Lecture 6
Geometry Simplification and Repair

Introduction to ANSYS DesignModeler
Preprocessing Workflow

Geometry Creation
OR
Geometry Import

Sketches and Planes

Geometry Import Options

Direct CAD/Bi-Directional CAD

3D Operations

Extrude, Revolve, Sweep, etc

Geometry Cleanup and Repair

Automatic Cleanup

Merge, Connect, Projection, Flow Volume Extraction, etc

3D Operations

Boolean, Body Operations, Split, etc

Meshing Methods

Hybrid Mesh: Tet, Prisms, Pyramids

Hexa Dominant, Sweep meshing

Assembly Meshing

Global Mesh Settings

Local Mesh Settings

Sizing, Body/Sphere of Influence, Match Control, etc

Meshing

Solver

Geometry Import Options

Direct CAD/Bi-Directional CAD

Geometry Import Options

Fluid Flow
Geometry Types

Import/Attach in R14.5 supports two options for target geometry type:

- **Workbench Geometry:** Form of geometry representation that is used by various applications within ANSYS WB, including WB Mechanical and WB Meshing.
  - Workbench type bodies must be converted to Parasolid for some operations
  - Conversion from Workbench format to DesignModeler format will occur automatically as needed by some operations
  - Avoids time-consuming conversion of entire assembly during import if only some of the bodies will be worked on/modified in DM

- **DesignModeler Geometry:** Geometry representation which is used only by the DesignModeler application.
  - DM, Parasolid, IGES, STEP, and MCNP import only as native DM type (Parasolid)

Note: Almost all geometry editing operations are performed in this geometry representation. Geometry in versions of DesignModeler prior to DesignModeler 14.5 are entirely in this form.
Conversion

• Why some operations may fail if Geometry Type is Workbench?
  – DM features will automatically convert the geometry to DM type before performing the particular feature operation
  – However, sometimes the conversion step can fail in which case the feature will also fail
  – Reasons for failure
    – The conversion of WB type body that is disjoint might have produced multiple DM type bodies
    – Failure to convert specific faces of WB body may cause the resultant DM body to be of a different type, e.g. a surface body instead of solid body
    – A non-manifold configuration of WB geometry may fail to construct an equivalent DM representation

• Conversion of some bodies can be done manually
  – Avoids time-consuming conversion of entire assembly during import
  – User can selectively control mixture of WB Type and DM Type bodies for most efficient use of operations
  • Parasolid body cleaning operations available per set of bodies being converted
  – Can be used to manually Heal, Simplify and/or Clean selected bodies
Geometry Cleanup/Repair: Introduction

Why Repair?
• Several translation methods available to enable data exchange with CAD/CAE systems
  – Direct Integration/CAD Readers
  – Import of generic CAD formats (IGES, ACIS etc)
• Translation can:
  – Return incomplete, corrupt, or disconnected geometry
    • Requires repair
  – Return geometry details unnecessary for CAE analysis
    • Requires defeaturing

How to Fix?
• Geometry cleanup
  – Processes required to prepare geometry for meshing
    • Fix incomplete or corrupt geometry and connect disconnected geometry
    • Remove unnecessary details (defeaturing)
    • Decompose geometry into meshable sections
Geometry Cleanup/Repair: Introduction

- DM provides geometry tools to:
  - Analyze
  - Repair
  - Modify/Simplify
- All these commands are available under the Tools Menu
- May need to view the model in wireframe mode to visualize the defects
- DM also give the ability to color edges depending on connectivity
Many potential issues

- Missing faces
- Sliver faces
- Hard edges
- Small edges
- Sharp angles
- Others ...

These issues must be fixed to

- Create watertight volume bodies
- Prevent meshing issues
Analysis Tools

- Set of features that provide information, detect faults in geometry
Repair Tools

• Easy search and fix of unwanted geometrical features or geometric errors

• Can be executed on both frozen and active bodies

• Repair Types
  – Repair Hard Edges
  – Repair Edges
  – Repair Seams
  – Repair Holes
  – Repair Sharp Angles
  – Repair Slivers
  – Repair Spikes
  – Repair Faces
Repair: Automation

- Automatically detects and lists out geometrical issues

- Highlights the location of fault in the geometry
  - Zooms into the location, when clicked on the items in the list

- Proposes fixes to the issues
  - Choose a different method to fix, if needed

- Analyze the list

- Fix issues all at once
  - Upon clicking “Generate”
  - Can’t be done one after the other
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Repair: Example

Repair Edges

Small edge in the model

Details View of Repair Edges

Small edge removed

Small edge in the model

Details View of Repair Edges

Small edge removed
Repair: Example

Repair Holes

Holes in a solid body

Details View of Repair Holes

Holes removed

Hole in a surface body

Details View of Repair Holes

Hole removed
Repair: Example

Repair Hard Edges

Hard edge in the model

Details View of Repair Hard Edges

Hard edge removed

Repair Seams

Small crack in the model

Details View of Repair Seams

Small crack removed
### Repair: Example

#### Repair Sharp Angles

- **Sharp angle in the model**
- **Details View of Repair Sharp Angles**
  - **Details of RepairSharpAngle4**
    - **Repair**: RepairSharpAngle4
    - **Bodies To Search**: Visible Bodies
    - **Min Sharp Angle Limit**: 0°
    - **Max Sharp Angle Limit**: 20°
    - **Find Faults Now?**: No
    - **Sharp Angle 1 (RMB)**
      - **Repair Method**: Face Merge
      - **Merging Entity**: Automatic Selection
      - **Angle**: 1.6623°

- **Sharp Angle removed**

#### Repair Slivers

- **Sliver face in the model**
- **Details View of Repair Slivers**
  - **Details of RepairSliver6**
    - **Repair**: RepairSliver6
    - **Bodies To Search**: Visible Bodies
    - **Min Sliver Width Limit**: 0 mm
    - **Max Sliver Width Limit**: 3.5 mm
    - **Find Faults Now?**: No
    - **Sliver 1 (RMB)**
      - **Width**: 1.992 mm
      - **Repair Method**: Automatic

- **Sliver face removed**
Repair: Example

Repair Spikes
- Spike in the model
- Details View of Repair Spikes
- Spike removed

Details View
- Details of RepairSpike8
  - Repair: RepairSpike8
  - Bodies To Search: Visible Bodies
  - Min Spike Width Limit: 0 mm
  - Max Spike Width Limit: 6.3 mm
  - Find Faults Now?: No
- Spike 1 (RMB)
  - Width: 0.62706 mm
  - Repair Method: Automatic

Repair Faces
- Small face in the model
- Details View of Repair Faces
- Small face removed

Details View
- Details of RepairFace1
  - Repair: RepairFace1
  - Bodies To Search: Visible Bodies
  - Min Face Area Limit: 1 mm²
  - Max Face Area Limit: 2.3 mm²
  - Find Faults Now?: No
- Face 1 (RMB)
  - Area: 2.2278 mm²
  - Repair Method: Automatic

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Release 14.5
Face Delete

- Used to remove features such as fillets, chamfers, holes etc., and automatically heal the geometry at those locations
- Four Options for Healing: Automatic, Natural, Patch or No healing

- Edge Delete also available (see Appendix)
Edge Delete

- Used to remove blends, chamfers, and holes from surface bodies
- Can also be applied to imprinted edges from all body types
- Can choose healing types: Automatic, Natural or No healing

```
Details of EDelete3
Edge Delete  EDelete3
Edges        8
Healing Method  Natural Healing
```
Merge

- Merges a set of edges or faces
- Useful to reduce model complexity

**Type**
- Edge merging
- Face merging

**Method**
- Manual: user selects the entities to merge
- Automatic: clusters of entities to merge are automatically selected and highlighted
**Face Split**

- Allows faces to be broken down by:
  - Points and Edges
    - Combinations of sketch and 3D geometry
  - Locations
    - “Click” on the surface
    - Do not need to close the loop
Surface Patch (1)

- Fills the gaps in surface bodies
- Requires closed loop of edges
- Edges can be from different surface bodies
- Allows selection of multiple patch operations in a single go

Details View of Surface Patch

Gap filled using Surface Patch

Model with a hole

Natural Healing

Patch Healing
Surface Patch (2)

Surface Patch

[Main Menu] Tools → Surface Patch

- Attempts to fill gaps in the model
- Uses similar healing methods as face delete (natural and patch)
- Complex gaps may result in multiple surfaces being created to fill them

2 holes selected for patching

Two patches created using multiple surfaces
Projection

- Allows projection of points on edges/faces and edges on faces/bodies
- Options
  - Points on edge or face
  - Edge on face or body
- Works on both frozen as well as active bodies
Projection: Example (1)

Edge on Face

Edge to project

Type: Edges on Face

Extend Edges: Yes

Edge projected on face

Edge projected on face with ‘Extend Edges’ option YES
Projection: Example (2)

Points on Edge/Face

Points to project

Type: Points on Face

Points projected on face

Type: Points on Edge

Points projected on edge
Body Operation: Sew

- Sews selected surface bodies to form a single surface body where they have edges common to within a given Tolerance.
- **Create Solids?** option enables surface bodies forming a closed domain to be converted to solid bodies.
Fill

- Creates internal fluid volume
- Two options
  - By Cavity: user must select all wetted surfaces
  - By Caps: user must create closing surfaces at inlets and outlets, and select bodies

Details View of Fill

Cap surface bodies must be selected
Enclosure

- Creates enclosure around the bodies
  - Useful for external aerodynamic analysis
  - Can be used for extracting internal flow domain
- Input
  - All or selected bodies
  - Shape of enclosure
  - Extent of enclosure
- Output
  - A frozen body around the selected parts with specified extents
  - Internal flow volume as a result of automatic Boolean subtract
- Supports symmetry models
- Full or partial models can be included in enclosure

Enclosure created for an airplane
Enclosure: External Flow Example

Using Symmetry

User Defined Shape Enclosure
Symmetry

- Defines symmetry for the model
- Input
  - All or selected bodies
  - Up to three symmetry planes
- Operation
  - Symmetry planes slice the model
- Output
  - Sliced model (part lying on the positive side of the axis is retained)

Tip: The symmetry tool can be used as visualization tool when discovering the model (then the operation is deleted)

Note: Faces that are coincident with the symmetry plane are tagged with a “Symmetry” named selection under AMP
Symmetry: Example

- Symmetry using XY plane
- Symmetry using XY & ZX plane
Connect

• Aligns and possibly joins a set of vertices, edges or faces

• Properties
  – Location property
  – T-junction property
Connect: Example (1)

Edge Connect

Model with a gap

Location: Interpolated

| Tolerance | 0.1 mm |
| Location  | Interpolated |
| T-Junction | Off |

Both edges moved to interpolated location

Location: Preserve First

| Tolerance | 0.1 mm |
| Location  | Preserve First |
| T-Junction | Off |

Second edge moved to first edge location
Connect: Example (2)

Edge Connect

Model with a gap

Using T-Junction
Connect: Example (3)

Face Connect

- Additional options as per edge connect
Surface Extension

- Allows extension of surface bodies to the desired extent
- Extension type
  - Natural: Based on gradients of selected edges
  - User Defined: User specifies the direction

Details View of Surface Extension

Model with gap

Model with gap closed
Workshop 4 – Geometry Cleanup