Improved Experimental/Computational Aerodynamics Comparisons

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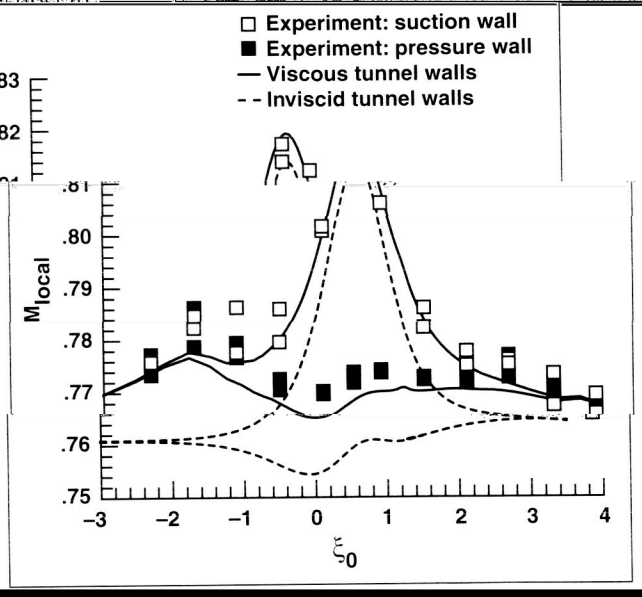
Improved turbulence modeling requires accurate computational simulation of carefully controlled experiments. Discrepancies between computational predictions and experimental results are the measure of turbulence model performance. The simulation of experimental conditions is one possible source of discrepancy between computation and experiment. This problem is most acute for the separated flow cases, in which small changes in experimental conditions can sometimes change the flow substantially. An improvement in the simulation of the wind tunnel walls dramatically improves the simulation of transonic tunnel experiments at transonic speeds, the expanded range in which civil transport aircraft fly.

The improved simulations include the effect of the tunnel-wall boundary layers. The boundary layer is a region, very close to a wall, where the airspeed changes dramatically in a very small distance. In this work, the fidelity of experimental simulations is increased by computing, instead of approximating, the effects of the tunnel-wall boundary layers.

The first figure shows pressures measured on the wind tunnel walls compared with those predicted using the old method (inviscid walls) and the improved method (viscous walls). The viscous-wall simulations improve the prediction of the experimentally measured pressures over the entire tunnel



pressures reasonably well, but misses the lower "pressure" surface by a substantial margin.

Experimental wing pressures are compared with the results of computations in the second figure. Both "viscous-wall" and "inviscid-wall" simulations match the experiment on the wing upper surface. Only the viscous-wall simulations match the lower surface pressures, however. This discrepancy is tied directly

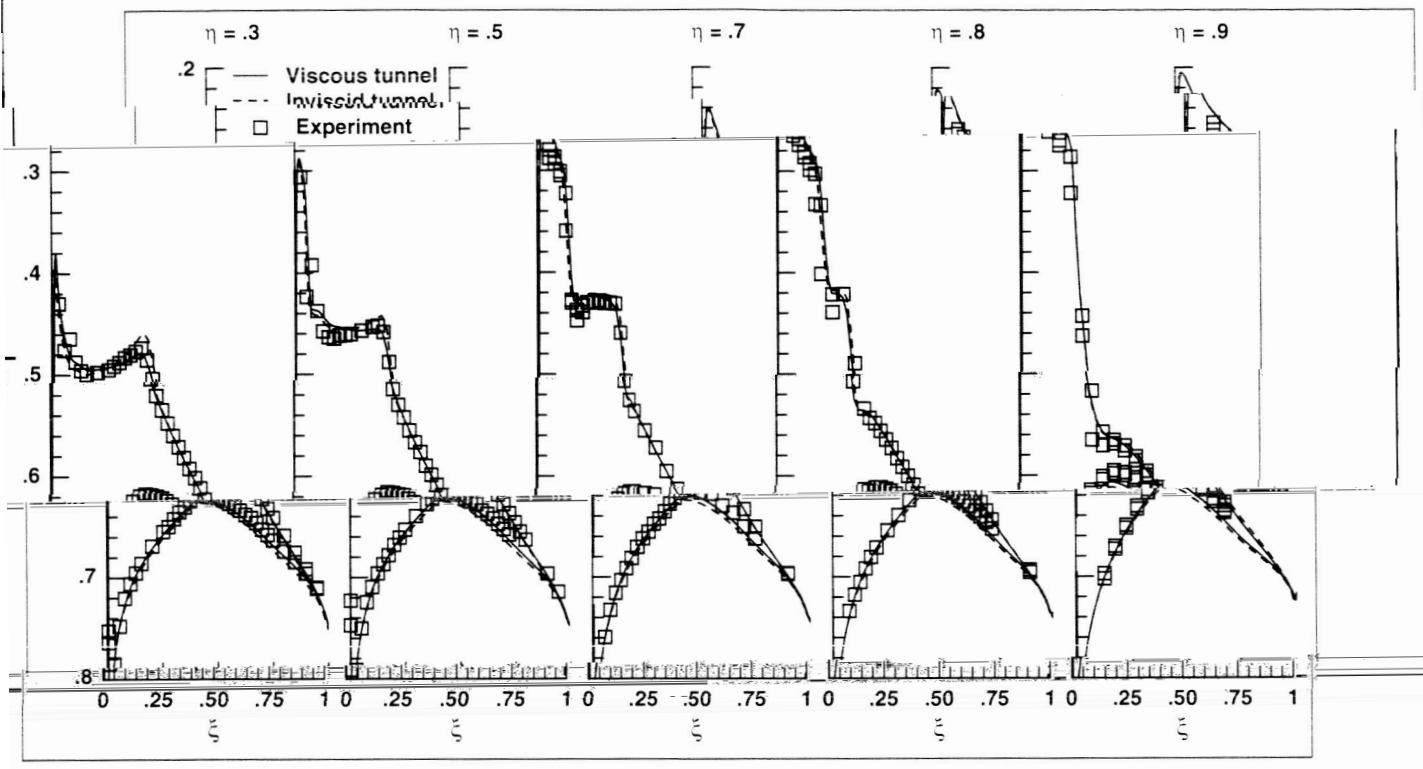


Fig. 2. Wing pressures.

to the effects of the wing pressure field on the tunnel-wall boundary layers. The tunnel-wall boundary layers create an effect similar to that of the divergence of the tunnel walls around the wing, lowering the effective Mach number/airspeed. By including

the local environment of the wing is more accurately simulated.

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