An Application of Numerical Optimization to a Wing Twist of SST Wing-Nacelle Configuration

Tetsuo Yamazaki and Mitsuru Saito
Aerodynamics Research Section, Aerospace Division. Fuji Heavy Industries Ltd.

In designing an aircraft it is necessary to evaluate the characteristics of various configurations by wind tunnel tests, CFD methods, and other estimation methods. So far it took too much time because of many design parameters. But improvements in numerical algorithms and computer hardware have made it possible to design an optimized configuration automatically. Therefore in this paper we have applied numerical optimization methods to the wing twist distribution of SST wing-nacelle configuration that maximizes the lift to drag ratio at a constant lift coefficient.

In order to improve the lift to drag ratio it is important to reduce the drag due to the wing-nacelle interference. The wing twist, the wing camber, and the nacelle position affect the flow field in the region between the wing and the nacelle. So we selected the wing twist as a design parameter, because the design process is simplified.

The analyzed model is given in figure 1. It has a cranked arrow wing and two nacelles which have two dimensional intakes.

The conditions of the numerical optimization are below.

Initial configuration: Wing-nacelle configuration
Initial wing twist: 0deg
CFD method: Panel method
Optimization method: Sequential quadratic programming, Modified feasible directions algorithm, Genetic algorithm
Objective: Maximize the lift to drag ratio
Constraint: CL=0.10
Variables: Wing twist angle at 5 sections.
η (=2y/b)=0.1,0.4,0.5045,0.75,1.0
Center of twist: 0.70x/c
Design point: Mach2.0

Surface pressure distributions of the initial configuration and the optimized one are shown in figure 2. At the optimized the interference between the lower surface and the nacelle is reduced, and the drag coefficient of the optimized is lower than that of the initial(see figure 3). And we have examined the dependence of the result on the optimization method, but the results of three methods are the same(see figure 4). Therefore the designing by numerical optimization methods is effective for SST wing-nacelle configuration.

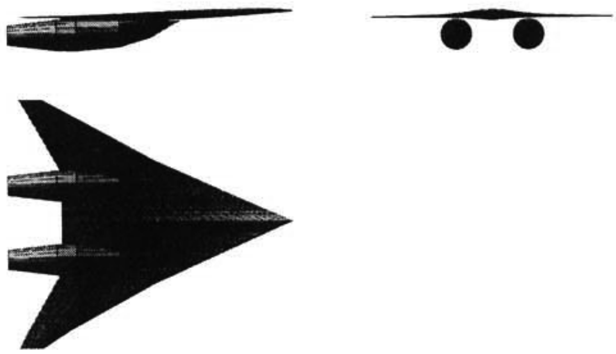
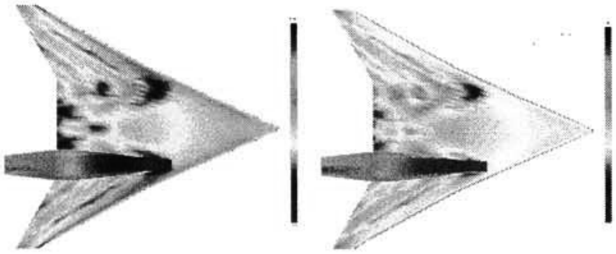


Figure 1 Analyzed model



(a)Initial (b)Optimized

Figure 2 Lower surface pressure distribution

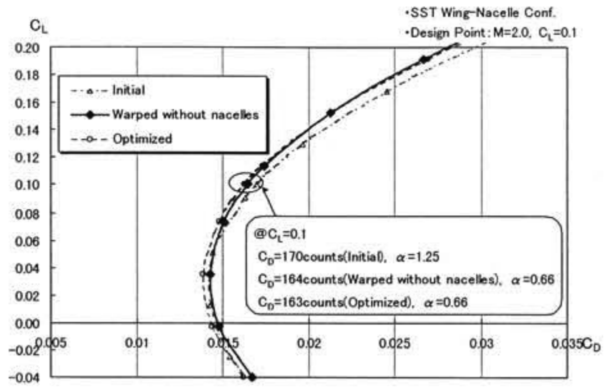


Figure 3 Drag polar

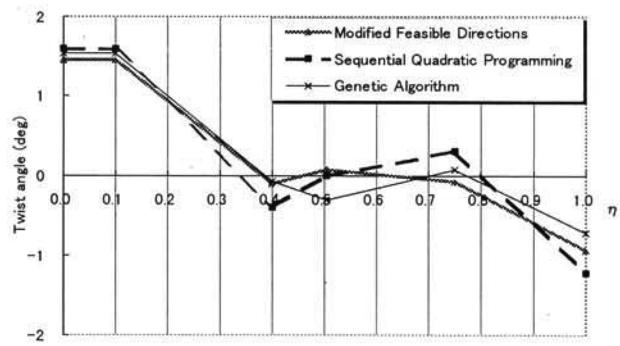


Figure 4 Comparison of the twist distribution