GMGW-1 Participant Questionnaire

1st AIAA Geometry and Mesh Generation Workshop

The purpose of this document is to collect data for an assessment of the current state of the art in mesh generation for a variety of mesh types and a variety of software tools. The comparisons will be made in terms of the quality of each mesh submitted (either from a priori metrics or from the quality of the CFD solutions that were produced using the mesh) as well as the resources (human and computer) required to generate the meshes.

For GMGW-1, the geometry and meshes referred to below are for the NASA High Lift Common Research Model (HL-CRM).

Completion of this questionnaire is required of all participants in GMGW-1 and participants in the 3rd High Lift Prediction Workshop (HiLift-PW3) who generate their own meshes (versus using the supplied baseline meshes). A separate copy of this Questionnaire should be completed for each family of meshes.

# Geometry

1. Software
   1. What software tool(s) did you use to import and prepare the HL-CRM geometry model for meshing?   
      Pointwise, HeldenMesh
2. Import & Preparation for meshing
   1. Which of the supplied geometry files did you use:

Native: NX (prt) file (HL-CRM gapped config)

CREO file (HL-CRM gapped config)

IGS file (HL-CRM gapped config)

STP file (HL-CRM gapped config)

Parasolid (x\_t) (HL-CRM gapped config)

Native: NX (prt) file (HL-CRM partially-sealed config)

CREO file (HL-CRM partially-sealed config)

IGS file (HL-CRM partially-sealed config)

STP file (HL-CRM partially-sealed config)

Parasolid (x\_t) (HL-CRM partially-sealed config)

* 1. What problems, if any, did you identify immediately after importing the geometry model (eg, missing geometry, poorly translated geometry, other)? None
  2. What steps did you take after import to make the geometry model ready for meshing? (Choose all that apply)

None

Layering (hiding components)

Simplification/defeaturing (removing components)

Repair (fixing/recreating components that didn’t import properly)

Modification (changing components)

Shrink-wrapping

Other

* 1. What was required level of user expertise (novice, intermediate, expert) for this task? Intermediate
  2. How long did import take (both elapsed time and labor required --- in hours)? Importing the geometry took less than a minute. We used Pointwise to recreate the two surfaces just fwd of the fuselage constant section (just aft of the cockpit) to improve the surface quality for HeldenMesh. This took less than 20 minutes.

# Initial Meshing

1. What type of mesh family did you generate?

Structured multi-block

Unstructured tetrahedra

Unstructured hexahedra

Hybrid

Overset

Cartesian

other (please specify Unstructered mixed element with tetrahedrals, prisms and pyramids)

1. Surface Meshing
   1. What software tool(s) did you use to generate your initial surface mesh? HeldenMesh
   2. How long did it take (elapsed time and labor – in hours)? 0.0397 hrs
   3. Provide a brief description of how mesh resolution was specified (explicit user inputs, sources, curvature based sizing, background distribution function, …)   
      We utilized curvature based sizing, along with automatic edge sourcing and user-specified volumetric sourcing. User specifies max grid size, min grid size, curve angle, edge angle, edge source size and stretch factor for each patch family (fams: wing, tail, fuse etc). We started with a grid resolution for the Medium grid that captured the geometry with a facet angle of 3 degrees for the wing, 6 degrees for the forward and aft fuselage, and 10 degrees for the rest of the fuselage. Edges sources with a size of 0.05 were used for the wing, flap and slat TEs.
   4. When/how did you judge surface mesh generation to be complete?   
      When the advancing front is completely closed for all surfaces. Leading edges and trailing edges were defined with tighter grid spacing using edge sources.
2. Volume Meshing
   1. What software tool(s) did you use to generate your initial volume mesh? HeldenMesh
   2. How long did it take (elapsed time and labor – in hours)? 0.7170 hrs
   3. Provide a brief description of how mesh resolution was specified (explicit user inputs, sources, curvature based sizing, background distribution function, …) HeldenMesh is similar to VGRID using an advancing layers method (anisotropic growth) near the surface and an advancing front (isotropic growth) once the advancing layer mesh length scale exceeds the advancing front mesh length scale locally. The advancing layer mesh resolution was specified using the following growth function:   
      dnj = dn1(1 + geometricGrowthRate \* (1 + exponentialGrowthRate) ^ (j-1)) ^ (j-1)
   4. For resolving surface boundary layers, what cell size growth rate did you use? Was it constant or variable? If variable, describe.   
      d1 = 0.0016, a 15% geometric growth rate and 2% exponential growth rate. Grid grew from first height off of surface.
   5. When/how did you judge volume mesh generation to be complete?  
      Upon closure of the advancing front volume mesh but prior to any mesh quality improvement iterations that HeldenMesh performs (to repair skewed cells).
3. Adherence to HiLift-PW3 meshing guidelines
   1. To what extent did your mesh(es) adhere to the HiLift-PW3 meshing guidelines?   
      With respect to the June 2016 3rd AIAA CFD HLPW Gridding Guidelines:  
      1. Yes: Farfield is at least 100 Cref  
      2. No: Constant cell spacing near wall is not a capability of HeldenMesh  
      3. No: Explained below in 4c  
      4a. Yes: Max cell size near nose and tail is ~1.0% Cref  
      4b. No: Used maximum facet angle of 3 degrees for wing, flap and slat LEs  
      4c. No: Root spanwise spacing ~0.2%, tip is less than 0.1%  
      4d. Yes: Grid spacing normal to symmetry plane is not directly controlled, but is generally much larger than viscous wall spacing   
      5a. No: Geometric growth rate is less than 1.25 and advancing layer grid parameters were kept constant for all grid levels  
      5b. No: Wake grid elements were not used
   2. Was it possible to adhere to the guidelines on the first attempt, or were there iterations involved? Several iterations were made on the medium mesh to adjust the mesh distribution to our liking. This excercise was utilized as an opportunity to get familiar with HeldenMesh gridding parameters. HeldenMesh was introduced to the author in the Spring of 2017
   3. What were the reasons that you did not adhere to the guidelines? (chose all that apply)

The guideline does not pertain to the type of mesh generated

The guidelines were (locally) inconsistent and therefore could not all be satisfied

The tools used do not give enough control to adhere to the guideline

Adhering to the guideline would have required more resources than were available

The guidelines were not appropriate for the CFD solver being used

Other (describe): The guidelines make it difficult to achieve an optimized grid resolution. Requiring a 3X growth between grid levels often means that the Coarse grids are unrepresentatie of the shape of the aircraft while the fine grids are too computationally expensive.

1. A priori metrics (such as skew, or maximum stretching ratio, maximum deviation of mesh nodes from OML or …)
   1. What a priori metrics did you apply on the initial mesh? maximum spanwise stretching factor of 10. Maximum advancing layers geometric growth rate of 15%
   2. What was the average and range of the metrics? Explained in a.
   3. Did the a priori metrics point out any problems that needed to be fixed? If so, which metric and how many times did you need to re-mesh?
2. Were there any additional best practices that you used in generating the meshes? We focused surface mesh resolutoin where we expected to see the highest density gradients (e.g. LEs ) We also focused grid resoution on where we expected the most grid dependency for lift (wing, slat and flap).
3. What was the required level of user expertise (novice, intermediate, expert) for this task? Intermediate

# Adaptive Meshes (Only answer if you generated an adapted mesh)

1. What adaptive meshing strategy did you use (technique and software)? NA
2. What criteria were used for mesh adaptation (e.g., pressure, vorticity, …)? NA
3. What, if any, further treatments (e.g. smoothing) were applied? (Please describe ) NA

# Mesh Families

1. What strategy did you use to generate the family of meshes (coarse, medium, fine, extra fine)? For example, did you generate the coarse mesh first and refine it, or did you start each mesh generation task essentially from the beginning? We started from the medium mesh and scaled the advancing front grid by a factor of 0.6, 0.8, 1.2, and 1.4. The advancing layer grid parameters were not scaled
2. In your opinion, what was the most time-consuming or tricky aspect of generating a family of meshes? Defining an intial medium grid
3. How did the times (labor, CPU, etc.) needed to generate them compare? XFine: 2.6 hrs; Fine: 1.66 hrs; Medium 1.14 hrs; Coarse: 0.9 hrs; XCoarse: 0.72 hrs. Values include grid quality improvement iterations
4. Were there any problems that you encountered in one mesh resolution that you did not encounter in another resolution? All resolutions seemed robust. XFine grid required more resources than we were willing to spend to run alpha sweeps

# Post-Solution Mesh Modifications

1. After generating an initial flow solution, where additional mesh modifications made to improve solver convergence or solution accuracy? None needed
2. Describe any post solution mesh modifications that were made? NA
3. How long did these modifications take (elapsed time and labor – in hours)? NA

# I/O

1. In which format did you export your meshes? (CGNS, Solver-native, …): AFLR3
2. What are the names of the files you uploaded to the GMGW-1 server?   
   GAC\_HCLM\_UnstrPrismTet\_HM\_XCoarse.b8.ugrid  
   GAC\_HCLM\_UnstrPrismTet\_HM\_Coarse.b8.ugrid  
   GAC\_HCLM\_UnstrPrismTet\_HM\_Medium.b8.ugrid  
   GAC\_HCLM\_UnstrPrismTet\_HM\_Fine.b8.ugrid  
   GAC\_HCLM\_UnstrPrismTet\_HM\_XFine.b8.ugrid

# Miscellaneous

1. Are there any other aspects of your HL-CRM mesh generation experience that you would like to draw our attention to?