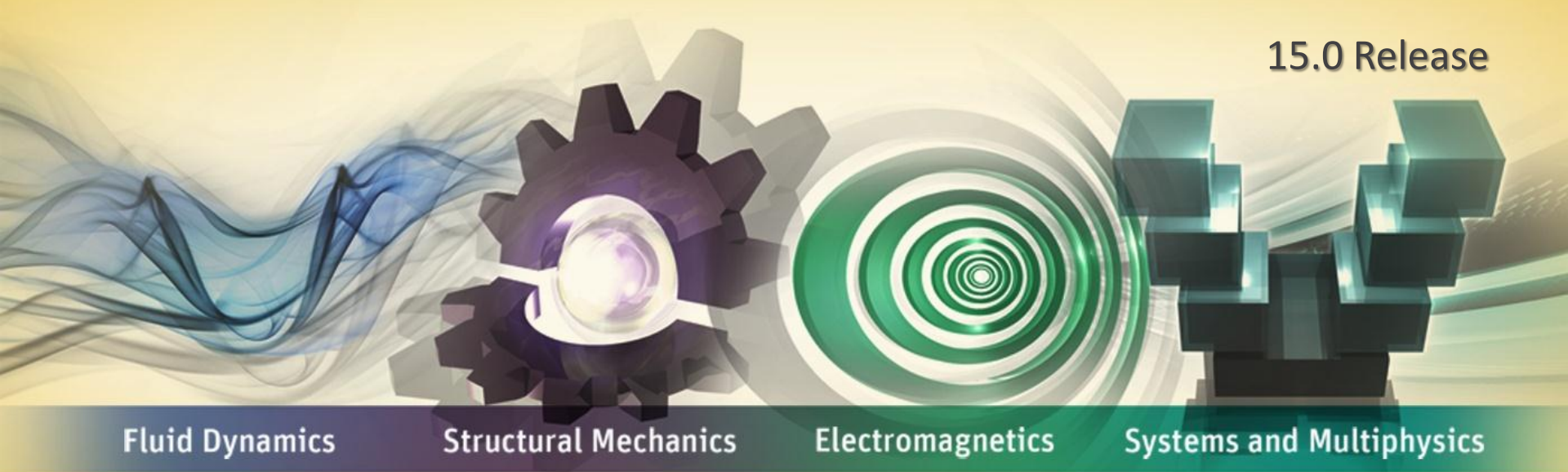


Lecture 13

Shell Meshing

15.0 Release

A horizontal banner with a yellow-to-orange gradient background. It features four distinct 3D visualizations: blue fluid flow lines, a purple gear with a glowing center, green concentric circles, and a stack of teal cubes. Below these images is a dark teal bar containing four white text labels.

Fluid Dynamics

Structural Mechanics

Electromagnetics

Systems and Multiphysics

Introduction to ANSYS ICEM CFD

Introduction to Shell Meshing

Usages of shell meshing:

- Thin sheet solid modeling (FEA) – stamped parts
- 2D cross sectional analysis (CFD)
- Input for volume meshing (FEA/CFD) – Delaunay, Advancing Front, T-grid
 - Filling a surface mesh is faster than tetra octree but requires well-connected geometry

Procedure

- First need to decide mesh setup parameters
 - Mesh method
 - Algorithm used to create mesh
 - Mesh type
 - quad/tri/mix
 - Mesh sizes
 - Small enough to capture physics, important features
 - Large enough to limit grid size (number of elements)
 - Memory limitations
 - Faster mesh/solver run
 - Set mesh sizes on parts, surfaces, and/or curves
 - Based on edge length
- Can have different types/methods set on different surfaces

Global Mesh Setup

Mesh Setup Icons



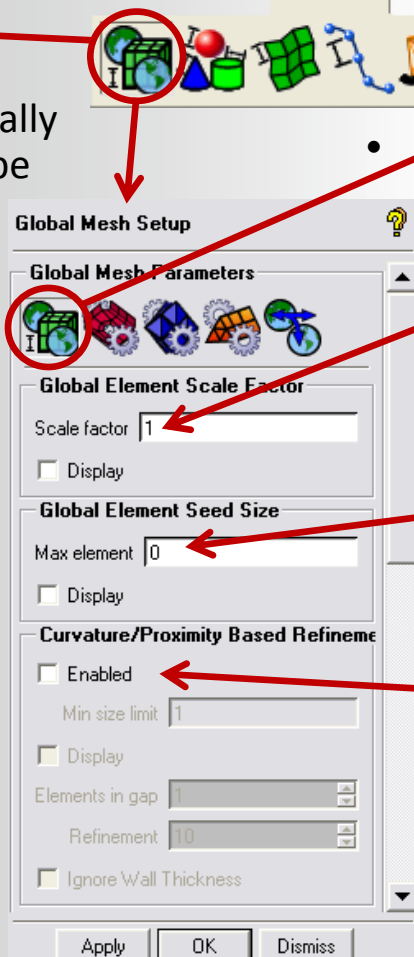
Mesh tab

Global Mesh Setup

- To change defaults globally for size, method and type
- For entire model
- For Shells
- For Volume
- For Prism
- To set periodicity

Parameters relative to scale factor

- Max size
 - Global and local
- Min size limit
 - Global and local
- Max deviation



Global Mesh Size

– For entire model

Scale factor

- Global setting by which many local settings are multiplied
- Good for scaling overall mesh

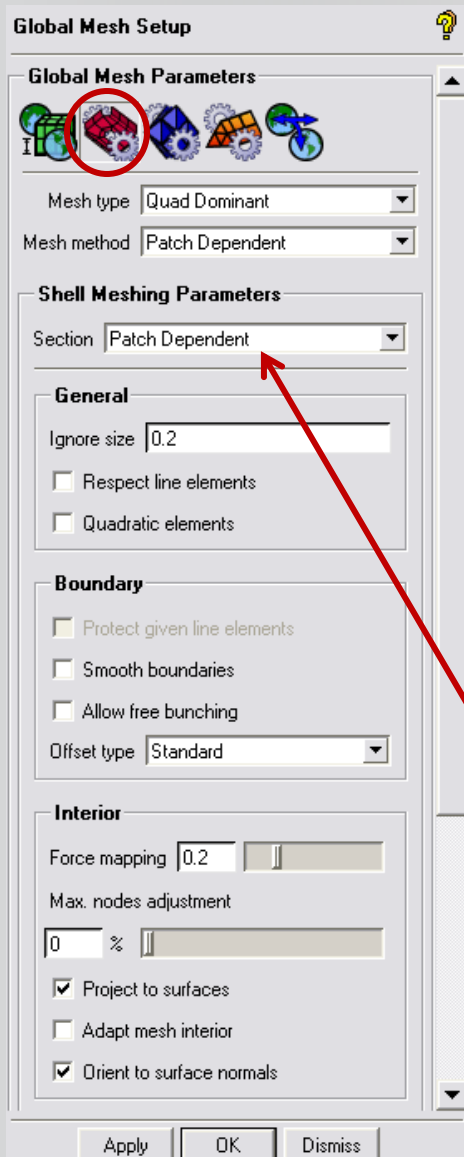
Global Element Seed Size

- Maximum possible element size in model
- Default size if don't wish to set local sizes

Curvature/Proximity Based Refinement

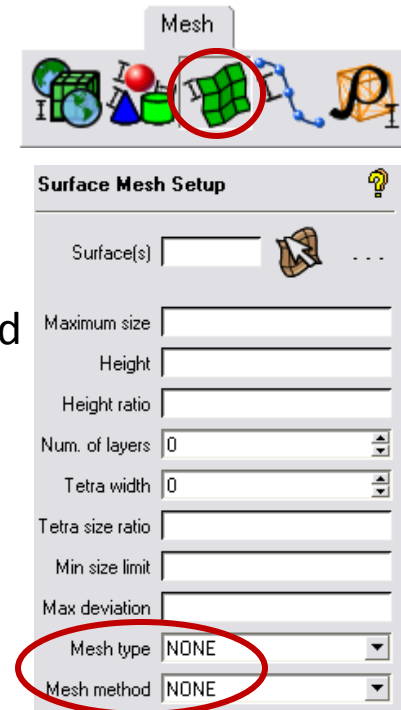
- Automatically creates smaller element size to better capture geometry
- Only for Patch Independent method and tetra octree

Global Shell Meshing Parameters



Global Shell Meshing Parameters

- From **Global Mesh Setup** tab
- Set surface mesh parameters globally
 - Defaults for the selected mesh method
- **Methods**
 - **Autoblock**
 - **Patch dependent**
 - **Patch independent**
 - **Shrinkwrap**
 - **Delaunay**
- **Type**
 - All Tri, Quad w/one tri, Quad dominant, All quad
- Options for different mesh methods
- Global types and methods can be overridden by
 - **Surface Mesh Setup**
 - Local settings
 - **Compute Mesh**



Part Mesh Setup

Part Mesh Setup (pop up spread sheet)

- Set mesh parameters on all entities within part
- Max. size**
 - Multiplied by global **Scale Factor** = actual size

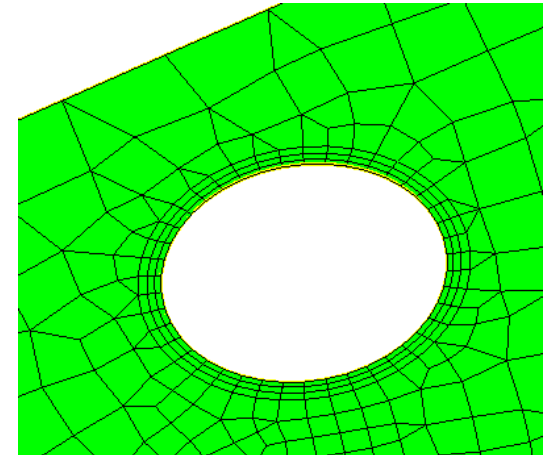
part	prism	hexa-core	max size	height	height ratio	num la
CYL	☐	☐	0	0	0	0
GEOM	☐	☐	0	0	0	0
PART.1	☐	☐	0	0	0	0
TOP	☐	☐	0	0	0	0

☒ Show size params using scale factor
☒ Apply inflation parameters to curves
☐ Remove inflation parameters from curves

Highlighted parts have at least one blank field because not all entities in that part have identical mesh parameters.

Apply

- Quad layers grown from curves (e.g. rings around holes), use these 3 parameters:
 - Height:** First layer quad height on curves
 - Height ratio:** growth ratio which determines the heights of each subsequent layer (multiplication factor)
 - Num layers:** Number of rings/inflation layers
- For quad layers, the minimum required to be set is **height** (for 1 layer) or **numlayers** (height = max. size)
- If done in the **Part Mesh Setup** spreadsheet you must toggle on **Apply inflation parameters to curves**



Curve Mesh Parameters

Method: General

Select Curve(s): box8.04.1e

Maximum size: 0.1

Number of nodes: 0

Height: 0.01

Height ratio: 1.1

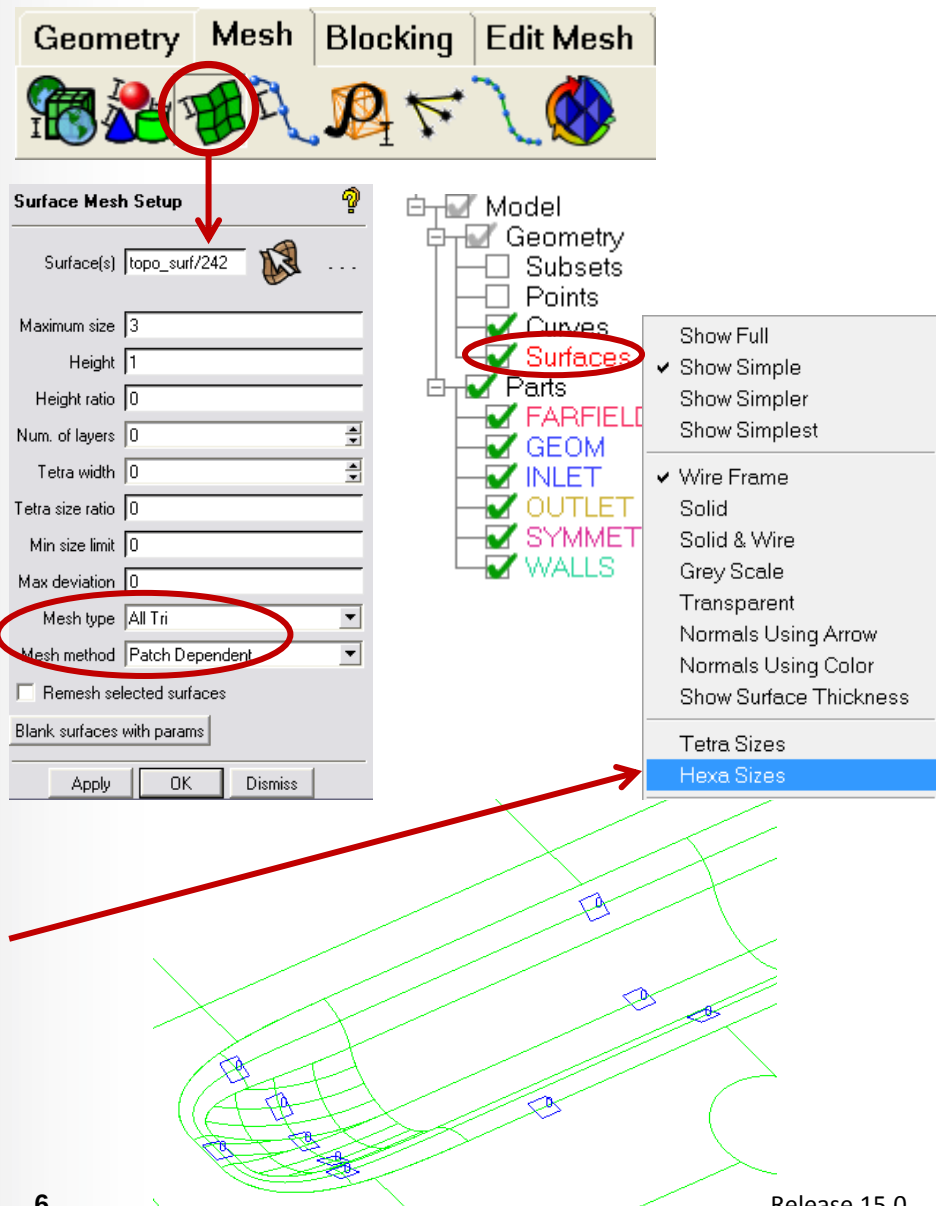
Num. of layers: 3

Or set on individual curves

Local Surface Mesh Setup

- Surface Mesh Setup**

- Same parameters as part mesh setup but also includes:
 - **Mesh type**
 - **Mesh method**
- Select surfaces first from screen, set sizes/parameters and **Apply**
- Mesh method/type will override global shell mesh settings for selected surface(s)
- Will override **Part Mesh Setup** settings if set afterward
- Display mesh sizes
 - Right mouse, select in Model tree on **Surfaces > Tetra/Hexa Sizes**
 - One Icon appears for each surface
 - Gives you a visual estimate of prescribed max. size and height

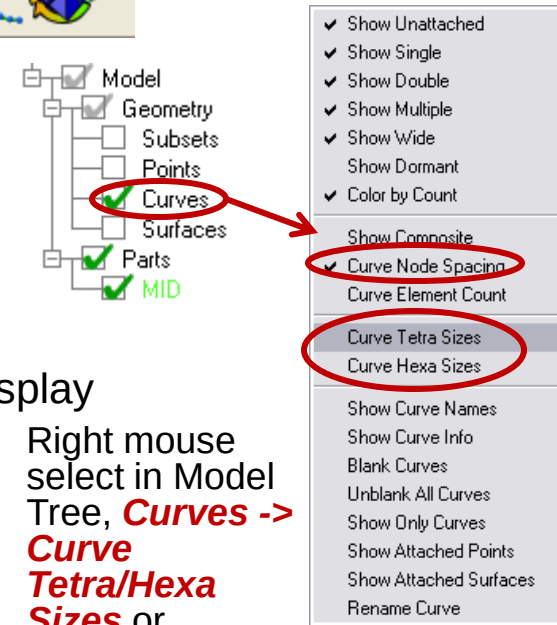
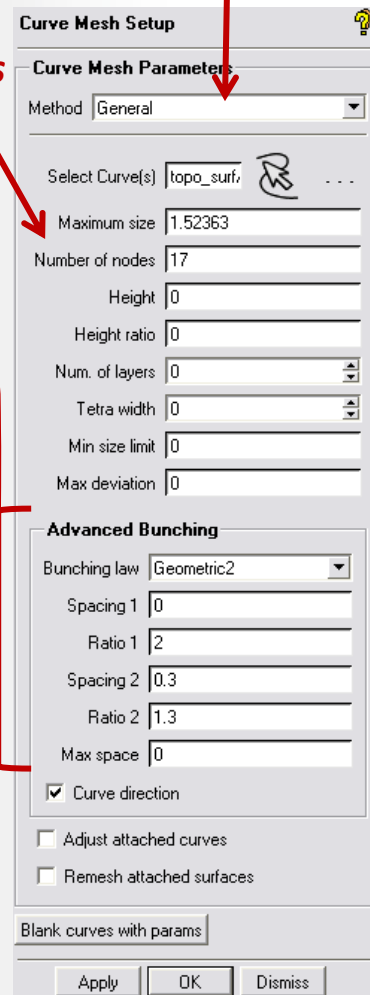
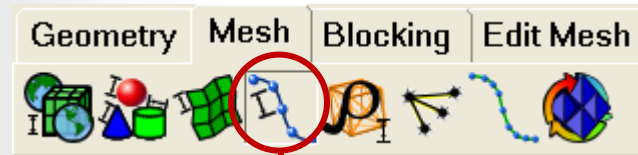
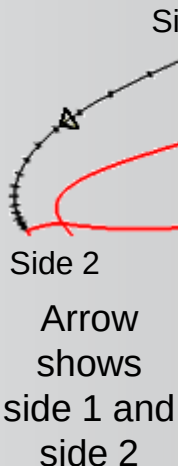


Local Curve Mesh Setup – General

Curve Mesh Setup

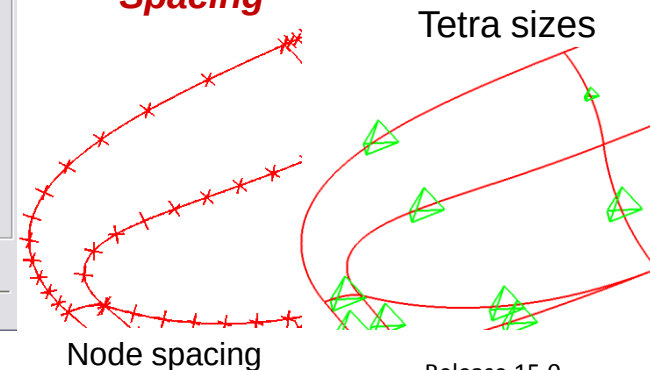
General

- Same as **Surface Mesh Setup**
- But also can prescribe **Number of nodes**
 - Instead of element size
- Also includes **node biasing along curves**
 - Initial spacing from either curve end
 - Bunching laws
 - Expansion ratios from either curve end
 - Matching of node spacing to adjacent curves
 - For a better description, refer to the Hexa chapter – **Edge Parameters**
- Select curves first, middle mouse to accept selection, then type in parameters/sizes - **Apply**



Display

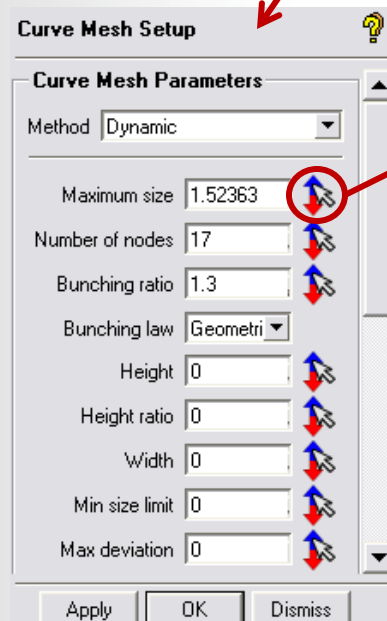
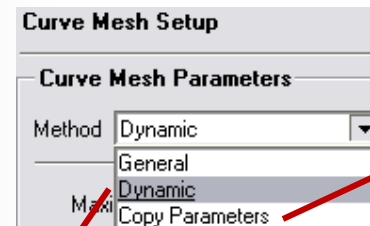
- Right mouse select in Model Tree, **Curves** -> **Curve Tetra/Hexa Sizes** or **Curve Node Spacing**



Local Curve Mesh Setup – Dynamic and Copy

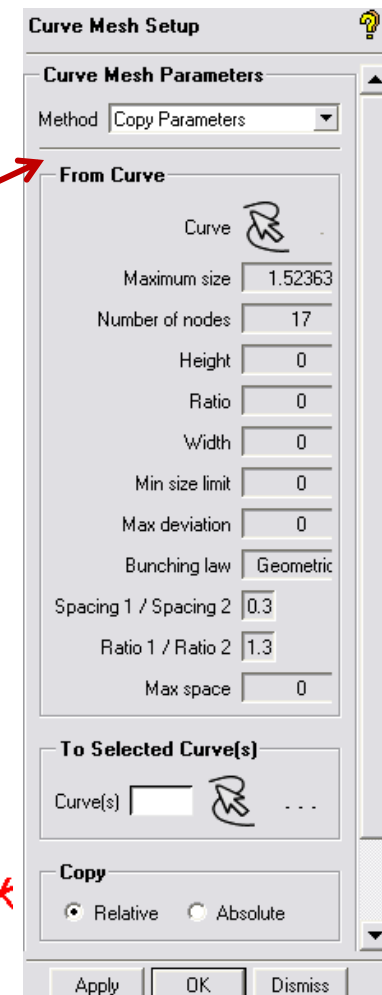
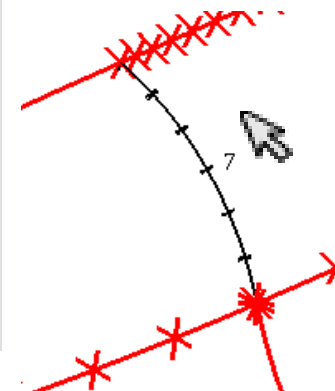
Curve Mesh Setup

- **Dynamic**
 - Adjust mesh parameters on screen
 - Interactively toggle displayed values near curve with left (to increase) or right mouse (to decrease) keys
- **Copy Parameters**
 - Copy parameters set on one curve to others
 - e.g. parallel curves downstream
- **Curve Mesh Setup** will override **Part Mesh Setup** parameters if set afterward



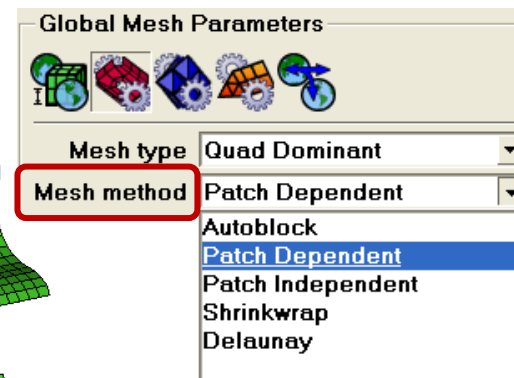
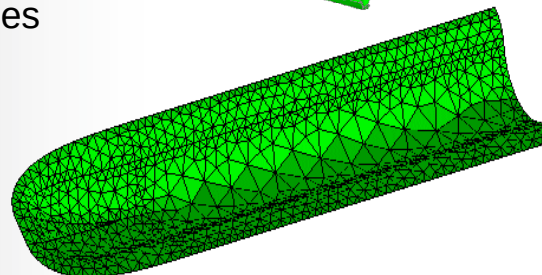
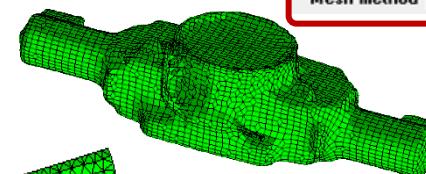
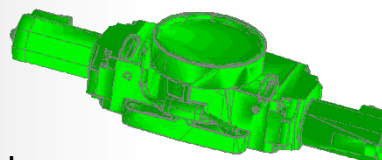
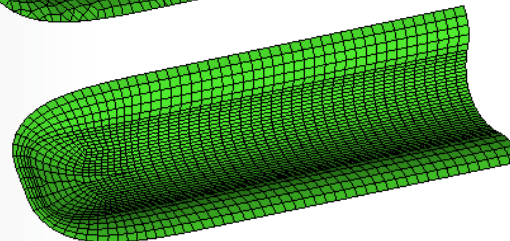
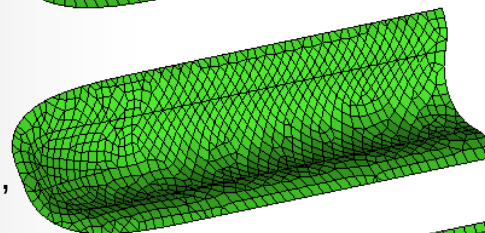
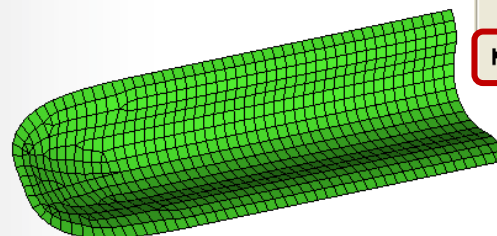
Left mouse to increase

Right mouse to decrease

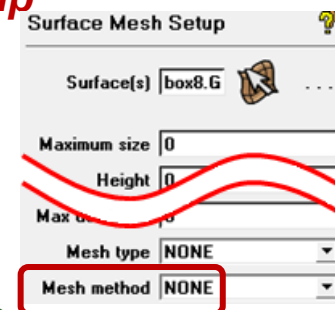


Algorithm used to create mesh

- **Patch Dependent**
 - Based on loops of curves surrounding patches
 - Best for capturing surface details and creating quad dominant mesh with good quality
- **Patch Independent**
 - Robust octree algorithm
 - Good for dirty geometry, ignoring small features, gaps, holes
- **Autoblock**
 - Based on 2D orthogonal blocks
 - Best for mapped meshing, mesh follows contours of geometry
- **Shrinkwrap**
 - Automatic defeaturing
 - Quick Cartesian algorithm
 - Allows ignoring of larger features, gaps and holes
- **Delauney (beta options)**
 - Allows for transition in mesh size
 - Coarser towards surface interior
 - Tri only

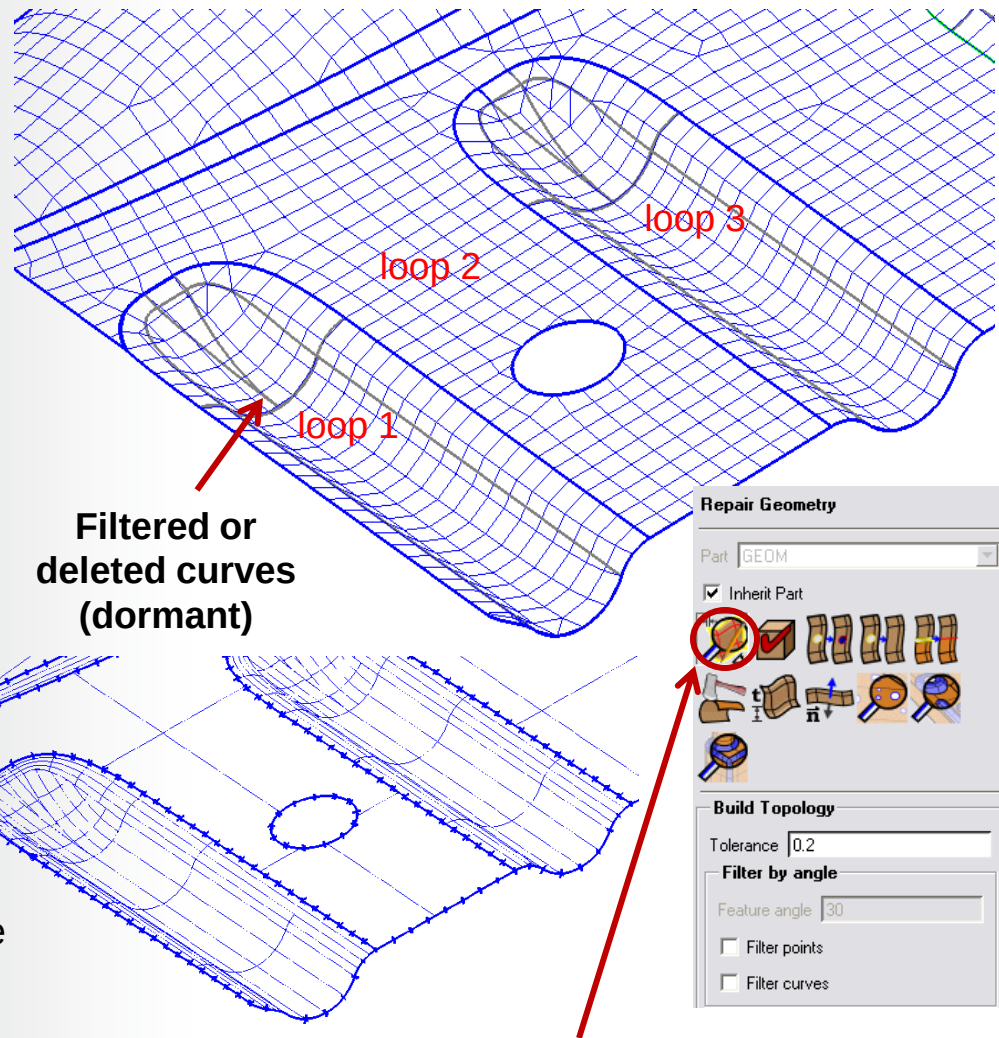


- Set in **Global Mesh Setup** or locally using **Surface Mesh Setup**



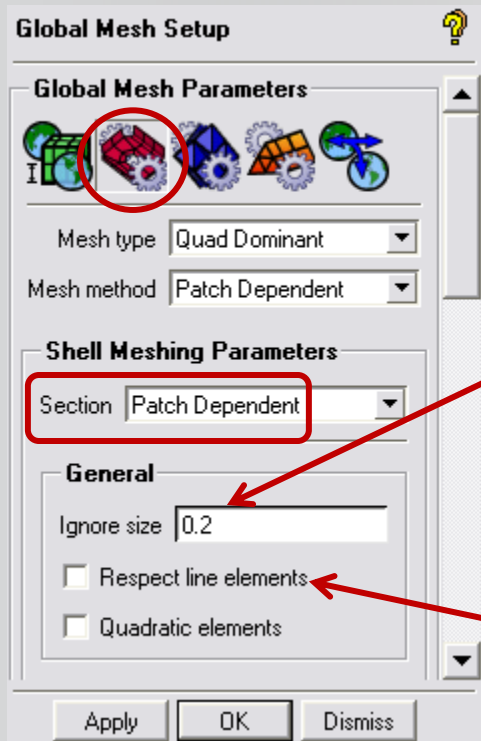
Patch Dependent Method

- Patch defined by a closed loop of curves
 - Typically each surface defines a patch
 - Loop defined by boundary curves
 - Curves automatically created by *Build Diagnostic Topology* - a must!
 - Can remove or filter out curves to define multi-surface patches
 - Delete curves (non-permanently)
 - Turn on filter points/curves when building topology
- Mainly uses curve sizes (curve nodes seed loop perimeter)
- Paving algorithm used to fill interior of loop
 - Interior nodes typically projected to surface
 - Adjacent loops share nodes at common edge making mesh conformal throughout
- Default method, fastest method



Build topology MUST be done first to build surface connectivity and curves

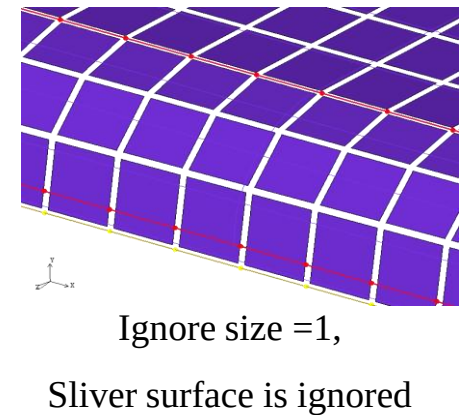
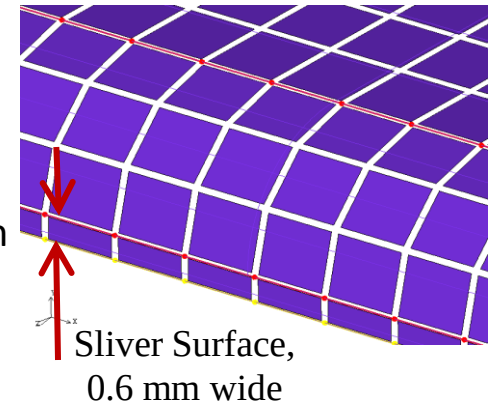
Patch Dependent – Common Options



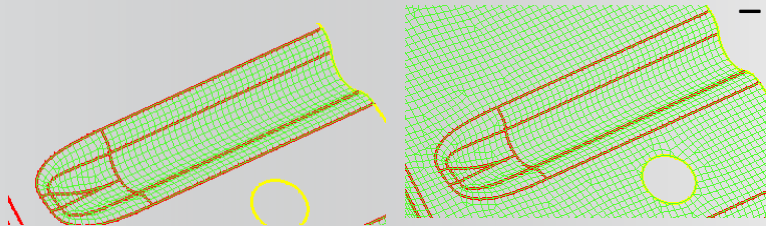
All method options set from **Global Mesh Setup -> Shell Meshing Parameters** section

General

- **Ignore Size**
 - Small features, such as sliver surfaces smaller than defined value are ignored. Merges loops behind the scenes
 - Will override max. size setting if smaller
- **Respect line elements**
 - Line elements (bars) on existing mesh are respected
 - Maintains conformal mesh between newly created mesh and existing mesh on adjacent surfaces



Surrounding mesh done afterwards is conformal to existing mesh



Patch Independent

Uses robust Octree method

- Volumetric tetra elements created around geometry
- Faces projected to surfaces
- Only surface mesh is retained
- Discussed in more detail in *Volume Mesh* lecture

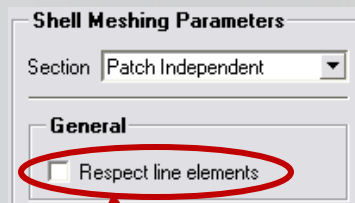
Mesh sizes defined on surfaces and curves

Can walk over small details, thin gaps, small holes

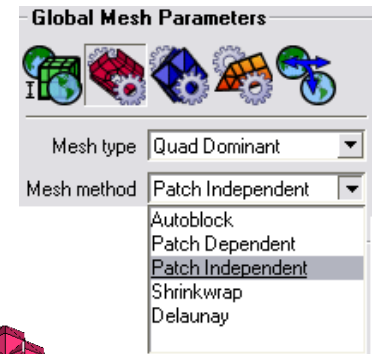
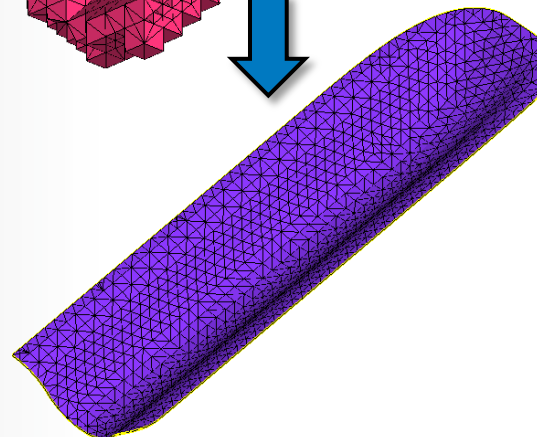
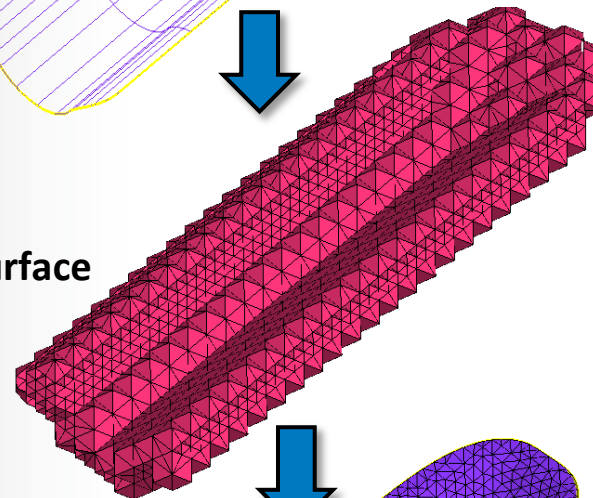
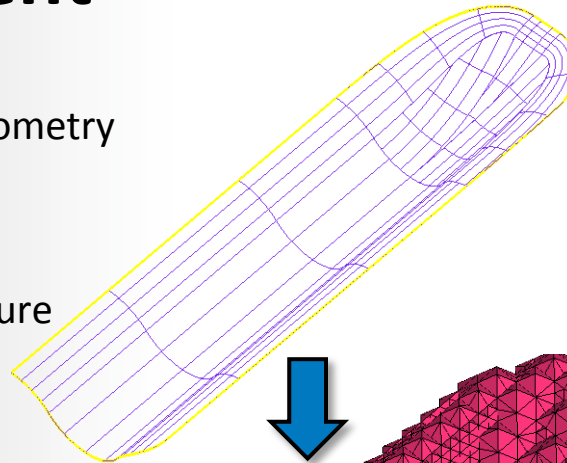
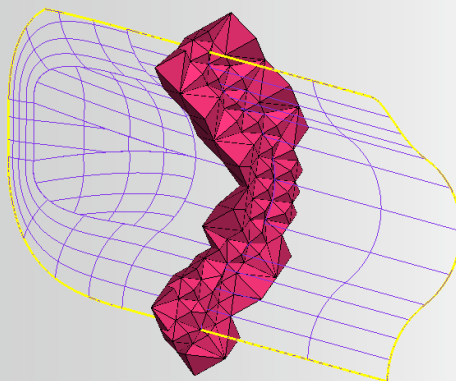
- Relative to mesh size

Nodes and edges don't have to be lined up with surface edges

- Only lined up where curves exist



Matches up with
previously meshed
surfaces



Volume
around is
first
meshed

Nearest nodes
projected to surface
and only surface
mesh is left

Surface (2D) blocks are created automatically from each surface

- Internal, blocks aren't recognized or visible
- For further description of blocking, refer to Hexa chapter

Blocks structurally connected

- Conformal mesh between blocks and surfaces

Structured blocks result from 4-sided surfaces

- For regular or four-sided blocks, structured (mapped) mesh follows contours of geometry

Best for recognizing rounds or fillets

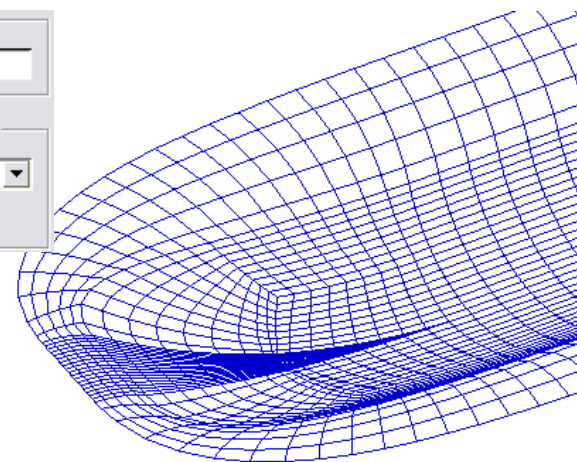
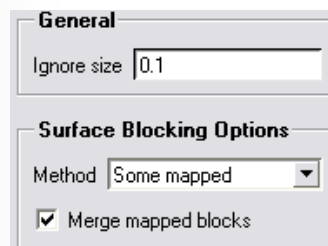
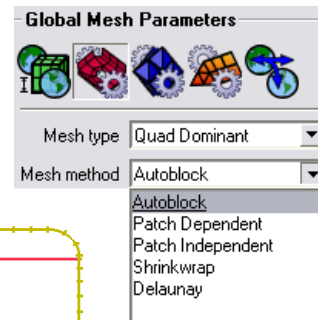
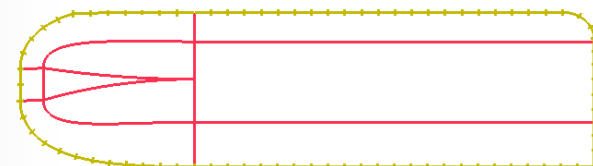
Irregular (non-4 sided) or trimmed surface patches may be unstructured

Mesh sizes set on surfaces or curves

Options

- **Ignore size**
- **Mapped** or **free** (unstructured as in patch dependent)

Build Topology MUST be run beforehand





Global Mesh Setup

Global Mesh Parameters



Mesh type

All Tri

Mesh method

All Tri

Quad w/one Tri

Quad Dominant

Shell Mesh

All Quad

Global settings

Surface Mesh Setup

Surface(s)

Maximum size

3

Height

0.99988091

Height ratio

0

Num. of layers

0

Tetra width

0

Tetra size ratio

0

Min size limit

0

Max deviation

0

Mesh type

Quad Dominant

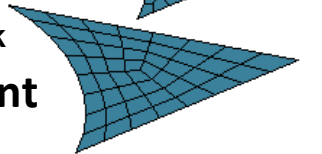
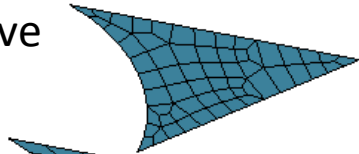
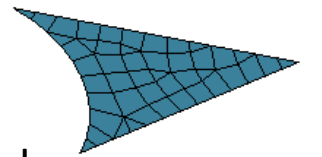
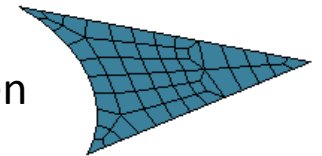
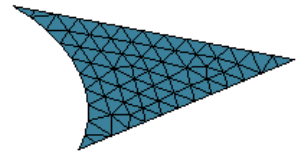
Mesh method

NONE

Local surface settings

- Set in **Global Mesh Setup > Shell Mesh Parameters** or **Surface Mesh Setup** (local upon selected surface entities)
 - Global defaults overridden by local settings or **Compute Mesh** options
- **All Tri**
- **Quad w/one Tri**
 - Almost all quad except with one tri per surface
 - Single tri allows transition between uneven mesh distribution on loop edges
 - Where pure quad will fail
- **Quad Dominant**
 - Allows for several transition triangles
 - Very useful in surface meshing complicated surfaces where a pure quad mesh may have poor quality
- **All Quad**

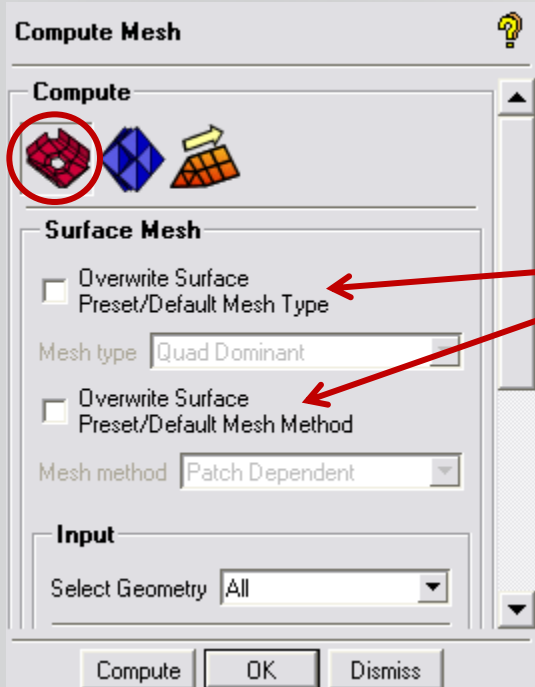
Examples done with patch dependent mesher



All quad, autoblock

These mesh types will look different with the different mesh methods

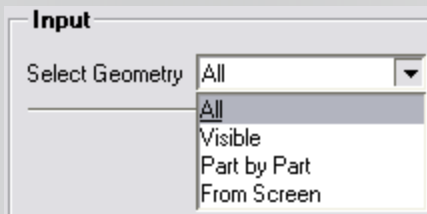
Compute Mesh



Once sizes, methods and types are set – ready to compute!

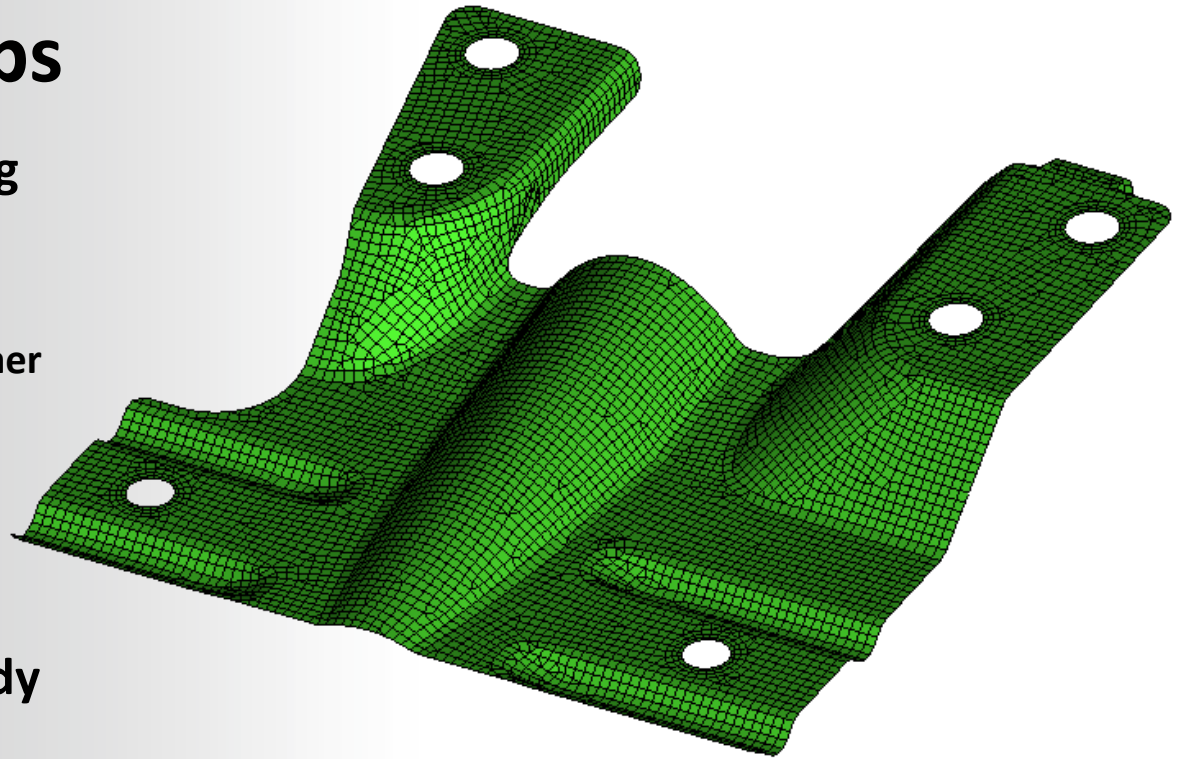
Select **Mesh > Compute Mesh > Surface Mesh Only**

- Most of the time can just select **Compute** at bottom of panel which will create shell mesh for entire model (**Input = All**)
- Other options
- **Overwrite Surface Preset/Default Mesh Type/Method**
 - To quickly override global and local settings
 - Avoid going back to other *Mesh Setup* menus to change parameters
- **Input**
 - Can mesh **All** (default – entire model)
 - **Visible** – only visibly displayed surfaces/geometry
 - **Part by Part**
 - Parts meshed separately
 - Mesh will be non-conformal between parts
 - **From Screen**
 - Select surfaces or a loop of curves to mesh from screen



• Workshop 3.1 - stamping

- Build diagnostic topology
- Setting curve parameters
- Patch based surface mesher
- Dormant curves
- Ignore size
- Quad rings



• Workshop 3.2 - Wingbody

- Global element size
- Mesh setup by parts
- Different mesh method on selected surfaces
- Curve parameters – dynamic method
- Deleting elements – flood fill
- Try harder setting – patch independent
- Respect line elements
- Remesh only selected surfaces

