turbodesign
shaper

information

Fast Sensitivity Based Optimization Software For Geometrically Complex Shapes

Basic features of Shaper

Shaper optimizes complex geometries with respect to given targets, such as total pressure loss and velocity uniformity, by making changes to the surface mesh . It does so by computing the sensitivities of the geometry itself versus those targets and then modifying it. The sensitivity information comes directly from the flow field so the optimized shape is the one that fits the given flow best. Also, the computations related with such a process are independent from the number of design variables, delivering the sensitivities or optimized shape at minimum cost.

Shaper introduces a new method which is independent of the number of design variables and can optimize arbitrary shapes at the same cost for any number of design variables.

Shaper versus existing design methods

Existing optimization methods tend to rely on changes to control points of a NURB representation of the surface. This can limit designs space in terms of complex variations in shape and can make it harder to specify geometrical constraints directly. To specify more complex geometrical change would require larger number of control points and this will prohibitively increase the computational cost and preparation time.

Competitive advantages of Shaper

Sensitivity computation & optimization of complex geometries

Complex geometries can be examined for sensitivity analysis and optimization, providing designs with improved performance.

Computational cost independent from complexity

No matter how complex the geometry to examine is, the cost of the computations will always be independent from the number of design variables.

Straightforward setup of design

No time consuming setup of design parameters. They will be automatically recognised from the boundaries.

Innovative design

With no constraint on the number of design variables, the design space is larger than ever before. New shapes and ideas can be generated in a matter of minutes or hours.

Significant manpower and design time savings

Instead of expensive trial and error, an accurate mathematical approach drives the design to the best shape.

Integration with existing workflows

Create meshes and post process results in any of the major packages in the market.

Design process

Step 1: Create mesh

- Create a computational mesh in any of the major mesh generators
- Name the boundaries of the mesh
- Export it in cgns format

Step 2: Import mesh in Shaper

Shaper will import meshes in cgns format and recognises the boundary names.

Step 3: Setup flow

- Set the flow parameters
- Set the boundary conditions

Step 4: Setup design

- Select boundaries to design
- Impose geometrical constraints

Step 5: Compute

- Compute the sensitivities or
- Optimize

Step 6: Post process

Post process the results in any major post processing software by opening the exported cgns files of Shaper.

Examples

Automatic design variables

All mesh nodes laying on boundaries that have been selected for design will automatically be considered as design variables. These could be hundreds or thousands but the cost will remain the same. This approach makes it easy and fast for the user to set up.

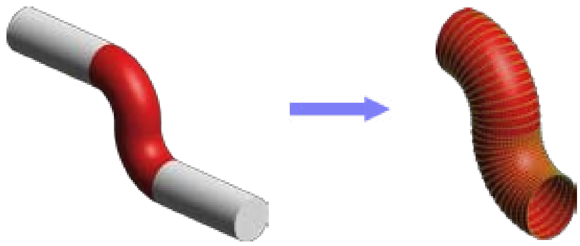

Figure 1: All the nodes on the (red) boundary are design variables

Sensitivity maps

One of the functions of Shaper is to compute the sensitivity of the design surfaces for the given cost functions. These can give insightful information to the engineers on what parts of a given geometry should be modified and how. This accelerates the design process significantly. The sensitivities can be presented in scalar or vector form.

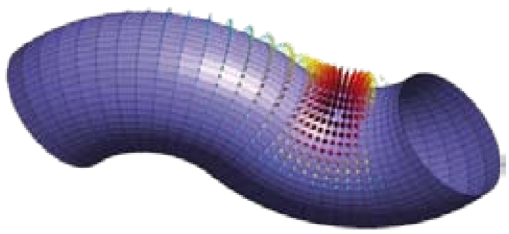

Figure 2: Sensitivities in vector form

Optimization

Shaper can also optimize the geometry and provide improvements in just a few iterations. This eliminates manual changes and drives the shape to a better design mathematically. Optimization can be performed using a single or multiple cost functions.

Figure 3: [Left] Velocity uniformity improvement by 5% in 5 design iterations.
[Right] Velocity uniformity and total pressure drop improvement by 5% and 8% respectively.

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