of massively parallel computers. Applications to the optimization of aircraft configurations demonstrate the effectiveness of these approaches in designing aircraft wings for minimum fuel burn. The results show optimal trade-offs with respect to wing span and sweep, which was previously not possible with high-fidelity models.

### Biography

Joaquim R R A Martins has completed his MSc in Aeronautics and Astronautics at Stanford University and ME in Aeronautical Engineering at the Imperial College, UK. He has completed his PhD in Aeronautics and Astronautics from Stanford University of California, USA. He is a Professor at University of Michigan, USA. His academic areas are focused on "Aircraft design, mechanics of structures and design optimization techniques".

[jrram@umich.edu](mailto:jrram@umich.edu)

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