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An Analyst's Guide to Resolving Common Geometry Problems

IN THIS WEBINAR:

- Refining a thin-walled solid wing box structure with common imperfections
- Aligning and associating geometry to a mesh with an undefined offset in all 6 DOF
- Modifying an existing mesh for common design changes, such as hole diameter changes and flange width increases

PRESENTED BY:

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Agenda

1. Refine flawed wing box geometry
    1. Reduce solids to clean surfaces
    2. Zip surfaces into cohesive structure
    3. Transfer features to new geometry
2. Align and associate geometry to offset mesh
    1. Define reference point
    2. Align structure
    3. Associate mesh
3. Modify mesh for common design changes
    1. Hole diameter change
    2. Flange width change

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Design Intent

- The first step in deciding how to move forward with geometry is understanding the design intent.
  - Is the OML, midplane, or IML Fixed by design?
    - Wings usually have the OML Fixed, but we will discuss OML and midplane strategies
  - Can any features be ignored by stress?
    - Small Bolt holes through primary structure can usually be ignored
    - Large pass-thru holes usually need to be modeled
  - Will any additional features be added in the future?
    - If there is a control surface, there will most likely be an actuator and an access panel added in the future

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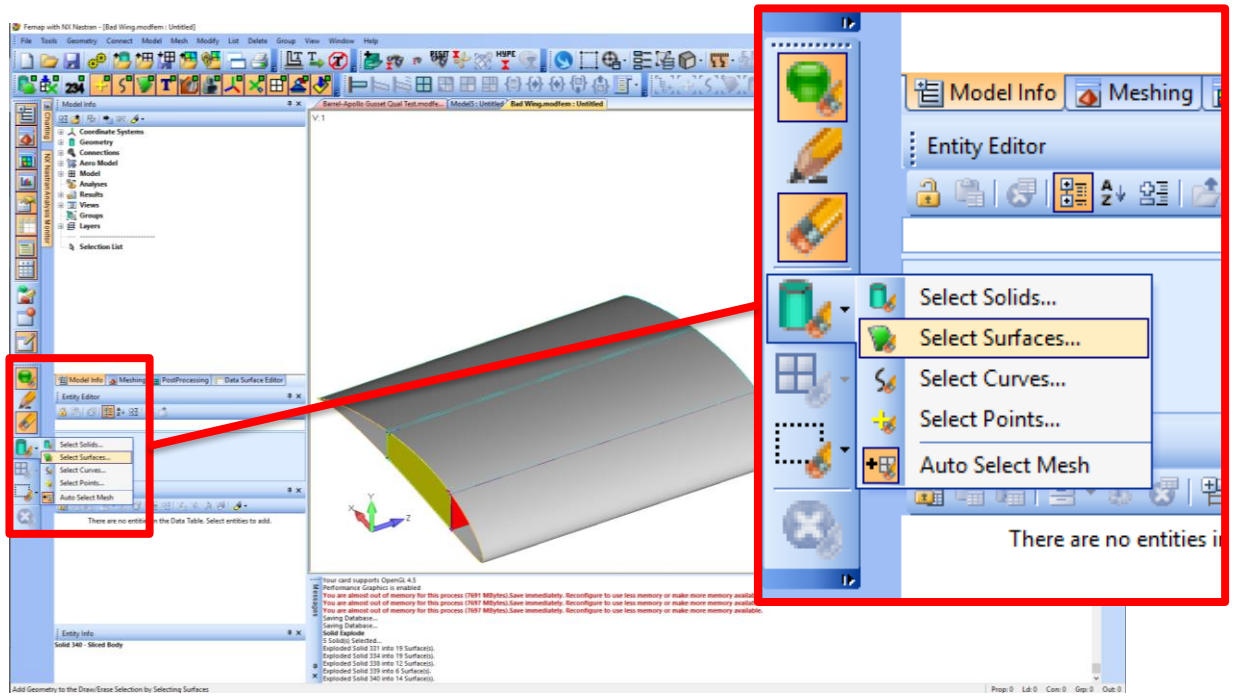
Wing – OML Approach

- First step when dealing with a thin sheet solid is to explode the solid into individual surfaces: **Geometry** → **Solid** → **Explode**
- Use the “Draw/Erase” tool to hide the surfaces you want



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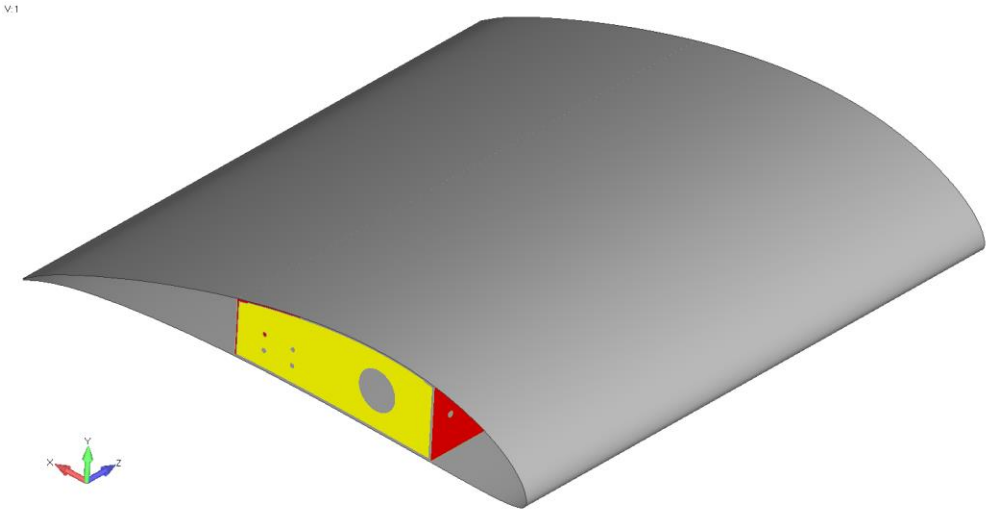
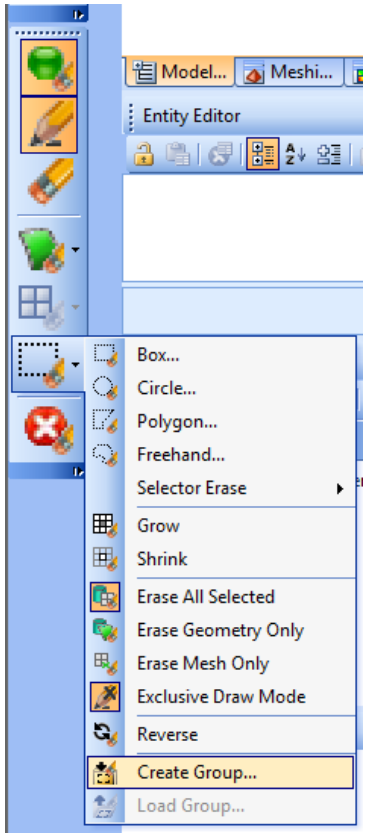
Create A Working Group

- Flip show/hide to show the surfaces you want to work with

- Create a working group with the surfaces





Clean Up And Connect Surfaces

- Clean up spar geometry with the meshing toolbox
  - **Feature Removal** → **Loops** can be used to remove unnecessary holes
  - **Geometry Editing** → **Extend** can be used to extend the spars to meet the ribs and skin
- Split wing skin at spar locations:
  - **Geometry** → **Curve – From Surface** → **Slice**
  - **Geometry** → **Curve - From Surface** → **Intersect**
- Boundary Surfaces can be much quicker in certain instances (like the ribs)
  - **Geometry** → **Boundary Surface** → **From Curves**
  - **Geometry** → **Surface** → **Convert**

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Fixing The Trailing Edge

- Boundary Surfaces can be helpful when creating features that aren't modeled in the original CAD
  - Rib in the fwd and aft bay
- The aft bay shows a common problem with boundary surfaces: unclosed loop
  - The trailing edge of this wing was modeled with a blunt edge
    - Connecting these two edges with a flat surface could be undesirable because it drives a high fidelity mesh or high AR elements
    - Extending the surfaces until they meet increases the chord length and could drive up stiffness
      - **Mesh toolbox → Geometry Editing → Extend → Linear → Distance**
    - Moving the curves to meet in the middle is a conservative method that is mesh friendly
      - It is helpful to define a midpoint before moving the curves
      - **Modify → Move By → Curve**

Non-Manifold Adding and Mesh Preparation

- Adding spar caps and rib flanges
  - Use the draw/erase tool to find the flange edge surfaces
  - **Geometry** → **Curve – From Surface** → **Project** can project the extent of the flanges to the skin
  - **Geometry** → **Curve – From Surface** → **Slice** can define a constant rib flange width
- Non-manifold adding greatly reduces meshing effort:

  Geometry → **Surface** → **Non-Manifold Add**
- Boundary Curves are the last thing to add before meshing because they are unstable when manipulating the geometry:

  Mesh Toolbox → **Combined/Composite Curves**

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Wing – Midsurface Approach

- Automatic midsurface tools are always a good first step

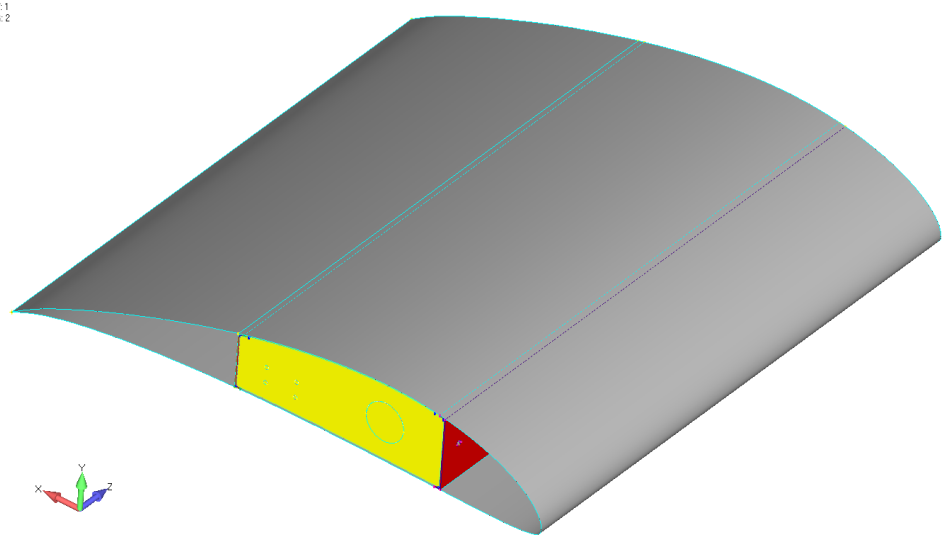
  Geometry → Midsurface → Automatic

- Offset Tangent Surface can be helpful in situations where auto midsurfacing doesn't work
  - First you need to know the target thickness
    - **Geometry → Curve – Line → Perpendicular**
    - **Geometry → Point → Intersect – Curves**
  - Geometry → Midsurface → Offset Tangent Surfaces

Note: Make sure to set your workplane

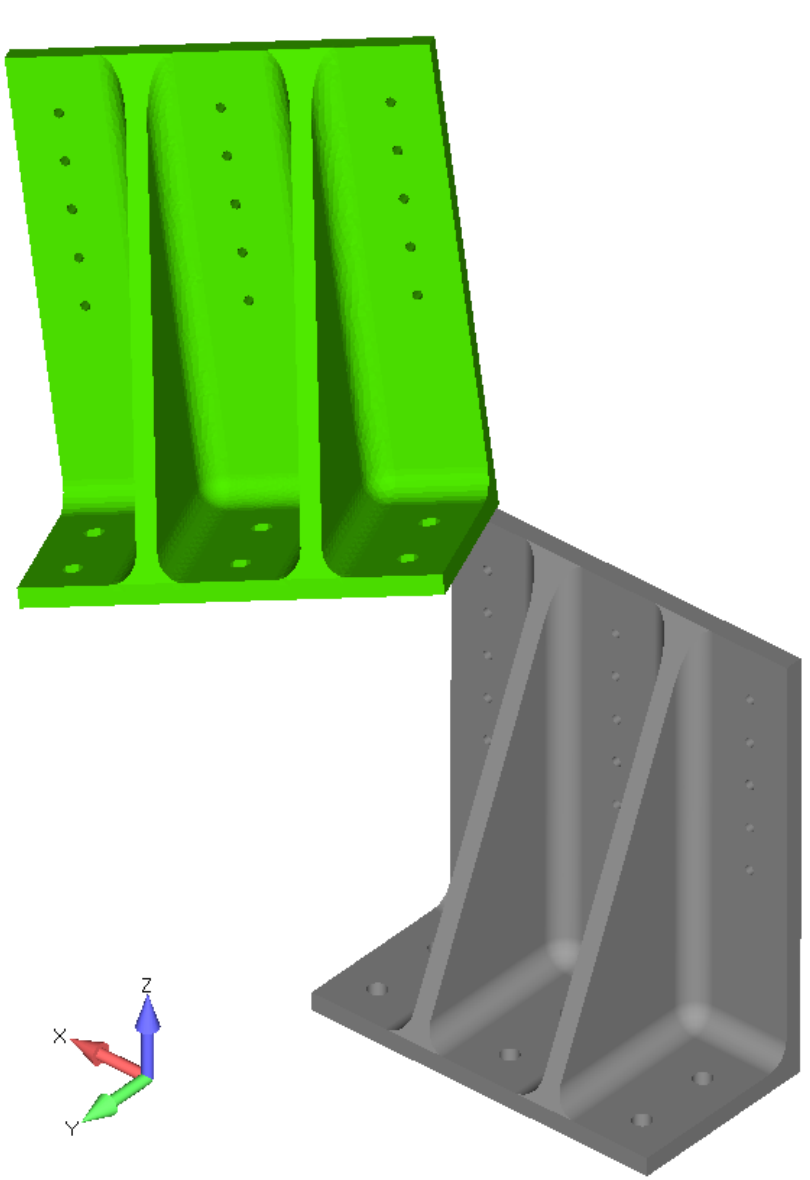
Fix The Trailing Edge

- Modify → Move By → Curve can’t be used on the trailing edge because the entire skin is one surface.
  - The skin needs to be split: Geometry → Curve – From Surface → Slice
- Now, any of the previous methods can be used



Mesh Alignment and Association

- **Modify** → **Align** is a great tool for aligning a free mesh to geometry that was exported in the wrong coordinate system
  - Align by common edge
  - Align by bolt pattern
- **Modify** → **Associativity** → **Automatic** will associate nodes and elements to solids, surfaces and curves.
  - This is helpful when applying a distributed load



Modify Mesh

- Meshing Toolbox → Feature Editing will modify the geometry and update associated meshes automatically
  - Resize Holes
  - Resize Fillets
  - Extend Planar Surfaces

Note: The feature editing tool is dependent on the mesh attributes of the solid body

Note: Any changes to the mesh will result in coincident nodes at interface locations

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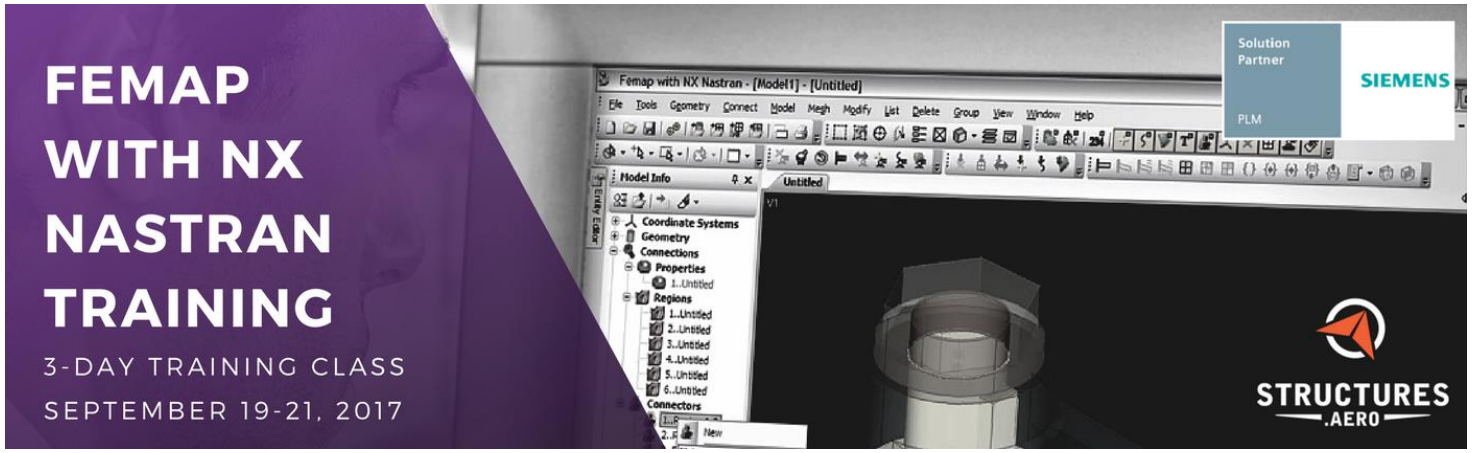

Topics

- Geometry Preparation and Meshing
  - Midsurfaces, meshing toolbox, hex and tet meshing
- Materials, properties, and boundary conditions
- Analysis Model Checks and Solver Submission
- Post-processing tools
  - Data Table, Postprocessing Toolbox, Freebody diagrams, XY Plots

Logistics

- September 19-21, 8:30AM-5:00PM
- Hosted at SDA's office in Sterling, Virginia
  - Located near Dulles Airport and Udvar-Hazy Space Museum
- Cost: $1575 per attendee
  - FREE Copy of Learning FEMAP by Eric Gustafson

More information at https://structures.aero/femap-training/

Questions?

For questions on the material covered today, please contact **Ryan Tatman.**

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For questions about pricing, or to see a demo, please contact **Marty Sivic**.

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