Best Practices Workshop: Parts & Mesh-Based Operations
Overview

- What are Parts and Mesh Based Operations?
- Transition from Region Based Meshing
- Why move to Parts Based Meshing
- How to use Parts Based Mesh Operations
- Demonstrations
Introduction to Operations

What are Parts and Mesh Based Operations?

- A new way of organizing your geometry and mesh introduced in v8.02
  - A fundamental shift from the existing region based approach
- Meshing setup is now accessible at the parts level
- Mesh operations perform actions on geometry parts that you can repeat whenever their input parts or properties are changed. The output from a mesh operation is a new mesh description or geometry part. Input parts remain unchanged.
Demo 1: Race Car

- Region Based Meshing
- Parts Based Meshing
Why Parts Based Meshing

- **Increased adaptability of meshing process**
  - User defined pipeline to fit any analysis requirement, enabling what-if studies
- **Improved ease of use**
  - CAD aware meshing processes
  - Simplified simulation tree through reduced entity count
- **Greater Control**
  - Extended and flexible mesh capabilities with simple setup
- **Full automation**
  - Replay sophisticated sequences of operations
- **Reduced turnaround times**
  - Remesh only parts that are modified or replaced
Operations are used to generate meshes
Some operations can also create new parts
Operations are executed in the same sequence they are created

<table>
<thead>
<tr>
<th>Mesh Operation</th>
<th>What Is It?</th>
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<tbody>
<tr>
<td>Automated Mesh</td>
<td>A single or multi-option meshing operation that can include automatic surface repair, the surface remesher, or available volume meshers and the prism mesher</td>
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<tr>
<td>Surface Wrapper</td>
<td>A surface wrapping operation that can work on a single part or multiple parts, including per-part meshing</td>
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<tr>
<td>Extract Volume</td>
<td>An internal volume extractor that can extract the useful &quot;working&quot; volume space for meshing</td>
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<td>Fill Holes</td>
<td>An internal automatic hole filler that can close off voids in the geometry</td>
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<td>Boolean Unite</td>
<td>A Boolean unite operation to join two or more parts together</td>
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<td>Boolean Intersect</td>
<td>A Boolean intersect operation to intersect two or more parts</td>
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<tr>
<td>Boolean Subtract</td>
<td>A Boolean subtract operation to subtract a part from one or more other parts</td>
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<tr>
<td>Imprint</td>
<td>A discrete surface imprinter to imprint two parts together</td>
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Certain operations create new parts. These are generated as soon as the operation is created so that operations may be chained together without having to execute the pipeline.

- **Inherited Parts** – Input part(s) to an operation
- **Descriptions** – Different versions of Parts’ surface mesh based on executed operations
- **Operations** – Perform actions on Parts
Creating and Executing Pipeline

Right clicking to add operations and create a pipeline

Entire pipeline may be executed using the volume mesh icon or by right clicking and selecting “Execute All”

Individual operations executed by right clicking on the operation and selecting “Execute”
Automated Mesh Operation

To execute
- Surface remesher
- Automatic surface repair (a new option for PBM)
- Polyhedral, trimmed cell and tetrahedral volume meshers
- Prism layer mesher

To run an Automated Mesh operation, parts must be assigned to regions if a volume mesh is being created
- Prism layers will behave according to the assigned boundary
- Automated mesh operations create a volume mesh representation, not a description which is for surface meshes
Surface Wrapper Operation

✎ Surface wrapper now an operation
- Allows wrapping of parts independently
- May be used to create a new part
- Sizing independent of the surface mesh

✎ Per-part meshing allows multiple disconnected parts to be wrapped separately
- Creates a new description for the wrapped parts

Local sizing handled through curve, surface and volume custom controls
Multiple parts may be added to a single control
Contact prevention is now set at the operation level
Local mesh sizing is specified through custom controls
  - Controls are created then parts are added to them

Improves ease of use as a single entity controls many objects

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<th>Control type</th>
<th>Curve</th>
<th>Part</th>
<th>Surface</th>
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<td>Trimmer growth rate</td>
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Contacts

- New entity defining connectivity between different parts and part surfaces
  - Contacts may become interfaces when parts are transferred to regions

- Four types of contact
  - In-place, Weak in-place, Periodic, Baffle
  - Weak contacts are meshed non-conformally

- Part-part contacts may be created
  - Automatically on import
  - By imprinting
  - By tolerance based searching
  - Manually

- Baffles and periodics manually created by right clicking on the relevant part surface(s) or automatically with a volume extraction of split by surface topology
  - They behave in the same way as their region equivalents with conformality maintained where relevant
Demo 2

Helicopter: Parts Swapping
Initial Geometry

Two analyses to be run:
1 – Simple momentum source
2 – Configuration change with rotor blades
Pipeline

Momentum source and blade configurations as separate parts

Wrap Main helicopter region
  • Include cylindrical interface in wrap

Wrap momentum source region
  • Separate wrap operation

Automated mesh with per part meshing
  • Remesher, trimmer & prisms

Change input parts of wrap to include blades

Re-run pipeline
  • Pipeline only re-executes for changed parts
Final Meshes

- Parts
  - Actuator Disk
  - Actuator Disk 2
  - Cylinder
  - Cylinder 2
  - Fluid
  - Helicopter
  - Helicopter Wrap
  - Junk
  - Rotor Domain
- Descriptions
- Contacts
- Tags
- Filters
- Operations
  - Helicopter
  - Actuator Disk
  - Automated Mesh
- Meshers
  - Surface Remesher
  - Trimmed Cell Mesher
  - Prism Layer Mesher
- Default Controls
- Custom Controls
  - Surface Control
  - Surface Control 2
  - Volumetric Control
  - Volumetric Control 2
Using Specialized Meshers

- Specialized meshes are being progressively migrated to PBM

- Only core meshers are available in the first release of PBM
  - Specialized meshers will be included in a later release

- It is still possible to use the specialized meshers in combination with PBM
  - For conformal cases surface meshing may be done in parts - volume in regions
  - For non-conformal cases volume meshing with core meshers may be done in parts, specialized meshers executed in regions

- The initial surface representation contains the final surface mesh from PBM