Technology Update: Workbench, Geometry, Meshing, Workflow

ANSYS Users Group Meeting
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Hannover
Agenda

- Workbench
- Geometry
- Meshing
The Path to Robust Design

- Single Physics Solution
  - Accuracy, robustness, speed
- Multiphysics Solution
  - Integration Platform
- "What if" Study
  - Parametric Platform
- Design Exploration
  - DOE, Response Surfaces, Correlation, Sensitivity, etc.
- Optimization
  - Algorithms
- Robust Design
  - Probabilistic Algorithms
  - Adjoint solver methods

Increasing understanding, innovation, ROI
Integrates ANSYS tools and solvers

Parametric, persistent and scriptable environment
DesignXplorer is everything under this Parameter bar...

• Low cost & easy to use!
• It drives Workbench
• Improves the ROI!
Typical Workbench Add-In
Typical Workbench Add-In
Design Assessment

• Introduced in Workbench to enable customized post-processing of Mechanical systems
• Programmable/scriptable means to access results
• Explicit Dynamics can now be an upstream system for Design Assessment
Workflow - Customization

Explicit (Autodyn)  Implicit (MAPDL)

Parameter Support

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Workbench - Customization

- Complexity
  - GUI operations
  - Extended functionality
  - Parameters

- External Connection
  - Add-in

- Functionality

- C# Add-in
- WB GUI customization
- Custom systems
- More access

- Python Scripting
- Parameters
Focus on enhancing your productivity through new features, increased flexibility, efficiency and usability

- ANSYS DesignModeler
  - Core modeling improvements
  - Application-specific modeling
- ANSYS SpaceClaim Direct Modeler
  - Improved Workbench integration
  - Enhanced Model Preparation
- Interoperability
  - Support for new CAD releases
  - New CAD file readers
Improved ANSYS Workbench Integration
- Improved Associativity and data transfer
- Support for multiple design points

Preview options for Topology Sharing
- Preview sharing to view topology sharing before transferring the model into Workbench
- Help detect and fix topology sharing issues before transfer
Flow Volume Extract Tool Improvements
• Progress reporting
• Options to specify multiple faces as seeds to create more than one volume in a single step
• Option to preview face selection propagation to detect leaks during volume extraction
Improved Selection and Repair Options

- More Selection Options
  - Select Parents
  - Select Children
- ClipView option to isolate and examine selected region
- Multi-face patch option for fixing missing faces
• Direct entity selections are accepted for Extrude, Revolve, Sweep and Skin/Loft operations

• Named selections and sketches remain supported as valid inputs for greater automation and flexibility
Workflow & Usability – Visualization Controls

- Improved visualization controls for modeling and topology verifications
- Available through View options or directly from the Toolbar

- Edge Direction Display
- Vertex Display
Workflow & Usability – Add’l Enhancements

Single/Box selection toggle
• RMB + LMB combination to easily toggle between the two selection modes

Auto Freeze during slicing
• Slice feature and Slice Material operations are now available for all bodies
  – Both active and frozen
• Active bodies involved in the slice are changed to frozen state automatically
Workflow & Usability – Add’l Enhancements

- Improved Named Selection transfer between ANSYS DesignModeler and other ANSYS Workbench applications
- New Hot Keys
- Improved Error handling
  - Attach failures
  - Share topology failures

A new export property inside DesignModeler to control named selection transfer to other workbench applications

Improved error handling to provide appropriate error and warnings in case of failures
Several new readers to provide two types of interfaces for all major CAD systems for improved productivity and flexibility

- Associative Interfaces
  - Associative, parametric and Bi-directional

- Readers
  - Native file readers for users without live CAD access
  - A new DWG Reader for AutoCAD
  - Improved model processing for faster and targeted updates
  - Updated geometry interfaces
Workflow & Usability – Interoperability

Geometry Interfaces at R14.0

Associative Interfaces
(Associative, bidirectional and parametric)
• Creo Parametric
• Creo Elements/Pro
• Creo Elements/Direct Modeling
• Inventor 2012
• SolidWorks 2011
• Solid Edge ST3 (103)
• Solid Edge ST4
• CATIA V5 R21
• Teamcenter 8.0. 8.1, 8.3

CAD Readers
• AutoCAD 2012*
• Creo Elements/Pro
• NX Unigraphics 7.5
• Inventor 2011
• SolidWorks 2011
• Catia V5 R20
• Catia V4
• IGES and STEP
• Parasolid 24.0
• ACIS R20
• GAMBIT 2.4

* Requires an AutoCAD installation
Rapid & Robust Meshing

Top on the list of challenges engineering companies are facing is shortened product development schedules while at the same time the product designs themselves are becoming increasingly complex.

Meshing of these designs introduce challenges in terms of speed, robustness and accuracy.
Rapid & Robust Meshing

Enhanced productivity through increased automation, flexibility, efficiency and robustness

- Assembly Meshing (Tet and CutCell)
- Performance (Speed, Robustness)
- Selective Meshing
- Virtual Topologies
- Hex Meshing
- ICEM CFD/TGrid
Assembly Meshing enables dramatically reduced time to mesh for typical CAD models by eliminating the tedious geometry clean-up.

Top-down approach to mesh all parts at once:

- Uses Virtual Bodies (material points or groups) to automatically extract internal regions from assemblies.
- Supports:
  - Meshing solids from sheet bodies
  - Conformal mesh between parts without requiring multibody parts
  - Overlapping bodies
  - Tet (linear) and CutCell (hex-dominant) mesh types
  - Inflation

Assembly Meshing
Assembly Meshing: Process Compression

The overall meshing process can often get elongated if the geometry is complex:
Assembly meshing reduces the overall meshing time, by combining the flow volume extraction and meshing operations.

**High Complexity - Part Meshing:**

- Geometry Prep
- Mesh Setup
- Mesh Generation

**Assembly Meshing:**

- Geometry Prep
- Mesh Setup
- Mesh Generation

Note: Mesh Generation time is slightly longer, but overall time is significantly reduced.
Assembly Meshing: Release 14

• Maintains characteristics from CutCell at R13
  – High fraction of hex and prismatic cells
  – Supports global size functions, feature capture, tessellation, etc. controls
  – Operates on parts, multi-body parts, etc. with new option to define virtual bodies
  – Patch independent:
    • Eliminates the need for pinch control and VT operations

• Creates conformal meshes across parts in contact
  – Eliminates the need for multi-body part generation in CAD

• Ability to create flow volumes from a “closed” set of bodies (sheet or solid)
  – Eliminates the need for Boolean/Fill operations in CAD

• Supports both CutCell and Tetrahedral meshes
  – Tetrahedral meshes supported by CFX and Mechanical solvers
Assembly Meshing: Flow Volume Extraction

Flow volume extraction: Three simple steps
1. Define Coordinate system inside the Fluid Void
2. Insert a Virtual body
3. Assign the proper Coordinate System to the Material Point
Assembly Meshing: Keep Solid Mesh

In the Assembly Meshing panel, you can choose to keep or discard the mesh in all solids.

Parts can be marked as Fluids/Solids.
R14 Inflation Improvements

Speed and Flexibility of inflation:

- Several improvements to both assembly and part meshing
  - Better quality during stair stepping
  - Better handling of high aspect ratio inflation
  - Improved Speed of inflation creation ~30-100%

Assembly Meshing Flexibility

- CutCell: Full support of 2-stage inflation
  - CutCell and inflation in two separate steps
- Tetrahedron: Uses pre-inflation
  - Faster, more layers, and better quality

Industrial Example:
- 68 Million cells, 5 inflation layers
- Total Mesh Time:
  - R13: 6 hrs 39 mins
  - R14: 3 hrs 38 mins
Assembly Meshing: Automatic Inflation

- Also supported for Virtual Bodies
- Program controlled inflation acts only on Fluid Bodies
Assembly Meshing: Sharp angle tool

- A special cell cutting algorithm has been developed to properly capture sharp 3D angles
- Can be used to improve feature capturing in general
- Insert a “Sharp Angle” and pick adjacent faces
- Example:

**Sharp angles in the Flow volume of drill bit**

**Mesh without Sharp Angle**

**Mesh with Sharp Angle**
Assembly Meshing: Leak Handling

- CFD users often need to extract the flow volume from CAD using Fill, Stitch or Boolean operations.
- Because of missing rubber seals, bad CAD, imposed tolerances, etc., gaps appear in the model and creation of the flow volume might fail.
- Finding and closing these gaps in CAD can be tedious.

Solution:

Assembly meshing solves this problem in several ways:

1. Tolerances only need to be resolved to level of discretization of mesh
2. Gaps that are still too large can be visualized through leakage identification
3. Tools to guide mesher in resolving gaps
Assembly Meshing: Leakage Path

• **Find leaks using material points:**
  Any time you are using material points (for internal flow), and it is leaking to the outside, you can automatically see the leak-path together with the surface mesh.

There is a small gap between the valve plug and the valve seat.
Closing a leak:

1. Define a Contact between the entities that are leaking
   - Edge/face or Face/Face
2. Drag and drop the contact on top of the Mesh Icon
   - Creates a Contact sizing
3. Adjust Contact sizing
   - Use roughly 1/5 of min-size

Pick the face of the valve plug (blue) and the edge of the valve seat (red)
Assembly Meshing: Miscellaneous features

• Size Function improvements
  – Separate Min size for Curvature and Proximity
  – Reduced mesh clustering
  – Support for Body of Influence

• Fluid Surfaces option for Virtual Body
  – Needed when creating fluid regions from surface bodies only
  – More memory/speed efficient when Keep Solid Mesh is off
    • Uses Connections and Extend to Connection picker helper to pick all the boundaries of the fluid body
    • Allow for adding property to fluid body (curvature angle)

• “Mesh Unite” Fluid or Solid bodies using Mesh Groups
  – To simplify setup and improve quality of the mesh
Assembly Meshing: Summary

• Improved turnaround time
  – Fewer manual steps
  – Fewer geometry cleanup operations
  – Avoids fluid extraction and other Boolean operations
• Cell count reduction of 50%
  – CutCell vs. Patch Conforming Tet
• High fraction of Hex cells
• Can find and close gaps in the model
Persistence

- Record and replay sequence of meshing steps
Virtual Topologies (VT) enabling improved automation, flexibility, and usability:

- More interactive usage through direct graphics interaction rather than tree objects
- Ability to run “Auto VT” on selected edges, faces or bodies
- Clustering of faces/edges
- Create hard vertex
- Face splits
- Improved meshing performance w/VTs
Rapid & Robust Meshing – Virtual Topologies

Flexibility: Allows user to get mapped or swept mesh in easier fashion

- Non-sweepable geometry
- Add virtual edge/face splits
- MultiZone with inflation for all-hex mesh
Rapid & Robust Meshing – Virtual Topologies

- Improve shell mesh quality and orthogonality with VT combinations
- Here you can quickly improve surface mesh quality with some interactive splits/merges
MultiZone improvements

- Handling of cylindrical side faces
- Imprinting
  - Through bodies
  - Through long stretches of connected side faces
- Support for Match control
- Robustness
- Speed
Productivity enhancements through increased robustness, flexibility, and efficiency

- Stability and usability
  - ~160 defects and feature requests resolved
- User interface
  - Speed (display, selection)
  - Model tree
- Tetra/Prism
  - Prism editing
  - Upgraded TGrid implementation
- Hexa
  - Options, usability, smoothing
  - MultiZone
Productivity enhancements through increased robustness, flexibility, and efficiency

- Assembly Meshing
- CutCell-to-Tet conversion with remeshing
- Prism speedup (~2x)
Thank you!

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