International Forum on Aeroelasticity and Structural Dynamics
IFASD 2026
16 - 19 June 2026, Goettingen, Germany

NASA LANGLEY CONTRIBUTIONS TO THE AEROELASTIC OPTIMIZATION BENCHMARK WORKING GROUP

Andrew S. Thelen,* Kevin E. Jacobson,† Bret K. Stanford‡1

1NASA Langley Research Center, Hampton, VA, 23681

ABSTRACT

The AIAA prediction workshop series, such as the Drag Prediction Workshop [1], the High Lift Prediction Workshop [2], and the Aeroelastic Prediction Workshop [3], have been invaluable for assessing and advancing the state of the art for simulation tools. These workshops focus on a common suite of cases, often with wind tunnel data, with participants from many organizations providing results using their different simulation tools. An in-depth comparison between results can be used to identify strengths and shortcomings of the various computational methods involved. The AIAA Aerodynamic Design Optimization Discussion Group (ADODG) [4] similarly provided a common suite of aerodynamic optimization problems that allowed participants to compare methods specifically geared towards aerodynamic shape optimization.

At AIAA SciTech 2024, a special session kicked off the beginning of another workshop, the High-Fidelity Aeroelastic Optimization Benchmark Working Group, which seeks to achieve similar goals as ADODG but for aeroelastic optimization problems. The session established a set of specific aeroelastic design problems proposed by Gray and Martins [5] with a few modifications based on group discussions. At AIAA SciTech 2025, the three established design problems were tackled by several groups [6–9]. These optimization problems are based on a well-established MACH framework tutorial wing, shown in Fig. 1, which is based on the Boeing 717 wing geometry. The first of these optimization cases minimizes the mass of the MACH tutorial wingbox subject to structural failure constraints and trim constraints computed during 2.5g pull-up and -1.0g push-down maneuvers. The design variables include structural parameters with the addition of the angle of attack of the two maneuver conditions. The second and third cases build on this first case; their objective is to minimize the fuel burn based on an additional transonic cruise condition. The second case adds geometric design freedom while maintaining a fixed planform, and the third case allows the planform to be optimized as well. The addition of the geometric design variables introduces the need for additional constraints such as having sufficient volume for fuel in the wingbox and minimum leading edge radius and trailing edge thickness constraints.

At the previous workshop at SciTech 2025, the current authors presented results for the first case [6]. This paper will therefore extend our previous results to cover those of the second and third optimization cases using the same toolset developed at NASA Langley Research Center. This toolset, in particular, includes the Stabilized Finite Element (SFE) solver in the

*Research Aerospace Engineer, Aeroelasticity Branch, andrew.s.thelen@nasa.gov.
†Research Aerospace Engineer, Aeroelasticity Branch.
‡Research Aerospace Engineer, Aeroelasticity Branch.

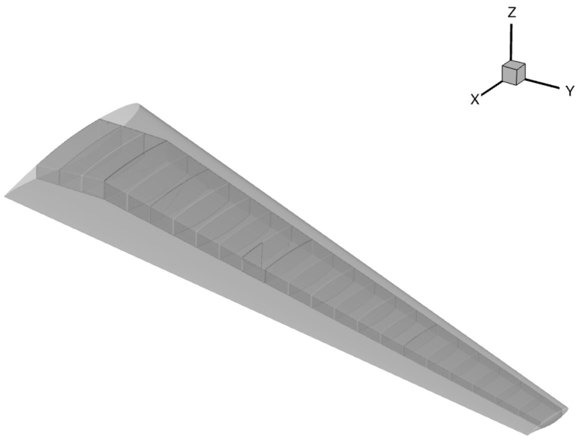

Figure 1: The MACH tutorial wing's outer mold line and wingbox.

FUN3D CFD suite [10, 11], in-house Vortex Lattice Method (VLM) and structural solvers, and the Matching-based Extrapolation of Loads and Displacements (MELD) [12] transfer scheme. The framework is implemented with the help of the MPhys [13] library for OpenMDAO [14]. The geometry parameterization will be implemented using Free Form Deformation (FFD) control points within the pyGeo [15] python package.

1 References

[1] Vassberg, J., Tinoco, E., Mani, M., et al. (2010). Summary of the Fourth AIAA CFD Drag Prediction Workshop. In *28th AIAA Applied Aerodynamics Conference*.

[2] Rumsey, C. L., Slotnick, J. P., and Sclafani, A. J. (2019). Overview and summary of the third aiaa high lift prediction workshop. *Journal of Aircraft*, 56(2), 621–644.

[3] Heeg, J., Chwalowski, P., Schuster, D., et al. (2013). *Overview and Lessons Learned from the Aeroelastic Prediction Workshop*. American Institute of Aeronautics and Astronautics.

[4] Martins, J. (2022). Aerodynamic design optimization: Challenges and perspectives. *Computers & Fluids*, 239.

[5] Gray, A. C. and Martins, J. R. R. A. (2024). A proposed benchmark model for practical aerostructural optimization of aircraft wings. In *AIAA SciTech Forum*. Orlando, FL. doi: 10.2514/6.2024-2775.

[6] Jacobson, K., Stanford, B., and Thelen, A. (2025). Investigations of an Aeroelastic Optimization Benchmark Problem With MPhys and FUN3D. In *AIAA Scitech 2025 Forum*. Orlando, FL: American Institute of Aeronautics and Astronautics. doi:10.2514/6.2025-2812.

[7] Burke, B. J., Engelstad, S. P., and Kennedy, G. J. (2025). Evaluation and Optimization of the Open AeroelasticBenchmark Model using FUNtoFEM. In *AIAA Scitech 2025 Forum*. Orlando, FL: American Institute of Aeronautics and Astronautics. doi:10.2514/6.2025-2814.

[8] Volle, F. A. (2025). Aero-Structural Optimization of the AIAA MDO BenchmarkModel with TAU and Lagrange. In *AIAA Scitech 2025 Forum*. Orlando, FL: American Institute of Aeronautics and Astronautics. doi:10.2514/6.2025-2815.

[9] Gray, A. C. and Martins, J. R. R. A. (2025). Aerostructural Optimization of the Simple Transonic Wing Using MPhys, ADflow, and TACS. In *AIAA Scitech 2025 Forum*. Orlando, FL: American Institute of Aeronautics and Astronautics. doi:10.2514/6.2025-2813.

[10] Anderson, W. K., Biedron, R. T., Carlson, J.-R., et al. (2024). FUN3D 14.1 Manual. Tech. Rep. TM-20240006306, NASA.

[11] Anderson, W. K., Newman, J. C., and Karman, S. L. (2017). Stabilized finite elements in fun3d. In *55th AIAA Aerospace Sciences Meeting*.

[12] Kiviaho, J. F. and Kennedy, G. J. (2019). Efficient and robust load and displacement transfer scheme using weighted least squares. *AIAA Journal*, 57(5), 2237–2243.

[13] Yildirim, A., Jacobson, K., Anibal, J., Stanford, B., Gray, J., Mader, C., Martins, J., and Kennedy, G. (2025). MPhys: A Modular Multiphysics Simulation Package using the OpenMDAO Framework. *Structural and Multidisciplinary Optimization*, 68(1). doi:10.1007/s00158-024-03900-0.

[14] Gray, J. S., Hwang, J. T., Martins, J. R. R. A., et al. (2019). OpenMDAO: An Open-Source Framework for Multidisciplinary Design, Analysis, and Optimization. *Structural and Multidisciplinary Optimization*, 59, 1075–1104. doi:10.1007/s00158-019-02211-z.

[15] Hajdik, H. M., Yildirim, A., Wu, E., et al. (2023). pyGeo: A geometry package for multidisciplinary design optimization. *Journal of Open Source Software*, 8(87), 5319. doi:10.21105/joss.05319.