Meshing Techniques Using NX 9.0 Features
**NX 9 CAE Objectives**

**Mesh automation, robustness, and new techniques**
- Additional mesh density controls
- Minimize dependency on 2D meshes to seed solid meshes
- Batch meshing’s next generation
- Transform meshes to updated geometry without remeshing

**Expanded solutions**
- Introduction to multi-physics environment
- Transient behavior through parameterization
- Rotor dynamics
- Mixed element types in a single analysis
- New thermal loads

**Post processing usability**
- Less interaction
- Better integration with graphing
- Leverage geometry to isolate areas of concern

**Continuous improvements**
- CAD abstraction tools
- CAE graphics
- CAE translators
- Fields
- Loads and boundary conditions validation
- Navigator organization
- Ribbons user interface
Mesh controls

- Fillet and cylinder types
- Recipe based controls
- Individual presentation in the Simulation Navigator
  - Groups of controls represented as a single entity

Mesh morphing

- Modify node locations relative to updated CAD
- Update a geometry based mesh without remeshing
- Automatic and manual methods
Tetrahedron meshing

- Support new mesh controls to avoid difficulty related to previously recommended cylinder/fillet meshing: 2D mesh locally first
- Make local 2D mesh requirements part of the 3D process
- Improved robustness particularly with respect to fillet meshing

Fillet detection robustness

Surface meshing

- Support new mesh controls, especially fillets and mapped holes
- Ability to suppress holes within the 2D free mesh command
- Focus on improvements to target minimum element size

Batch meshing

- Rewrite of the application and extended capabilities
Geometry Preparation

Synchronous Modeling Delete Face
- Option to delete all blend faces below a user defined radius

Midsurface
- Focused improvements to extend, trim, and hole filling
- Datum plane option when specifying a replacement sheet for a face pair
- Merge selected face pairs into one face pair
Meshing Details and Demonstration
Fillet Mesh Size Options

Size along fillet/blend axis
- By size – specify element size
- None – inherit size from global mesh size

Size on the fillet/blend circumference
- By angle – specify number of elements per 90°
- By size – specify element size
  - This method will place a minimum of 2 elements in the fillet arc provided minimum size requirement is satisfied
- None – inherit size from global mesh size
- Minimum size – no element edges less than this size

Aspect ratio – sizes are relaxed if aspect ratio is violated
Cylinder Mesh Size Options

Size along cylinder axis
- By number – specify number of elements along the axis
- By size – specify element size
- None – inherit size from global mesh size

Size on the cylinder circumference
- By angle – specify number of elements per 90°
- By number – specify number of elements around the circumference
- None - inherit size from global mesh size

Aspect ratio - sizes are relaxed if aspect ratio is violated
Cylinder and Fillet Mesh Controls

Objective: Assign mesh parameters specific to cylinders and fillets

Implementation

- New mesh controls similar to edge and mapped hole mesh controls
- Requires no 2D meshing to affect 3D meshes
- Select faces individually, with smart selection, or by filtering input geometry based upon min/max size parameters
- Mesh size options
  - Element size, number of elements along a direction, or inherit size from the global element size
Mesh Control Definitions

Objective: Include specific mesh control definitions as a basic component of the meshing process

- Repeatable for parts of similar geometry or class
  - Similar blend, cylinder, hole sizes

Implementation

- Allow the user to define mesh control definitions
- Use FEM templates containing mesh control definitions
- Assign geometry to the mesh control definitions
Mesh control definitions defined in template FEM and applied to the polygon body

- Filter for features by size ranges
- Fillet
  - Size through fillet and number of elements through fillet
- Mapped holes
  - Layer settings and number of elements around holes

Target minimum element length during meshing
Suppress small holes during meshing
Next Generation of Batch Meshing

Batch meshing updates

- Accept template FEM as a means for assigning mesh control parameters
- Filter edges and faces by mesh control geometric size ranges
- Matches face and edge names with mesh control names
- Java UI and command line input (-t option) updated to support template FEMs
- Original version was based upon User Functions
- NX 9.0 version replaces User Functions with NX Open functions
Mesh Controls in the Navigator and Interaction

Objective: simplify wholesale editing of mesh controls defined with the same properties

Implementation

• Assign multiple geometric entities to a mesh control
  • Previously only 1 geometric entity permitted
• Represent each mesh control in the navigator
  • Organize navigator by mesh control types
• Editing a mesh control updates the mesh control for every geometric entity that belongs to it
Mesh Morphing

What is it?
- Transformation of a Mesh to Updated Geometry
- No remeshing
- Strictly repositioning of nodes to conform with updated geometry

How is it done?
- Through automatic and manual mechanisms
- Nodes are mapped or already associated to geometry
- If topology doesn’t change, the nodes are moved to the new topological locations
- Unmapped (orphan) nodes may move based upon displacement of neighboring nodes
- Manual tools provided for complete user control of the update
Mesh Morphing Example: 3D Automatic

Geometry associative solid mesh
Parabolic tetrahedron mesh
Faces moved in the CAD model
• No topological changes
Morph
• Existing nodes are displaced according to updated geometry
• Interior nodes are smoothed
• Association to geometry is maintained when CAD changes and/or meshing abstractions do not lead to topology differences to polygon geometry before/after CAD updates
Mesh Morphing Example: 3D Automatic

Imported mesh originally created in NX
- Linear hex mesh

Associate mesh to geometry
Faces moved in the CAD model
- No topological changes
- Mesh topology matches original and updated CAD topology in the regions that updated

Morph
- Existing nodes are displaced according to updated geometry
- Interior nodes are smoothed
- Association to geometry is maintained
Continuation from previous example
CAD change introduces small topology change
Automatic morphing isn’t complete as orphan nodes result
Manual methods complete the process
Mesh Morphing Example: 2D Automatic and Manual

Geometry associative mesh
- 2D free mesh

CAD update
- No topology changes
- Reasonably sized edges become fairly short
  - Original edge has 4 elements, but new edge size is on the order of 1 element

Morph automatically
Reconsider morphing using manual approach after geometry cleanup
- Merge edges in polygon geometry
- Rebuild edge-node associations manually then morph
Thank you!
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