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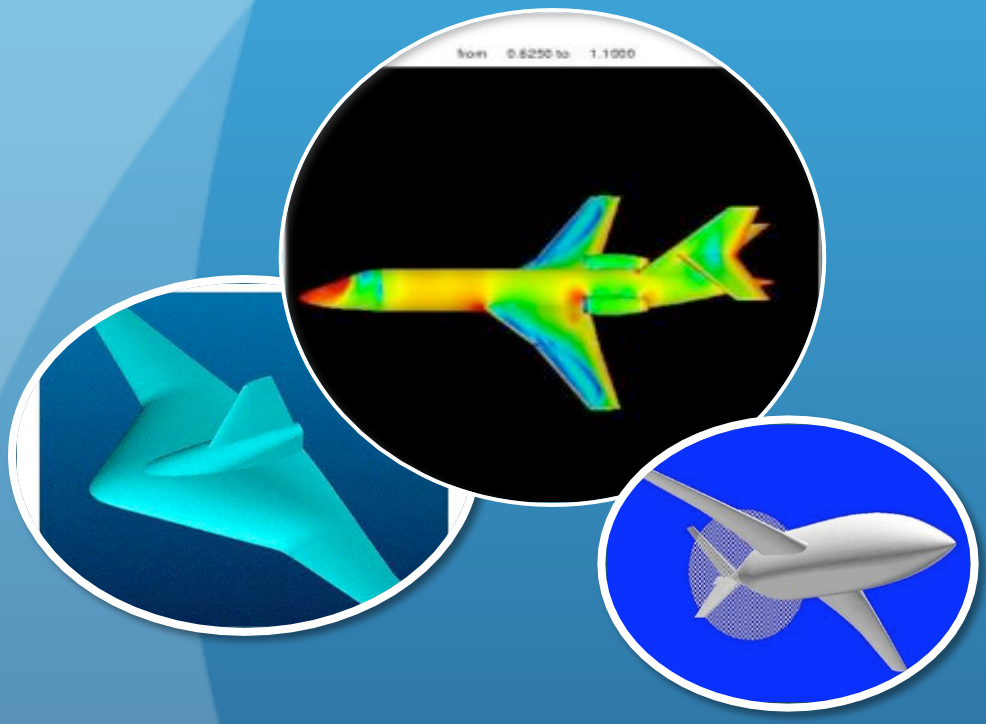
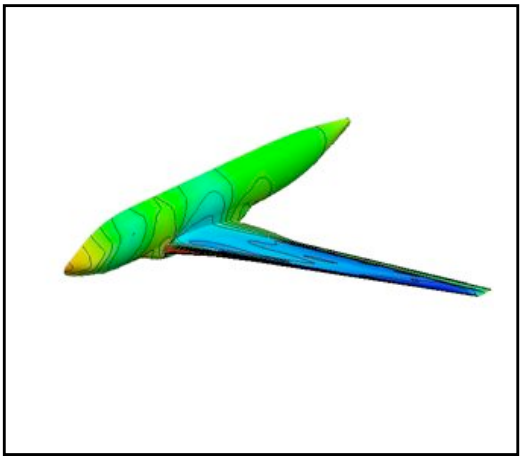


J-FLO

New Technology for Optimal Aerodynamic Design of Aircraft Wings

Aerodynamic shape selection largely remains a trial-and-error process consisting of testing, via fast computers, a large number of aircraft shapes based on the intuition and experience of the designer. Such use of CFD as a virtual wind tunnel will not necessarily lead to a truly optimal design. To examine a larger design space, CFD needs to be combined with search and optimization procedures that can automatically design components with ideal aerodynamic, structural and acoustic characteristics.

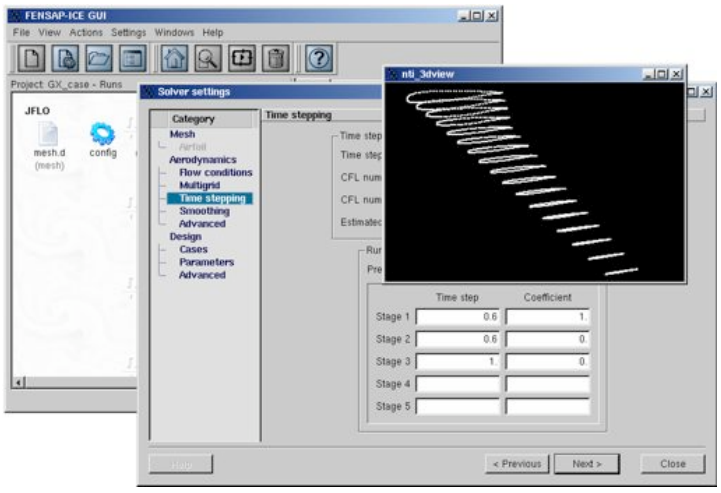


Optimal control design of wing for commercial airliner

Newmerical Technologies International (NTI) specializes in state-of-the-art novel numerical solutions to complex aerospace problems. One such example is the FENSAP-ICE in-flight icing simulation system, which, in a very short span, has become the standard of the industry. NTI has launched J-FLO, considered a paradigm shift and game-changer for aerodynamic design speed, accuracy and manpower requirements.

The simplest traditional approach is **Optimization,** defining the geometry through a set of design parameters, with a cost function such as drag or weight. The sensitivities are then estimated by making a small variation in each design parameter in turn, and each time recalculating the flow to obtain the change in the cost function. *The main disadvantage of this approach is obvious: a number of flow calculations proportional to the number of design variables to estimate the gradient. The computational costs become prohibitive as the number of design variables is increased.*

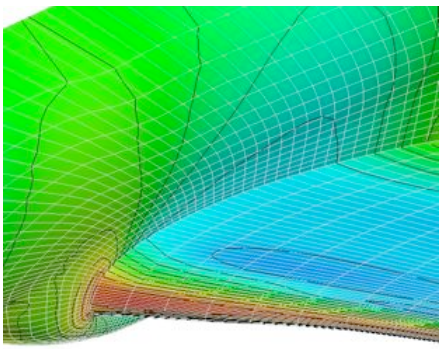
A higher-level approach would be **Inverse**, casting the problem as a search for the shape that will generate a desired pressure distribution. This approach anticipates the designer to know the pressure distribution that will lead to the desired performance. *Inverse design may lead to an intractable problem where the shape to achieve a desired pressure distribution does not exist and it incurs the same computational costs associated with optimization procedures.*



Sample J-FLO GUI windows for data management, parameter input, and geometry visualisation

The most cost-efficient approach as well as the trend of the future, is **Optimal Control**. The design of a wing can be regarded as an optimal control of the flow equations by variation of the shape of the boundary, regarded as completely arbitrary "point-by-point". Using techniques of control theory, the gradient can be determined indirectly by solving an adjoint equation that has coefficients defined by the solution of the flow equations and whose solution cost is comparable to that of solving the flow equations. *Thus, the gradient can be determined with roughly the computational costs of two flow solutions, independently of the number of design variables, which may be very large as the boundary is regarded as a free surface and the end result is a completely new and optimal geometry.*

The J-FLO aerodynamic design code is written by Professor Antony Jameson (Intelligent Aerodynamics Inc., IAI), a leading light of CFD algorithmic development and a pioneer of Optimal Control Aerodynamics. NTI is thus very proud to be the first in bringing such comprehensive technology to the market and to associate itself in its further development with Professor Jameson.



Users that base their aircraft or UAV designs on J-FLO will distinguish themselves by the speed of their design, its accuracy, and the drastic decrease in design team size needed.

Variants of J-FLO include analysis capabilities using Euler or Navier-Stokes equations, with automatically generated or user-provided, structured body-conforming grids for airfoils, wings or wing-body configurations.

Optimal control can be performed with drag minimization for wing section design. For planform control, drag or weight can be minimized with additional constraints for maximum range or endurance.

J-FLO applications, including design with unstructured grids, are being broadened rapidly to more aerospace and fluid flow application areas.

J-FLO is piloted by NTI's advanced graphical environment, including the ability to visualize the evolving 3D geometry to be meshed automatically by J-FLO.

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Newmerical Technologies International (NTI) develops and markets advanced CFD software and offers flow simulation services in the aerospace, architectural, automotive and marine markets. NTI and Intelligent Aerodynamics Inc. are acknowledged leaders for aircraft wing aerodynamic optimization and related services.

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