8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

Low-Boom and Low-Drag Design Exploration for Twin-Engine Supersonic Business Jet

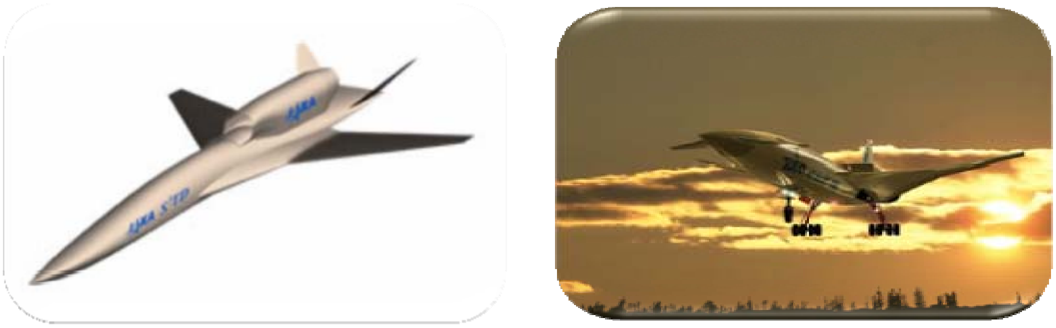
***S. Jeong[1], K. Sato[1], T. Kumano[1] and S. Obayashi[1]**

[1] Tohoku University
2-1-1 Katahira, Aoba-ku,
Sendai, 980-8577, JAPAN
jeong@edge.ifs.tohoku.ac.jp

Key Words: *Supersonic Business Jet, Low-Boom, Low-drag, Design Exploration.*

ABSTRACT

For a success of next generation supersonic transport, low-boom and low-drag should be achieved. Especially, low-boom characteristic is very important because supersonic flight is prohibited unless sonic boom regulation (less than 0.5 psf) is cleared. To realize the low-boom characteristic, various concepts have been suggested so far [1, 2]. Most configurations located its engines on the wing or fuselage to avoid the propagation of strong shock from the engine nacelles to ground as shown in Fig. 1. It might be very effective to reduce the sonic boom. However, these unconventional configurations include a lot of technological challenges, such as engine inlet airflow and a flight control.



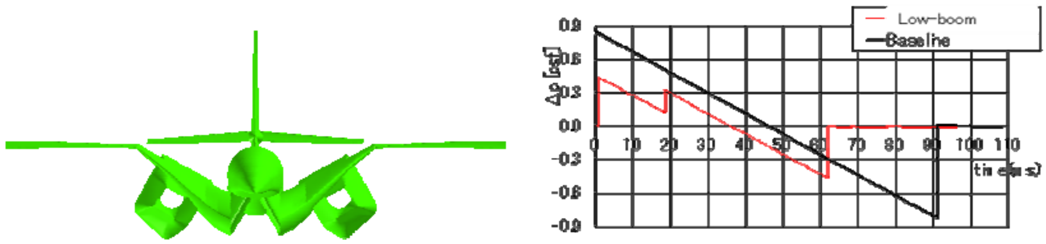
(a) JAXA Silent Supersonic Technology Demonstrator   (b) Sukhoi supersonic business jet

Fig. 1 Low-boom supersonic concepts

In this study, design exploration is performed to demonstrate a low-boom and low-drag characteristic for a conventional configuration whose engines are located beneath the wing as shown in Fig. 2.

For the design exploration, Multi-Objective Evolutionary Algorithm (MOEA) was adopted. To save the computational time, Efficient Global Optimization for Multi-Objective Problem (EGOMOP), which uses a Kriging model as surrogate model, was also adopted here.

Figure 2 Twin-engine supersonic business jet considered in this study



(a) Low-boom configuration (b) N-wave at ground level

Figure 3 Low-boom configuration and N-wave at ground level

Figure 3 shows the low-boom configuration obtained through the design exploration and its N-wave at ground level. The low-boom configuration has a negative twist at inner wing. It produces the strong expansion and weakens the strength of shock generated at engine nacelles. The low-boom configuration also has a large dihedral angle at inner wing to avoid concentration of shock generated from engine nacelles into under the fuselage. As a result, sonic boom intensity was reduced to less than 0.5 psf at both ends.

Data Mining was also performed to obtain the information about low-boom design for conventional configuration using Self-Organizing Map (SOM). It revealed that which geometrical changes are related with low-boom characteristic of conventional configuration.

REFERENCES

[1] Chiba, K., Makino, Y., and Takatoya, T., "Multidisciplinary Design Exploration for Silent-Supersonic-Technology-Demonstrator Wing Using CFD/CSD," EUROGEN 2007, Jyvaskyla, Finland, June 2007.

[2] http://www.sukhoi.org/