Scilab optimization process control with mesh morphing

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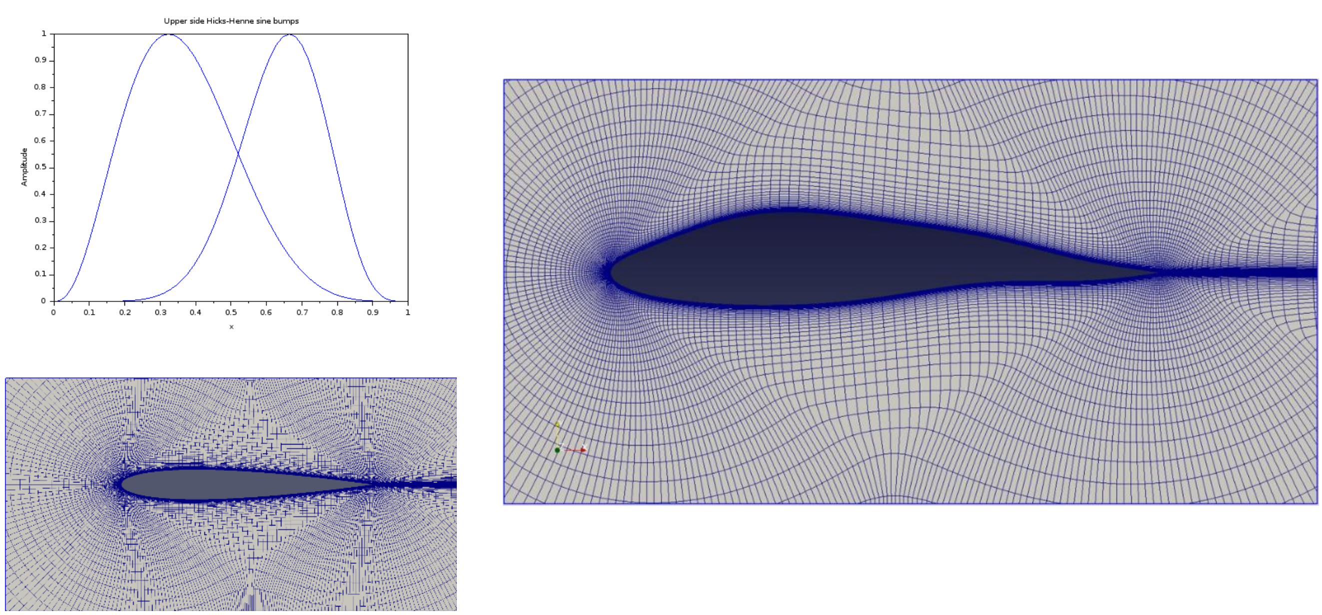
One of today's focus for industrial organizations is about optimization. Indeed, in such organizations, the engineering process around CFD is quite long and heavy, between the CAD design, meshing, solving and post-processing. As a result, it appears difficult to iterate on design, geometry and scenarios, and thus doesn't allow design space exploration. In this presentation we will show how to couple two ESI open-source solutions, OpenFOAM & Scilab, based on the simple case of a 2D airfoil shape optimization. The open-source dimension will prove useful to free the simulation from its traditional organizational constraints.

Scilab for complex control functions

Thanks to OpenFOAM capabilities, it is easy to set your own boundary conditions to patches. Those can be complex functions easily defined thanks to Scilab. For example, it is easy implementing Hicks-Henne sine bumps functions coupled to OpenFOAM mesh morphing features in order to make smooth perturbations over an airfoil.



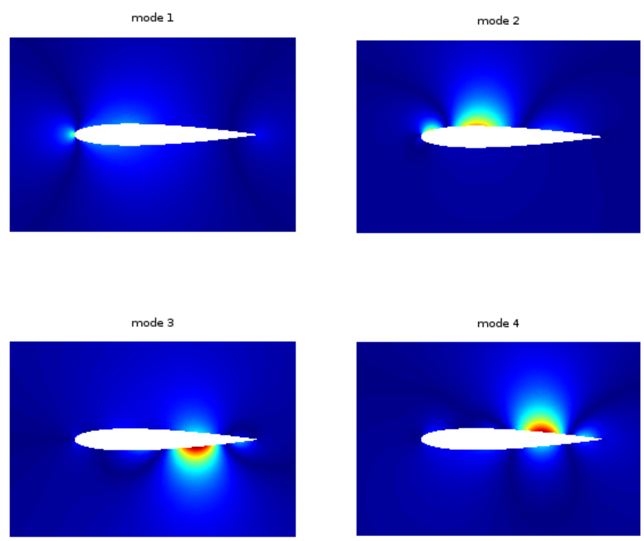
OpenFOAM + Scilab mesh morphing from NACA 0012

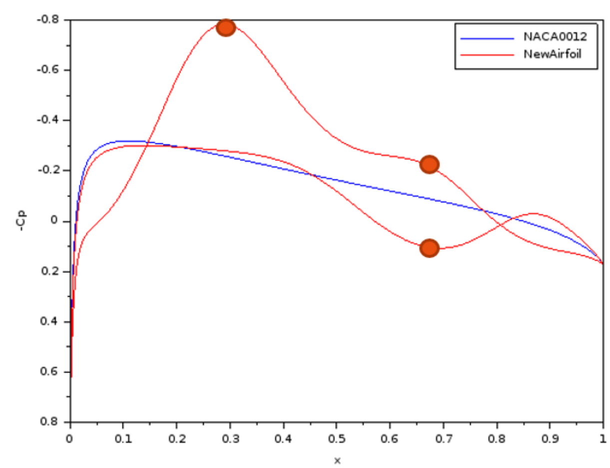
Scilab for process automation

Thanks to OpenFOAM structure (compiled applications and dictionaries), it is possible to manage an OpenFOAM case with Scilab. Based on an OpenFOAM template case, it is easy to access all the pre- and post-processing data located in text files and run the applications through Scilab command line. It is particularly interesting for repetitive tasks such as setting a complete Design of Experiment (DOE) for a design space exploration. Note that it could be easily shaped as an application thanks to Scilab GUI creation capabilities.

Scilab for advanced engineering tools

Finally, it is possible to leverage OpenFOAM post-processed data an Scilab advanced tools in order to make surrogate modeling (Proper Orthogonal Decomposition) or optimization (Gradient descent or Genetic Algorithm).





First 4 most energetics modes of pressure field (left) and 3 design points optimum airfoil Cp (right)