# **Exercise 4a - 2D Shell Meshing and Topology Refinement**

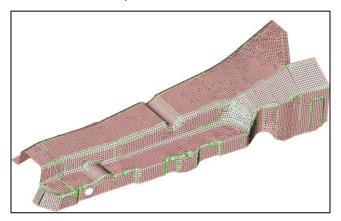
Step 1: Load the model: 04a-2D-MESH.hm.

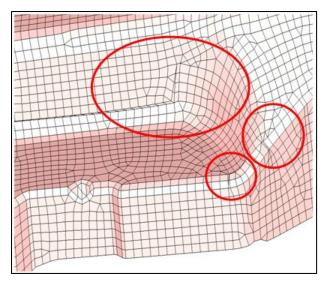
### Step 2: Automatic 2D Meshing

1. From menu bar, click *Mesh > Create > 2D AutoMesh* to open the Automesh panel and select the displayed surfaces.

•	surfs II	element size =		5.000	\$	elems to surf con	np		mesh
۲	size and bias	mesh type:	▼ □	mixed	\$	first order			reject
0	batchmesh/QI optimize				•	keep connectiv	ity		
0	edge deviation				flow:	🔲 align			
0	surface deviation				map:	🔽 size 🔽	skew		unmeshed
C	rigid body mesh								failed
\$	automatic				🗍 lin	k opposite edges with AR <		auto	retum

- 2. Mesh the part with an **element size** of 5. Set all of the options to match the picture above.
- 3. Review the mesh. Overall the mesh looks pretty good but closer examination of areas around the part reveals there are some extremely poor quality elements.

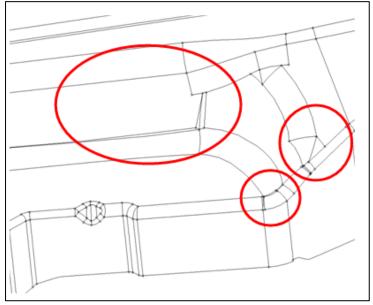




4. Manipulate the part using the Pan, Rotate and Zoom functions and identify areas of poor mesh formation.

As discussed in the lecture, HyperMesh always maintains all edges in the model except those that are suppressed.

Turning the mesh visualization off shows the surface edge lines and reveals that there are many features within the model that interfere with mesh quality. This is very often the case in geometric models imported from CAD. Topology refinement is used to fix those areas to improve the quality of the generated mesh.



#### **Step 3: Topology Refinement**

The goal of topology refinement is to manipulate the geometry to remove or alter geometric features that cause poor element quality. HyperMesh has many tools, both automatic and manual, to assist in this process.

- 1. Enter the *Geometry* > *Autocleanup* panel.
- 2. From the Autocleanup panel select the edit parameters button.

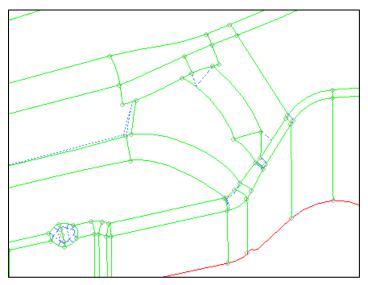
surfs	Μ	target elem siz	:e parameter =	5	autocleanup
		Topology cleanup parameters:			reject
	(	use current parameters	edit parameters		
		Elements quality criteria:		_	
	ŧ	use current criteria	edit criteria		
	_			-	
			preserve edges		return

- 3. Enter 5 for the Target element size.
- 4. Leave the **Geometry cleanup** option checked and deselect all other options.
- 5. Click **OK**.
- 6. Select the edit criteria button and check Advanced Criteria Table option.
- 7. Enter 5 for the **Target element size**, 3 for the *Min Size* > *Good* and 6 for the *Max Size* > *Good*.

Criteria File Editor - [*]	Criteria File Editor - [ *]						
File Help	ïle Help						
Criteria	Criteria						
Target element size: 5		5	🔽 Adv	vanced Ci	riteria Tab	le	
Checks	On	Weight	Ideal	Good	Warn	Fail	Worst
Min Size		1.0	5	3	2.5	2	1.75
Max Size		1.0	5	6	6.5	7	7.5
Aspect Ratio		1.0	1.000	2.000	4.400	5.000	10.000

- 8. Click **OK**.
- 9. Select all the surfaces and click **autocleanup**.

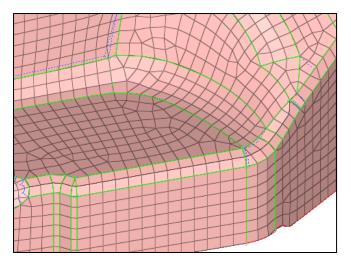
HyperMesh has suppressed edges that it felt would not allow elements that met the criteria to be created.



 Review the part again having a look at the new mesh that was remeshed automatically during the topology modification due to the **Meshing Options** already defined (*Preferences > Meshing Options > topology revision: > advanced remesh*).

You will see that the quality of the mesh has improved drastically.

HyperWorks 2017.2



There are still some issues with the mesh though.

- 11. Using the *Mesh* > *Quick edit (F11)* panel improve the quality of the mesh using the following functions:
  - toggle edge
  - adjust/set density
  - add/remove point
  - split surf-node; split surf-line;

#### Step 4: Interactive 2D Meshing

While automatic meshing is quick and the overall mesh quality is good, HyperMesh allows the user to interactively manipulate a preview mesh, controlling various settings before the mesh is finalized.

 Delete created displayed elements and click the Mesh > Create > 2D AutoMesh (F12) panel.

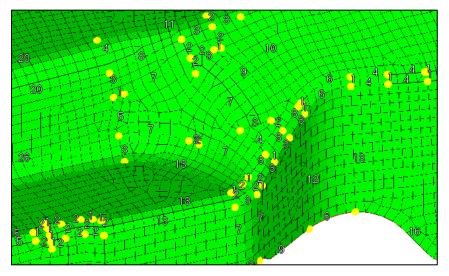
•	surfs 🛛 🖌	element size =		5.000	\$	elems to surf comp		mesh
(F	size and bias	mesh type:	▼ □	mixed	\$	first order		reject
C	batchmesh/QI optimize				•	keep connectivity		
C	edge deviation				flow:	🗌 align		
С	surface deviation				map:	🔽 size 🔽 skew		unmeshed
C	rigid body mesh	_						failed
ŧ	automatic				Г	link opposite edges with AR <  🌲	auto	return

- 2. Change the toggle from automatic to interactive.
- 3. Select the surfaces in the Standard collector.
- 4. Click on mesh to create 2D shell elements.

HyperMesh now enters in a secondary panel.

<ul> <li>density</li> </ul>	adjust:	edge	calculate:	edge	set:	edge	mesh
<ul> <li>mesh sty</li> </ul>	/le			recalc all		set all to	reject
<ul> <li>biasing</li> </ul>			elem size =	5.000	elem density =	1	smooth
C checks			🔲 link oppos	ite edges with A 🕴	🕽 auto 🛛		undo
				_			
							abort
						f local view	return

The green mesh that is shown is only a preview mesh and to see how changes affect it click the green **mesh** button. The mesh will not be finalized until the **return** button is clicked.

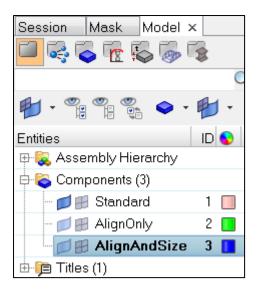


- 5. From this screen try the following functions and see the effect they have on the mesh. After each interactive change, click on **mesh** to update your green mesh to see effects.
  - Adjust the edge densities.
  - Recalculate the entire model to have a 6 mm element size.
  - Change the mesh style so that the element type is all trias and then all R-Trias.
  - Alter the biasing on edges and determine the difference between linear, exponential and bell curve biasing.
  - Recalculate the mesh to have 5 mm quad elements on all surfaces.
- 6. Click on **return** to save the mesh.

#### Step 5: Model Organization

As this exercise will demonstrate the differences between meshing options, multiple components will be necessary to separate the various meshes.

- 1. Create two new components called **AlignOnly** and **AlignAndSize** and make them distinct colors.
- 2. Organize a copy of all the surfaces into both collectors.



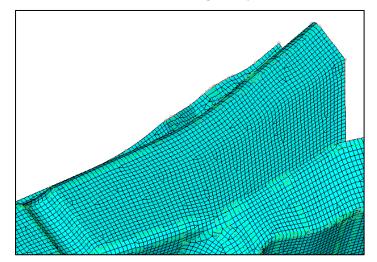
#### **Step 6: Meshing Options**

There are a few options in the **2D AutoMesh** panel which can have a profound effect on the mesh created. This section will explore these options.

- 1. Make the AlignOnly collector current and the only collector visible.
- 2. From the **2D** AutoMesh panel, size and bias sub panel, next to flow select the align option. Leave the two size boxes un-selected.

flow:	🔽 align	🔲 size
map:	🔲 size	🔲 skew

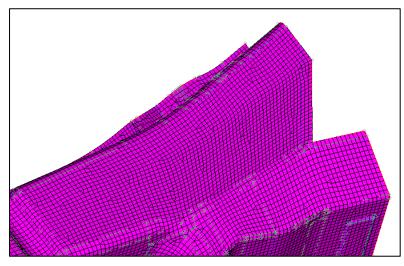
3. Select the surfaces in the AlignOnly collector and click on mesh.



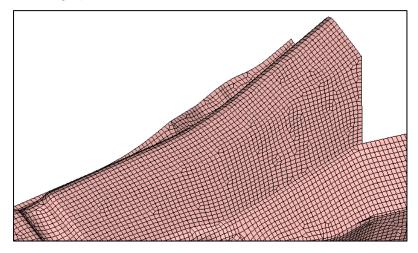
- 4. Make the AlignAndSize collector current and the only collector visible.
- 5. From the **2D** AutoMesh panel, size and bias sub panel, next to flow select the *align* and *size* options.

flow:	🔽 align	🔽 size
map:	🔲 size	🔲 skew

6. Select the surfaces in the AlignAndSize collector and click on mesh.



7. Utilizing the isolate function in the **Model Browser** to see the results of the different meshing options.



Note that the non-aligned standard mesh tends to be more orthogonal following the direction of the cardinal axis. The Align option allows the mesh to flow with the contours of the part and the addition of the size option controls the size of the elements more and results in less trias.

## Step 7: Edge and Surface Deviation

- 1. Create 2 more component collectors called **EdgeDev** and **SurfDev** and make them distinct colors.
- 2. Organize a copy of all the surfaces into both collectors.
- 3. Make Current the EdgeDev collector and the only collector visible.
- 4. In the the **2D AutoMesh** panel, select the **edge deviation** subpanel.

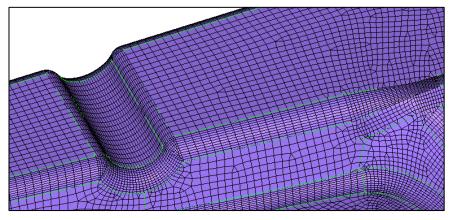
•	surfs I	min elem size  =	0.500	ŧ	elems to surf comp	mesh
С.	size and bias	max elem size 😑	5.000	ŧ	first order	reject
С.	batchmesh/QI optimize	max deviation =	0.025	▼	keep connectivity	
e	edge deviation	max angle =	15.000	flow:	🔽 align	
С.	surface deviation	mesh type: 🔹	D mixed	map:	🔽 size 🔽 skew	unmeshed
0	rigid body mesh					failed
\$	automatic			∏ li	ink opposite edges with AR < 🛛 🔶	auto

5. Set the values as follows:

min elem size  =		0.500
max elem size 🛛 =		5.000
max deviation =		0.025
max angle =		15.000
mesh type:	$\bullet$	mixed

6. Mesh the part and if in interactive mode, finalize the mesh.

Note how the mesh size varies depending on surfaces curvature. At rounded edges and around holes the mesh size drops down to the minimum element size to capture the curvature. Areas of no curvature are meshed at the largest element size.



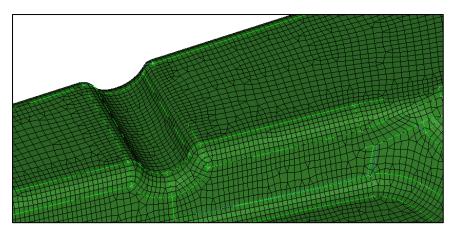
- 7. Make Current the SurfDev collector and the only collector visible.
- 8. Select the **surface deviation** sub panel.

▼ surfs	element size =	5.000	elems to surf comp	mesh
C size and bias	growth rate =	1.200	first order	reject
C batchmesh/Ql optimize	min elem size =	3.000	<ul> <li>keep connectivity</li> </ul>	
<ul> <li>edge deviation</li> </ul>	max deviation =	0.100	Closed volume proximity	
<ul> <li>surface deviation</li> </ul>	max feature ang =	15.000	free edge deviation	unmeshed
C rigid body mesh	mesh type:	▼ D mixed	refine 🔽 show refined	failed
				return

#### 9. Set the values as follows:

element size =	5.000
growth rate =	1.200
min elem size 🛛 =	3.000
max deviation =	0.100
max feature ang =	15.000
mesh type:	▼ 🕞 mixed

10. Mesh the part. Note how now the mesh size is dependent on and varies with the curvature of the surfaces. Fillets between and areas of high surface curvature are captured with smaller elements but large flat areas are of a higher element size.



11. Experiment in these two sub panels and determine how the interactive mesh controls can be used to enhance the feature capturing abilities of these meshing styles.