ENABLING MULTISCALE ANALYSIS OF VERY LARGE COMPOSITE STRUCTURES

S. T. Pinho[1*], M. Matos[1,2], R.O.S.S. Costa[1], A. Ibbotson[2], M. Ostergaard[2]

[1]Dept. Aeronautics, Imperial College London, UK. [2]Airbus, Filton, UK

* silvestre.pinho@imperial.ac.uk

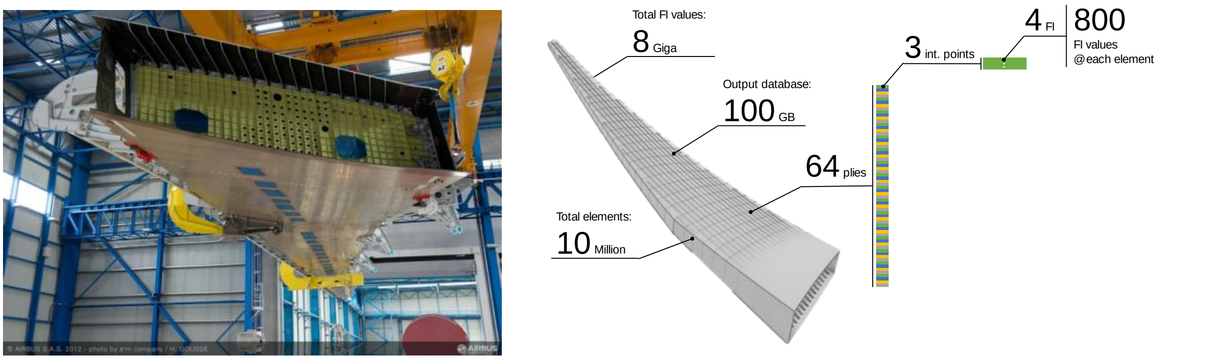
Modern composite structures, such as aircraft wings, are typically very complex structures 10s of meters long (Figure 1a). Design engineers therefore insist that, to be of practical interest, numerical damage models are required to be usable at this scale, with the constraint of being as accurate as possible.

The damage tolerance of these large structures is often the consequence of damage processes that become unstable at very small ply-level scales of o~0.1mm. Researchers therefore often insist that damage models are required to be developed at this scale, with the constraint of being as scalable as possible.

There is a wide gap between the two positions described above, and the outcome is that failure models for composites, including those available in commercial software, tend not to be readily usable for the design and analysis of very large composite structures (such as an entire aircraft wing, see Figure 1b). However, to enable multiscale analyses, hot-spots need to be identified at the large scale.

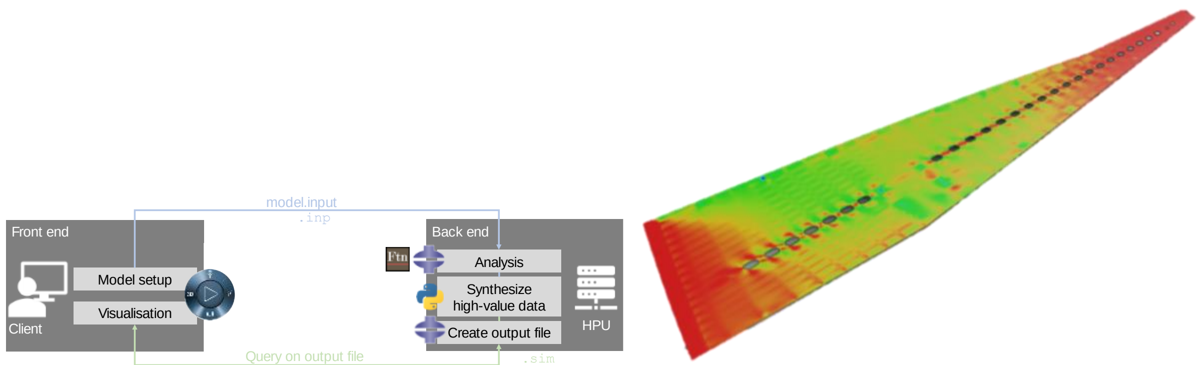
In this work, we propose a novel multiscale methodology developed around a different paradigm (Figure 2a): that post-processing of the results to define useful data for decision making (identifying hot-spots for multiscale analysis) is carried out and integrated into the same results database at the back-end (i.e. by nodes of a high-performance computing cluster), providing the user with access to high-value data at a lower computational cost to the client machine.

We show that the methodology proposed can successfully be used for running non-linear models of large wing boxes with o~10M elements (Figure 2b), and to correctly identify hotspots in this structure for subsequent detailed analysis. We detail examples of application of this methodology to a realistic wing model and identify the possibilities it enables. This provides an effective route for design of composites structures of this size using physically- based and effective analysis methods.



(a) (b)

Figure 1. (a) Large composite structure (wing box). (b) Typical size of an FE model for a wingbox.



(a) (b)

Figure 2. (a) Proposed modelling approach. (b) FE results for lower wing cover.