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OPTIMIZATION FOR SUPERSONIC VISCOUS
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ABSTRACT

WING-SECTION OPTIMIZATION
FOR SUPERSONIC VISCOUS FLOWSCem C. Item
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The recent interest in the High Speed Civil Transport (HSCT) has resulted in renewed research studies of optimized supersonic cruise transport configurations. Incorporation of flow viscosity effects in the design process of such a supersonic wing is currently under investigation. This may lead to more accurate problem formulations and, in turn, greater aerodynamic efficiency than can be obtained by the traditional, inviscid, linear theories. In this context, for a design code to be a candidate for a complex optimization problem, such as three-dimensional viscous supersonic wing design, it should be validated using simpler building-block shapes.

To optimize the shape of a supersonic wing, an automated method that also includes higher fidelity to the flow physics is desirable. With this impetus, an aerodynamic optimization methodology incorporating Navier-Stokes equations and sensitivity analysis had been previously developed. Prior to embarking upon the wing design task, the present investigation concentrated on testing the flexibility of the methodology, and the identification of adequate problem formulations, by defining two-dimensional, cost-effective test cases. Starting with two distinctly different initial airfoils, two independent shape optimizations resulted in shapes with very similar features. Secondly, the normal section to the subsonic portion of the leading edge, which had a high normal

angle-of-attack, was considered. The optimization resulted in a shape with twist and camber, which eliminated the adverse pressure gradient, hence, exploiting the leading-edge thrust. The wing section shapes obtained in all the test cases had the features predicted by previous studies. Therefore, it was concluded that the flowfield analyses and the sensitivity coefficients were computed and fed to the present gradient-based optimizer correctly. Also, as a result of the present two-dimensional study, suggestions were made for problem formulations which should contribute to an effective wing shape optimization.