ANSYS Fluent Meshing (TGrid) Update

June 13th 2013
Andy Wade
andy.wade@ansys.com
Outline

Fluent Meshing 14.5
- Overview and GUI
- Assembly Meshing
- New Prism tools

Fluent Meshing in 15
ANSYS Meshing Solutions for CFD

- **Workbench Meshing:**
  - General meshing solution:
    - CAD based
    - Good for multiphysics, DOE
    - Hybrid tet/prism/hex meshing

- **Fluent Meshing:**
  - Fluent with integrated TGrid
  - Complex Fluids Meshing
    - Faceted geometry, Large mesh
    - Wrapping dirty geometry
  - Mesh editing/mesh manipulation

- **ICEM CFD:**
  - Complex Meshing
    - Hex Meshing, Dirty CAD, Large mesh
  - Mesh editing/mesh manipulation
  - Mesh assembling, 3rd party solvers

As much as possible, development focus is on ANSYS Meshing Platform (AMP) so technology is shared between tools.
Fluent Meshing Overview

Advanced CFD Meshing
• Unified mesher/solver
• Import from CAD, mesh, and STL
• Large-scale, complex meshing
  – Wrapper technology for massive geometry simplification and surface remeshing
  – Advanced meshing for large meshes
    • > 100 million cells
    • Prism, tet, hexcore, cutcell, pyramid
  – Size functions, inflation, and assembly meshing
  – Extended meshing and mesh editing controls and tools inc. cavity remeshing
  – Scripting
• Same (or similar) core technologies as in ANSYS Meshing
  – CAD import, size functions, surface meshing, inflation, and assembly meshing
Fluent Meshing overview

- TGrid and Fluent share the same GUI under Fluent at 14.5;
- "ANSYS TGrid" is replaced by "ANSYS Fluent Meshing"
- Installing Fluent will also install Fluent Meshing
- Licence structure changes: "ANSYS Fluent Meshing" needs either
  - Standard TGrid / Extended Meshing License key (independent)
  - ANSYS Fluent / ANSYS CFD license key (shared)
- All TGrid and Fluent functionalities are preserved.
- To start Fluent Meshing from Fluent Launcher
  - Select the "Meshing Mode" option
- Fluent Meshing GUI
  - Aligned with Fluent look and feel
Workflow overview

- Click the Change Mode button to move from Meshing to Solution
- Data will be moved to Fluent Solution Mode, with memory-based I/O

Serial Mesh-to-Solver transfer is supported

- The transfer from solution to meshing is beta feature at 14.5
- However, the case file saved in solution after transfer from meshing, includes all mesh controls
Outline

Fluent Meshing 14.5
– Overview and GUI
– Assembly Meshing
– New Prism tools

Fluent Meshing in 15
Problem statement: *Complex flow volume extraction/meshing*

Do you have assemblies of solid parts and need to quickly extract the fluid region to simulate it?

Do gaps, overlaps, and other problems in the CAD model make this a difficult and time consuming process?

**Fluent Meshing at 14.5** includes several new tools to provide an end-to-end meshing workflow for this type of problem.

**Assembly Meshing in Fluent Meshing** allows:

- CAD import to convert to faceted geometry
- Gap closing and other tools to prepare the geometry for wrapping
- High quality wrapping approaches
- High quality inflation and HexCore volume meshing
- Integrated in the Fluent environment
**Fluent Meshing 14.5; Assembly meshing workflow**

- Fluent Meshing assembly meshing goals
  - Complementary to Assembly meshing in ANSYS Meshing: Handling more complex geometries where CAD based booleans can fail
  - Handle most geometry manipulation necessary to produce high quality surface meshes from disconnected CAD at a faceted level
  - Develop an end-to-end workflow from CAD to Fluent Solver within the same GUI
Fluent Meshing 14.5; Import CAD

• Fluent Meshing is using Workbench CAD import functionality
• The CAD is converted to faceted geometry
  – On-the-fly triangulation
    • Conformal (CFD-style) using global size function
    • non-conformal (STL-style) using tessellated refinement
• Available formats
  – ANSYS WB formats: agdb, meshdat, mechdat
  – ANSYS legacy formats: tin (ICEM CFD), dbs (Gambit)
  – Standard/Free CAD formats: Iges, STEP, ACIS, Parasolid
  – Licensed readers: Autodesk Inventor, Catia V4, Catia V5, Creo Parametric, JT Open, NX, SolidWorks
  – Plug-ins: Autodesk Inventor, Catia V5, Solid Edge, Creo Parametric, JT Open, NX, SolidWorks,
    • NOTE; most of these are Windows –only
  – Non-CAD formats; STL
  – Native PMDB (Part Manager Data Base) format
Assembly Meshing 14.5; Create operations

- Fluent Meshing GUI gives access to several creation tools for:
  - Capping holes (e.g. inlets and outlets)
  - Closing narrow annular gaps
  - Creating Wind tunnels and other far-field domains
  - Creating BOI for Size Function
  - Creating Material points
  - Define Size Function
  - Grouping of Zones
Assembly Meshing; Size Functions

• Characteristics of the Size Function in Fluent Meshing
  – Global Min, Max and Growth rate
  – Curvature and Proximity SF
    • Global and Local
    • Faces and Edges
    • Individual min and max values
    • 10 – 1000 times faster Face-Face Proximity at 14.5
  – Hard, Soft and Body-Of-Influence controls
  – Ability to draw sizes at 14.5
  – Fast “Default Size Function” creation at 14.5
Assembly Meshing - Wrap

• Goal of Assembly Meshing wrapping
  – Create conformal faceting (rough surface mesh) on selective bodies
    • Can optionally be done during import
    • Needed for Gap closing
  – Extracting out flow surface (faceted Subtract)
    • Flow volume surface mesh
  – Wrap together multiple solids (faceted Combine)
Assembly Meshing concepts; Remove gaps

- Remove Gap panel contains two different operations
  - Closing gaps between objects
  - Remove thickness of an object
Assembly Meshing - Sew

- The Sew operation produces CFD quality surface meshes
  - Sew globally connects disconnected wrapped meshes to a conformal mesh, and automatically improves the quality
  - Typically used for conjugate heat transfer problems or problems with multiple fluid regions (porous, heat exchanger, etc.)
Assembly Meshing - Auto Mesh

- AutoMesh includes:
  - Automatic domain creation and enhanced prisms face zone selection
  - Tet + prisms (inflation) generation in flow volumes and tet generation in solids
  - HexCore meshing
    - HexCore is a Hybrid method between CutCell and Tet. It supports prism generation.
- New Cleanup option
  - It includes
    - Deletion of unnecessary zones, renaming, etc.
    - Making the mesh ready for setup and solution
Assembly Meshing; Volume Mesh

• CutCell meshing method
  – Essentially the same as in Workbench Meshing
  – CutCell is integrated into the new assembly meshing workflow
    • Including a new panel for selective CutCell meshing and prism generation
Outline

Fluent Meshing 14.5
- Overview and GUI
- Assembly Meshing
- New Prism tools

Fluent Meshing in 15
**Fluent Meshing 14.5; Post ignore Prism**

- "Post-ignore" allows us to dictate final quality of the prism and tet mesh
- "Post ignore" workflow is based on these principals
  - Grow prisms (inflation layers) everywhere without any restrictions – do not check quality during growth
  - Improve quality as much as possible after growth using smoothing techniques
  - Remove any stack of prism cells containing any bad prism cells, based on several criteria like quality, high aspect ratio and self intersection
  - Remove additional stacks of Prism to form a cleaner cavity
  - Fill the cavity with tets, using non-conformal transition
Example

- Acute angles – inflation problems
  - How to ignore prism at one end and maintain at the other

- Post ignore pre-mark of bad prisms
  - To see the area of “ignore” before executing the deletion

- Final mesh
  - Good quality
Outline

Fluent Meshing 14.5
- Motivations
- Overview and GUI
- Assembly Meshing
- New Prism tools

Fluent Meshing in 15
Meshing Size Functions

Size Function Improvements

• Compute/View/Save/Import Size Function (field)
  – Use for CAD import
  – Use for Wrap
• Performance Improvements
• Display and probe sizes
Meshing Diagnostics/Cleanup

New model diagnostics and gap closing/hole fixing tools

• Guidance to find assembly problems
• Multiple tools provided to address problems

New hole fixing tool guides the user to the holes in the model

Auto or Manually close holes with new fast graphic tools

Gaps between objects are identified and can be closed with standard gap closing tool or using new fast graphic tools via hotkeys.
Meshing Preparation for Wrap and Sew

Improved part management with New Object and Zone handling
• Tree view in Object/Zone panels
• Fast and easy way to rename/add prefix to zones/objects

New Faceted Boolean (local Sew) uses Conformal Faceted Geometry
• Address problems such as free nodes, duplicate faces, self-intersection, etc
Meshing Quality

Better feature capture with wrapper
  • Address various problems
    – Deviation from original geometry
    – Acute angle

Conformal re-meshing for better mesh quality and smoothness
  • Address problems in
    – Mesh quality
    – Preparation for prism meshing
Volume Meshing Performance

Prism Layers
• 2-3x speed-up for 10-20 layers
• Post Ignore included in workflow

Tet meshing
• Common data structures for further performance improvements

HexCore
• ~2x speed-up

Parallel Meshing
• Tet and Prism using pre-decomposed domains (sew), > 90% scalability

Fast transfer to Fluent Solver
• Full Parallel support
Meshing Technologies

R&D Advances on Multiple Fronts

• Thin Volume meshing
  – Using Prism technology
  – Supporting multiple sources

• Direct Polyhedra meshing (beta)
  – Huge performance improvements
  – Improved quality
New Features in Release 14.5

- Integrated Fluent Mesher and Solver
  - Common Data structures and GUI
- New CAD import
- New Assembly meshing Workflow
  - Extract wetted surfaces at faceted level using wrapper techniques
  - Sew disconnected objects together
- New Prism meshing
  - Post ignore operations for complex or wrapped geometry

Release 15

- Massive performance improvements
  - Core meshers
  - Graphics
  - Workflow usability – diagnostics, GUI, etc.
  - Remeshing
  - And more…

Training course now available!
Questions?