

1) MULTIDISCIPLINARY DESIGN OPTIMIZATION TOOLS

NASA Question:

Can we make intelligent manufacturability and affordability decisions using modern design tools that accurately account for innovations in configuration aerodynamics? Are there issues that are related to testing tools (wind tunnels) for design validation?

Roskam's Response:

I do not believe that there is a significant role for multidisciplinary design optimization tools in the design and development of SATS configurations. One can perhaps "optimize" a Cessna Citation type airplane. A major issue even here is the turn-around time in the aerodynamic/structural analysis of a complete and arbitrary configuration. For configuration CFD to be really useful in advanced design requires a turn-around time of about 5 minutes. In addition it should not take a PhD degree to use such a code. I am told that this capability (using complete Navier-Stokes equations integrated for 1,000,000,000 grid-points) is at least 2-3 computer generations in the future.

Then there is the problem of a rather alarming lack of early structural design/analysis tools. This is the reason why NASTRAN and Flutter analyses cannot come into play until nearly all of the early design decisions have already been made.

All of this this still ignores the problem of educating that rare breed of experienced configuration designers in the use of such tools.

Intelligent manufacturing decisions can be made by using virtual reality tools such as used by Lockheed in designing for manufacturability of the JSF. A problem for small companies here is the acquisition of qualified personnel as well as the capital investments which will be required. For small airplanes I still believe that nothing can beat "horse-sense and experience". A combination of automated aluminum bonding and spot-welding should be considered.

My recent experience with a new business jet design shows that early windtunnel testing as a tool in developing even a conventional configuration is absolutely essential. In that program several aerodynamic design problems were identified during a windtunnel test conducted late in the program (and with a proof-of-concept airplane already flying!). The tests indicated the need for subtle changes in the exterior lines of the airplane which in turn will significantly delay its certification.

In terms of affordability decisions it is essential that the product be designed to have real value to the customer. Any design optimization study should bear this in mind. For a simplified analysis of a value-added-parameter see my response to Topic 8.