

POWERFLOW FOR HIGH-LIFT AERODYNAMICS SIMULATION



3DEXPERIENCE®

1. Transient High-Lift Simulations for Aerospace Applications

The development of high-lift systems is a major step in the design of modern aircraft and has a strong influence on the overall aircraft performance and cost. Many trade-offs must be considered, including performance, maximum lift, weight, cost, and noise. Today, the design and test of high-lift systems still requires many months of wind tunnel tests. Wind tunnel tests are costly and generally do not fully represent real flight conditions accurately — installation effects can influence the results, small-scale models cannot fully resolve all geometric details, and flight Reynolds and Mach numbers cannot be reproduced easily.

1.1. Technical Challenges

The aerospace industry looks to CFD for the answer. Simulation can be used during the preliminary and conceptual design stages — before wind tunnel or flight tests are feasible. Design alternatives can be pursued with much more flexibility and at lower cost than in the wind tunnel. And CFD can, at least in theory, overcome the installation and scale effects of a wind tunnel.

However, the accurate simulation of the highly unsteady and complex flow over a high-lift wing (in particular, the prediction of maximum lift) is still out of reach for traditional CFD tools. Meshing of a full wing takes weeks and requires significant simplifications, with unknown effects on solution accuracy. In addition, simulations are generally steady-state, ignoring the important effects of the unsteady nature of the real world — particularly for high angles of attack when large regions of separated unsteady flow are dominating the lift performance.

1.2. SIMULIA Solution

The PowerFLOW suite offers a promising alternative. High-lift wings can be represented in full geometric detail with slats, flaps, brackets, fairings, and all other details included — no simplification necessary. PowerFLOW simulations are inherently transient, and can therefore predict the highly unsteady flow over high-lift systems more accurately — to maximum lift and beyond. Numerous validations with industrial partners have confirmed that PowerFLOW can predict high-lift aerodynamics more accurately than traditional CFD tools. With modern computational hardware, an overnight turnaround is possible, even for a complete and fully detailed wing.

High-lift aerodynamics applications of PowerFLOW include:

- Prediction of c_L , max
- Optimization of slat and flap configurations
- Vortex generator design and placement
- Interaction of landing gears with high-lift systems
- Flap edge and slat noise reduction
- Flow control