Contribution of BETA CAE to GMGW-2
Case 3: OPAM-1 Parametric Remeshing

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GMGW-2 – Case 3 – Parametric Remeshing of OPAM 1

case3e
GMGW-2 – Case 3 – Parametric Remeshing of OPAM 1
Selecting the Hexa Meshing approach

- Geometry was as good as it gets for hexa meshing
- Re-use of box topologies for fast variant remeshing
- Hexa mesh ensures exact same mesh size resolution for all variants
- Hexa mesh benefits (structured solvers, mesh alignment, less elements)
- Need to test ANSA in something other than unstructured meshing
ANSA Hexablock meshing applications
Software and Hardware used for Case 3

- ANSA v19.0.1
- Linux Centos 6.8
- 2x20 core Intel Xeon ES-2660 v3 @ 2.6GHz
- 256 Gb RAM
- NVIDIA Quadro K4000
OPAM-1 geometry preparation

Geometry read in STEP format

- 1 engine
- 2 farfield
- 3 fuselage
- 4 horizontal_stabilizer
- 5 symmetry
- 6 vertical_stabilizer
- 7 wing
Required geometry modification for Hexa Meshing
Box topology construction process
Tools for detection of problematic boxes
Tools for auto distribution of box points for even edge length
Case 3a final surface mesh
1.8 million quad elements
O-Grid patterns on the tail
O-Grid patterns on the wing
O-Grid patterns on the wing-fuselage connection
Resulting mesh at connections of different O-Grid patterns
Additional O-Grid patterns at the wing, fuselage, engine and tail ends
Resulting surface mesh at wing tip with O-Grid pattern
Resulting surface mesh at tail tip with O-Grid pattern
Inner and Outer Hexablock topologies
Case 3a final volume mesh
158 million hexa elements
Fitting of Case3a boxes to other variants
Fitting of Case3a boxes to other variants
Fitting of Case3a boxes to other variants
Fitting of Case3a boxes to other variants
Case 3e not possible to mesh with original box topology
Mesh quality statistics for Case3a mesh
As calculated by Unstructured Mesh Analyzer

Distortion

Quad Edge Angle

% of quadrilateral faces

log_{10} (D)

Percentage of Angles

Angle

0 20 40 60 80 100 120 140 160 180
Mesh quality statistics for Case3a mesh
As calculated by Unstructured Mesh Analyzer

Growth ratio distribution

Quad-Quad Dihedral Angle

Fraction of Faces

Size Ratio

Percentage of Angles

Angle
Wide I/O selection

- FLUENT and CFX
- StarCD and StarCCM+
- OpenFOAM
- CFD++
- TAU
- SC/TETRA
- CGNS
- CMSOft AeroF
- Structured
  - Unstructured
- ADF
  - HDF5
- Mixed element type
- Separated element type
- NGON (facet based)
# Metrics for generation of 158 million hexa mesh

Memory requirement 53 Gb

<table>
<thead>
<tr>
<th>STEP</th>
<th>Time (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to build and fit Hexa Box topology with O-Grids</td>
<td>50</td>
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<tr>
<td>Time to assign proper mesh distribution</td>
<td>100</td>
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<tr>
<td>Time to generate shell and volume mesh</td>
<td>1.5</td>
</tr>
<tr>
<td>Time to adjust existing Hexa Box topology to other variant</td>
<td>5</td>
</tr>
</tbody>
</table>
Closing remarks

- ANSA v19.0.1 was used to generate structured hexa meshes for the parametric geometry, following the specifications and target mesh size

- The process is purely manual and requires a lot of time for the preparation of the first model, although this can be improved with user experience

- Subsequent models can however be quickly meshed by fitting an existing box topology to a new variant

- This process is limited to reasonable geometry changes

- This project helped ANSA development in improving the code and integrating new functionality to facilitate this kind of mesh generation

- Further development will take place targeting the biggest bottlenecks:
  - Smoothing of mesh with coupled O-Grid topologies
  - Automated tools for specification of mesh size distribution
  - Faster fitting of existing box topologies to new geometries
  - Implementation of Light Volume representation in Hexablock
Thank you

Stay connected

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