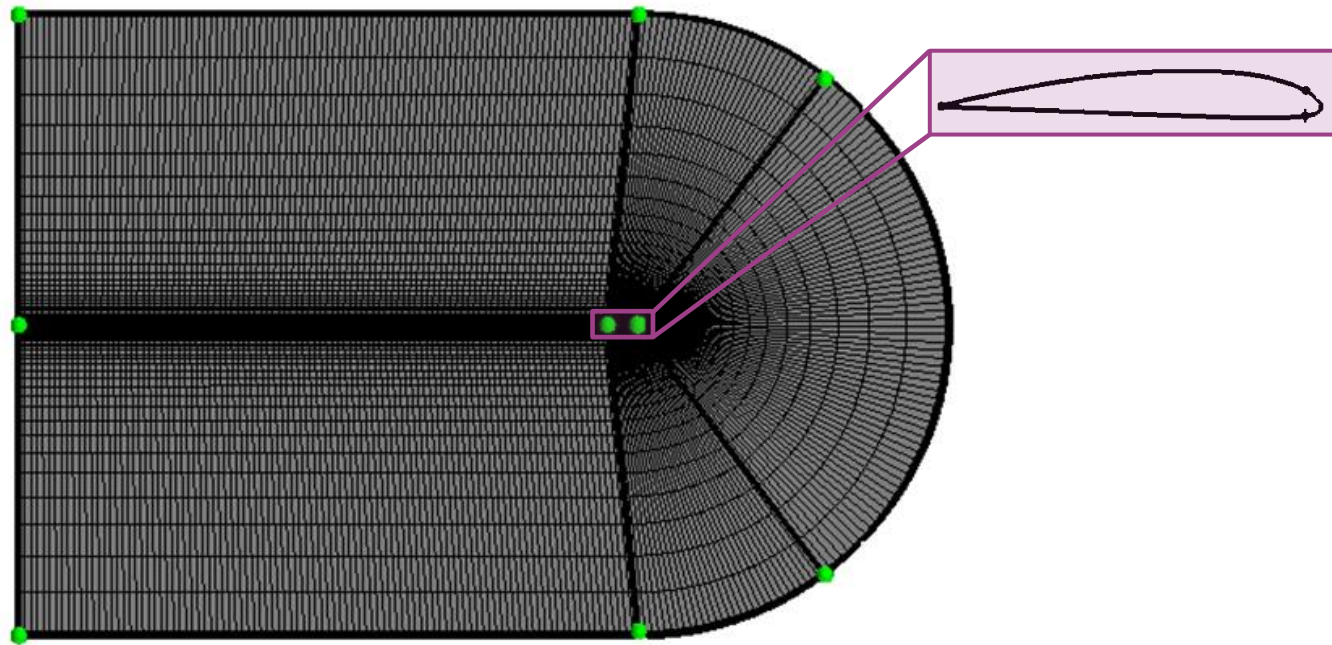


CFD applied to Turbomachinery

Francesco Romanò

francesco.romano@ensam.eu

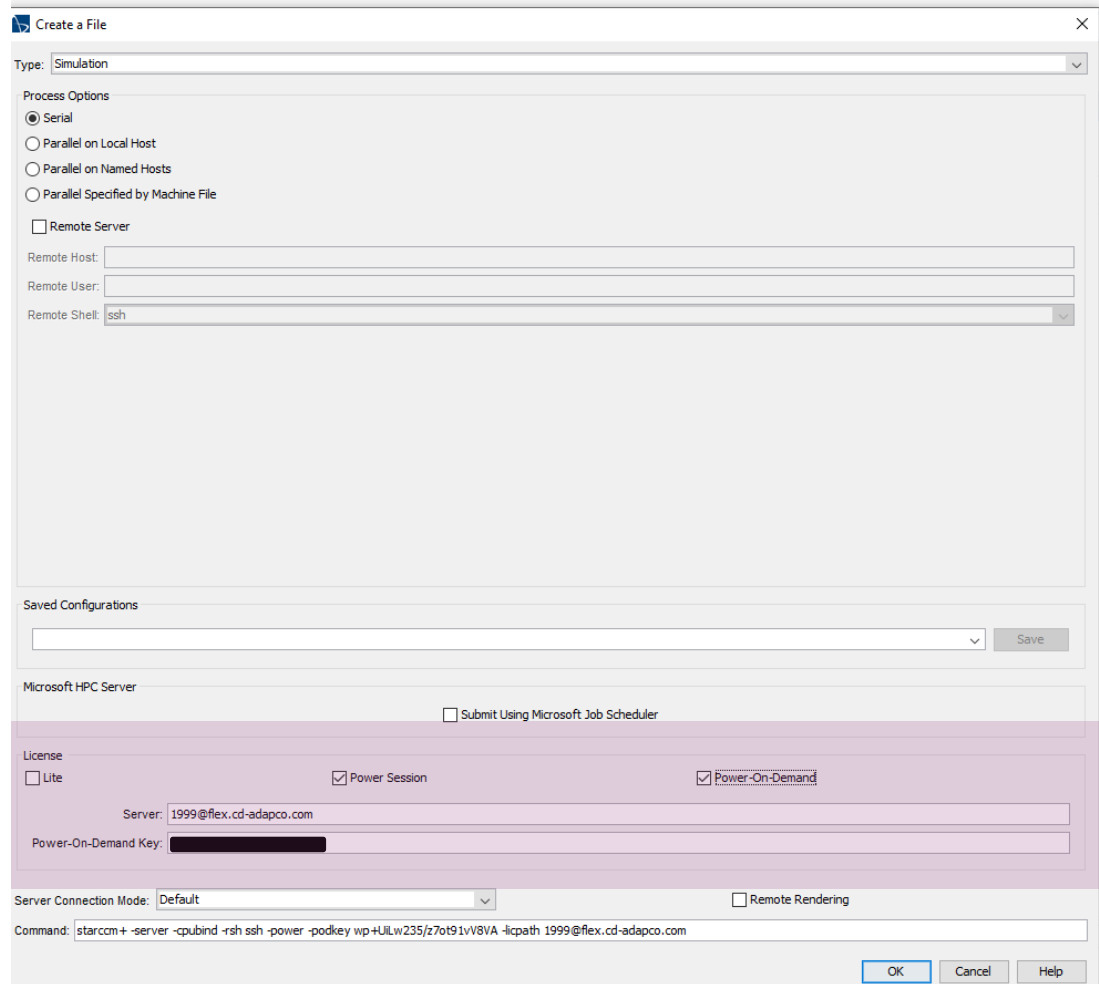
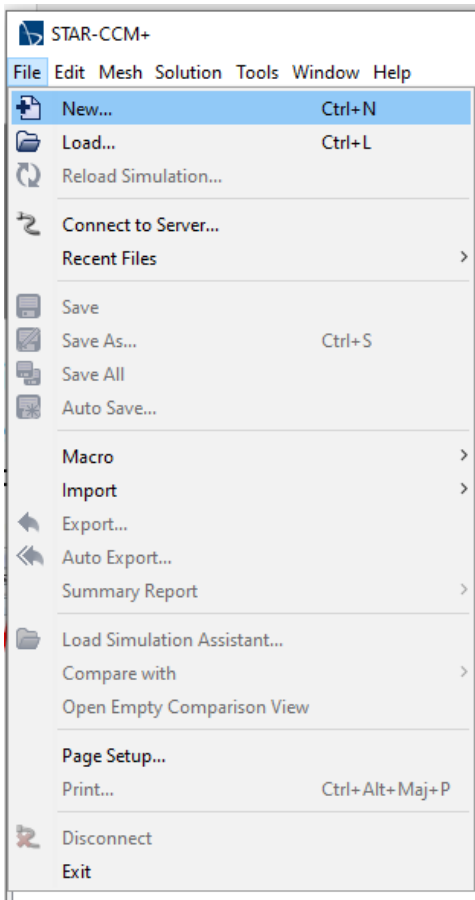
Laboratoire de Mécanique des Fluides Lille, Arts et Métiers Institute of Technology, 59800, Lille, France



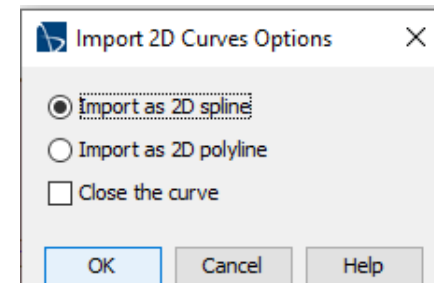
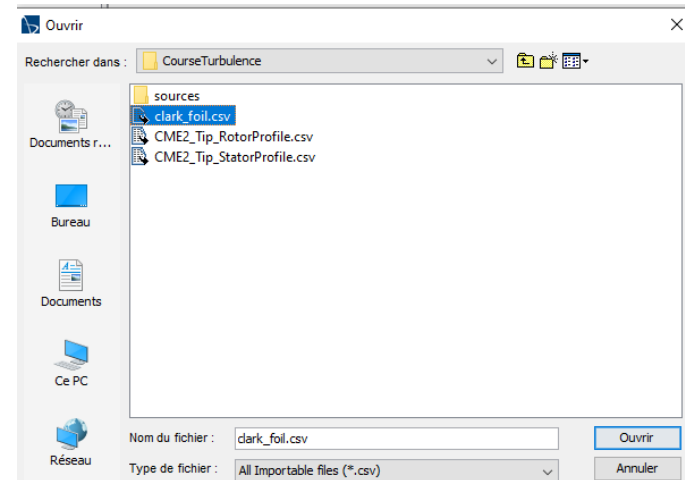
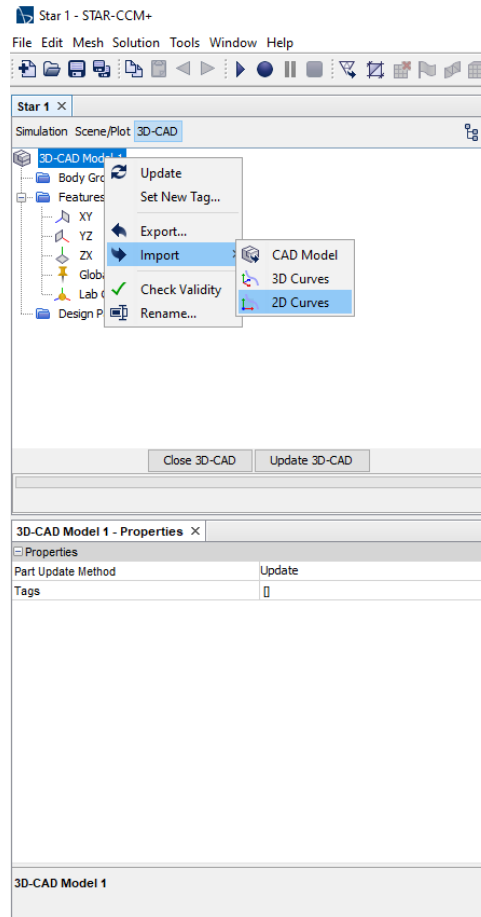
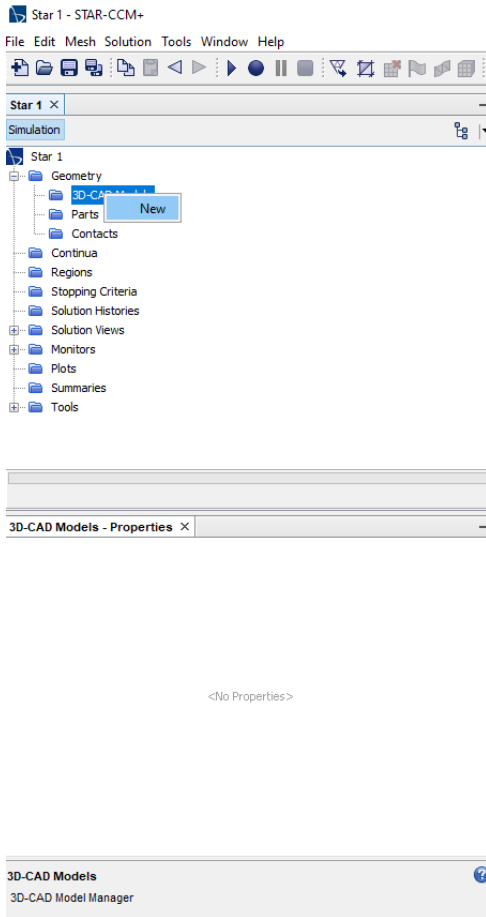
March 10, 2021, International Master of Turbulence



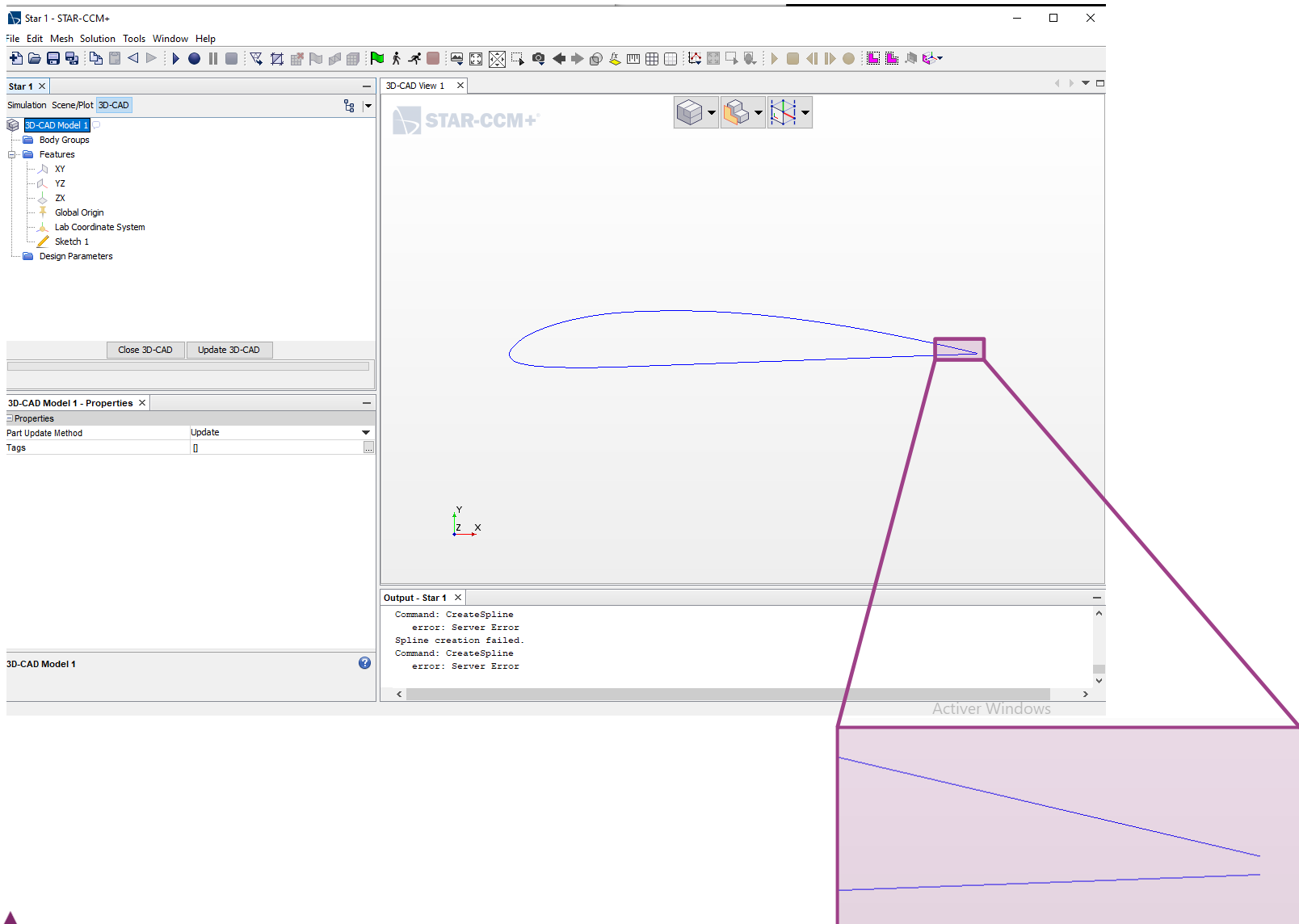
Creating a 2D Mesh in StarCCM+



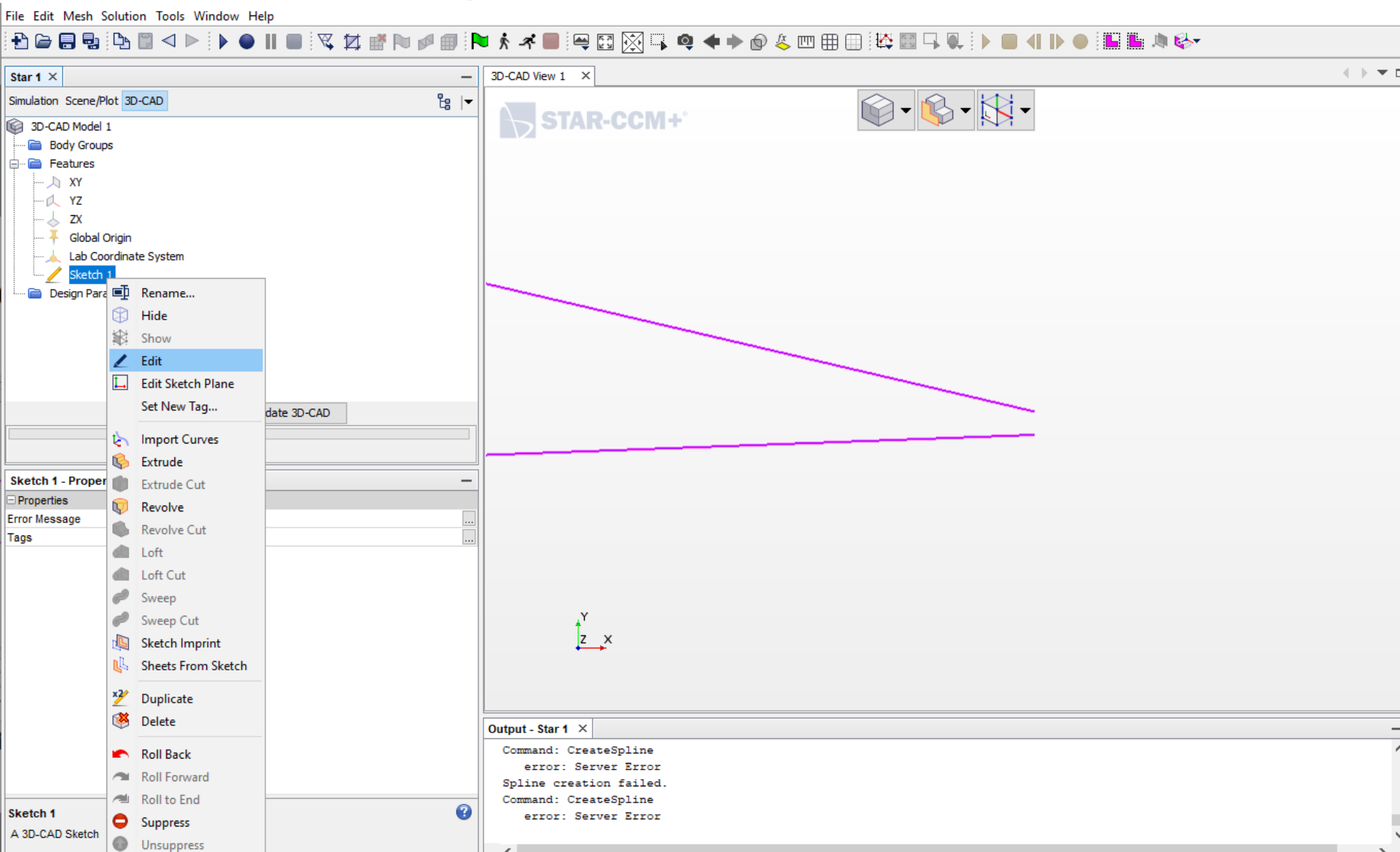
Creating a 2D Mesh in StarCCM+



Creating a 2D Mesh in StarCCM+

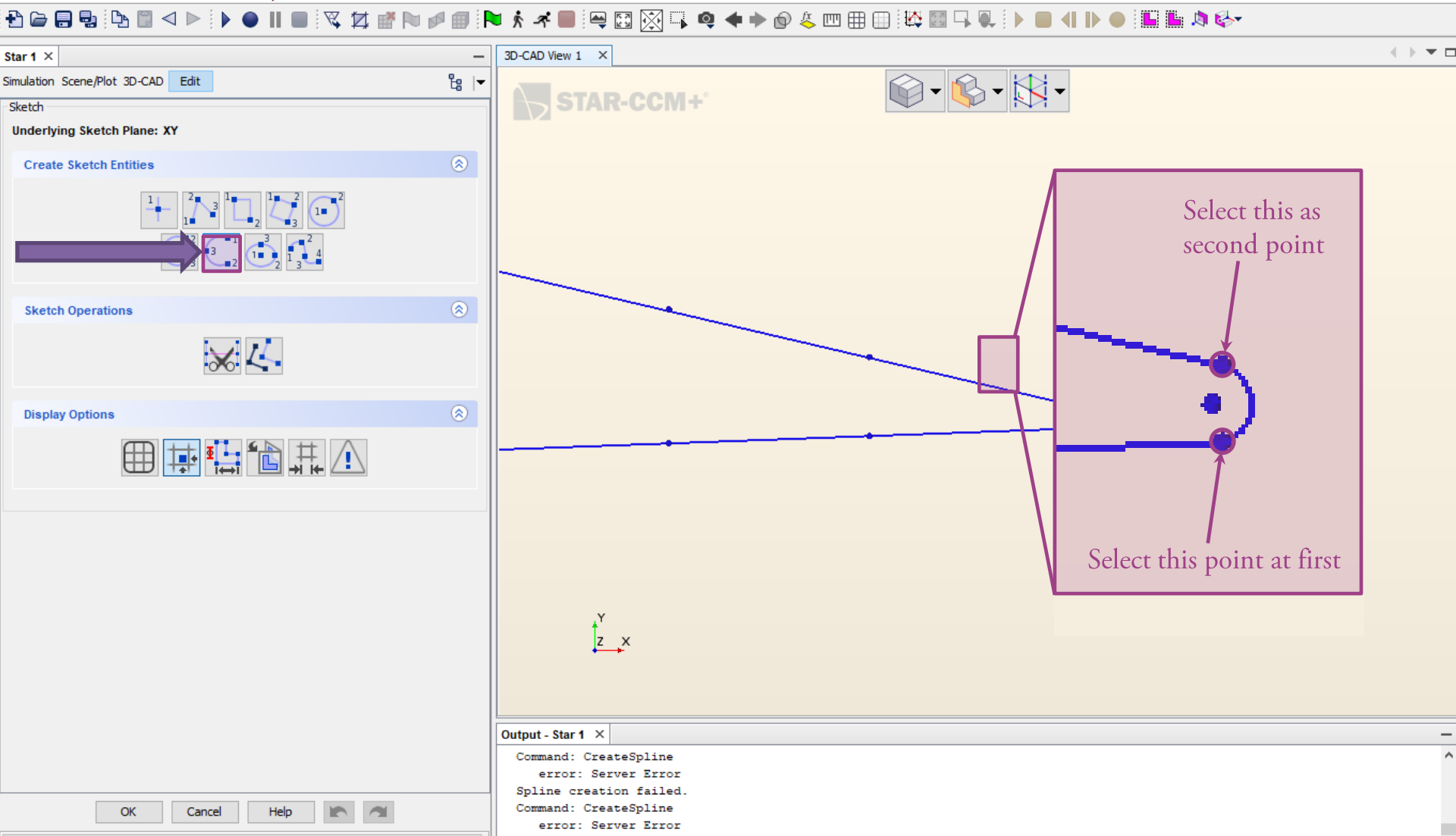


Creating a 2D Mesh in StarCCM+



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. The top menu bar includes File, Edit, Mesh, Solution, Tools, Window, and Help. The left sidebar shows the 'Sketch' tab with 'Underlying Sketch Plane: XY'. Below this are sections for 'Create Sketch Entities', 'Sketch Operations', and 'Display Options'. A purple arrow points to the 'Grid Spacing' dialog box, which is open and shows 'Grid spacing' set to 0.001 m and 'Number of fine grid divisions' set to 4.0. The main window, titled '3D-CAD View 1', shows a blue spline being created on the XY plane. The bottom right corner features an 'Output - Star 1' window with the following text:

```
Command: CreateSpline
error: Server Error
Spline creation failed.
Command: CreateSpline
error: Server Error
```



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Star 1 ×

Simulation Scene/Plot 3D-CAD Edit

Sketch

Underlying Sketch Plane: XY

Create Sketch Entities

Sketch Operations

Point Properties

Point

X 0.0 m

Y 0.0 m

Display Options

3D-CAD View 1 ×

STAR-CCM+

Right click on this point

Point 62

- Select Other Constraints
- Apply Fixation Constraint
- Duplicate Sketch Primitive
- Delete

Output - Star 1 ×

```
Command: CreateSpline
error: Server Error
Spline creation failed.
Command: CreateSpline
error: Server Error
```



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Star 1 x

Simulation Scene/Plot 3D-CAD Edit

Sketch

Underlying Sketch Plane: XY

Create Sketch Entities

Sketch Operations

Create Center-Point Circular Arc

Circular Arc Properties

Center

X 0.0 m

Y 0.0 m

Start Point

X 0.0 m

Y 0.005 m

End Point

X 0.0 m

Y -0.005 m

Radius 0.005 m

Angle 3.141592653589793 radian

Display Options

OK Cancel Help

3D-CAD View 1 x

STAR-CCM+

Origine of the semi-circle

Output - Star 1 x

Command: CreateSpline

error: Server Error

Spline creation failed.

Command: CreateSpline

error: Server Error



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Star 1 x

Simulation Scene/Plot 3D-CAD Edit

Sketch

Underlying Sketch Plane: XY

Create Sketch Entities

Sketch Operations

Point Properties Rescale the semi-circle

Point

X 0.0 m

Y 10 m

Display Options

3D-CAD View 1 x

At last rescale the domain of visualization « reset view »

Select the first point

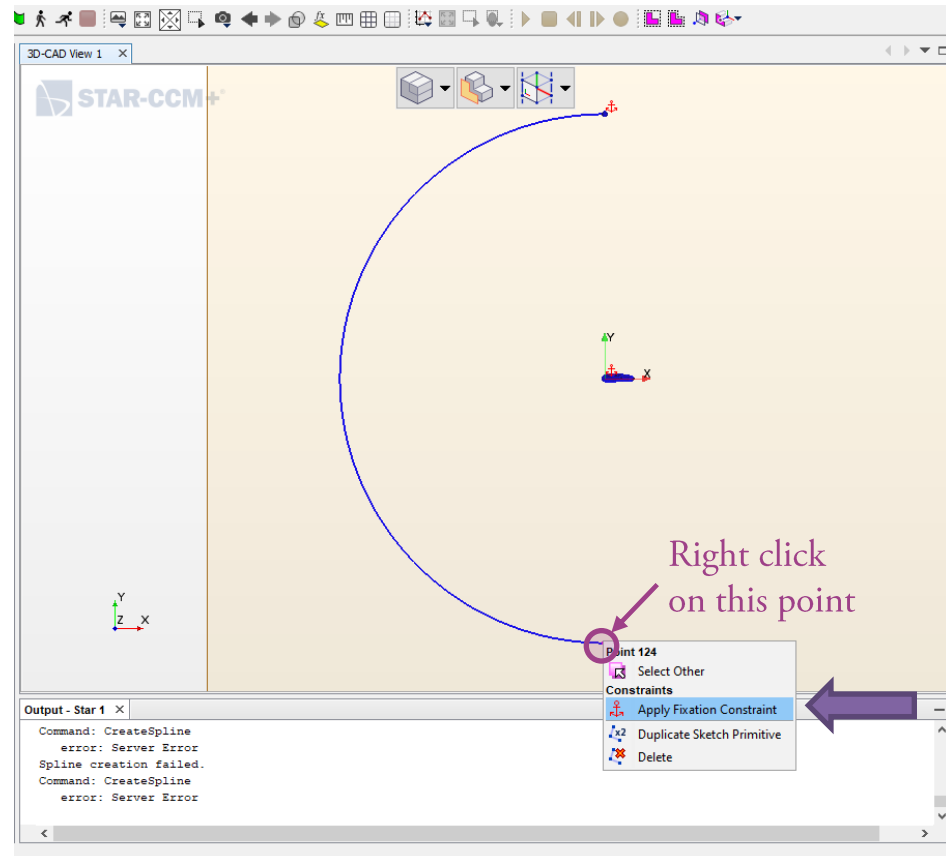
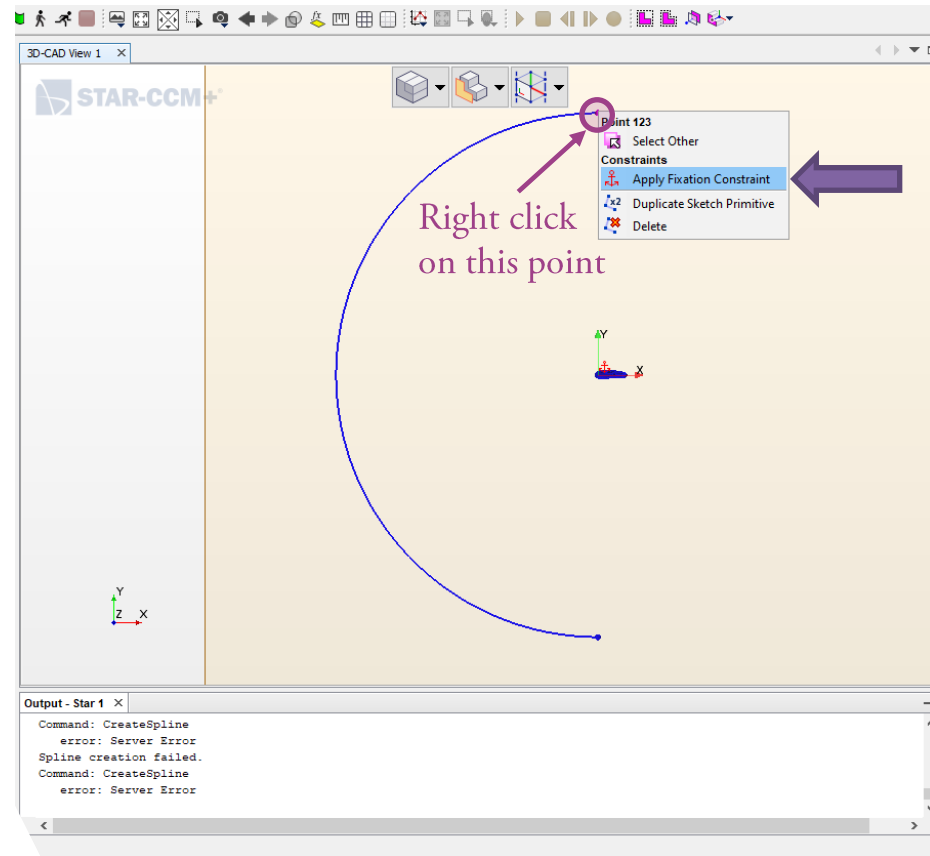
Output - Star 1 x

```
Command: CreateSpline
error: Server Error
Spline creation failed.
Command: CreateSpline
error: Server Error
```

The screenshot shows the StarCCM+ software interface. The main window is titled '3D-CAD View 1' and displays a 2D grid with a blue spline curve. A red circle highlights the first point of the spline, with a pink arrow pointing to it and the text 'Select the first point'. Another pink arrow points to the 'Reset View' icon in the top toolbar, with the text 'At last rescale the domain of visualization « reset view »'. The left sidebar shows the 'Sketch' tab with 'Create Sketch Entities' and 'Sketch Operations' sections. The 'Point Properties' section is highlighted, showing 'Rescale the semi-circle' and 'Point' properties (X: 0.0 m, Y: 10 m). The 'Output' window at the bottom shows error messages for 'CreateSpline'.



Creating a 2D Mesh in StarCCM+



Make sure to have an angle of 180°



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Star 1 x

Simulation Scene/Plot 3D-CAD Edit

Sketch

Underlying Sketch Plane: XY

Create Sketch Entities

Sketch Operations

Line Properties

	Start	End
X	11.776 m	0.0 m
Y	-9.859 m	-10.0 m

Length 11.776844101880604 m

Display Options

3D-CAD View 1 x

Close the outer domain

Output - Star 1 x

```
Command: CreateSpline
error: Server Error
Spline creation failed.
Command: CreateSpline
error: Server Error
```



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Star 1 x

Simulation Scene/Plot 3D-CAD Edit

Sketch

Underlying Sketch Plane: XY

Create Sketch Entities

Sketch Operations

Line Properties

	Start	End
X	0.0 m	11.81688393782388 m
Y	10.0 m	10.0 m

Length 11.81688393782388 m

Constraints

TangentConstraint 2

Display Options

3D-CAD View 1 x

STAR-CCM+

Right click on this line

« Apply Horizontal Constraint » also on this line

Line 4

- Select Other
- Constraints
 - Apply Horizontal Constraint
 - Apply Vertical Constraint
 - Apply Fixation Constraint
- Dimensions
 - Apply Length Dimension
 - Set As Construction
 - Duplicate Sketch Primitive
 - Offset Sketch Primitive
 - Delete

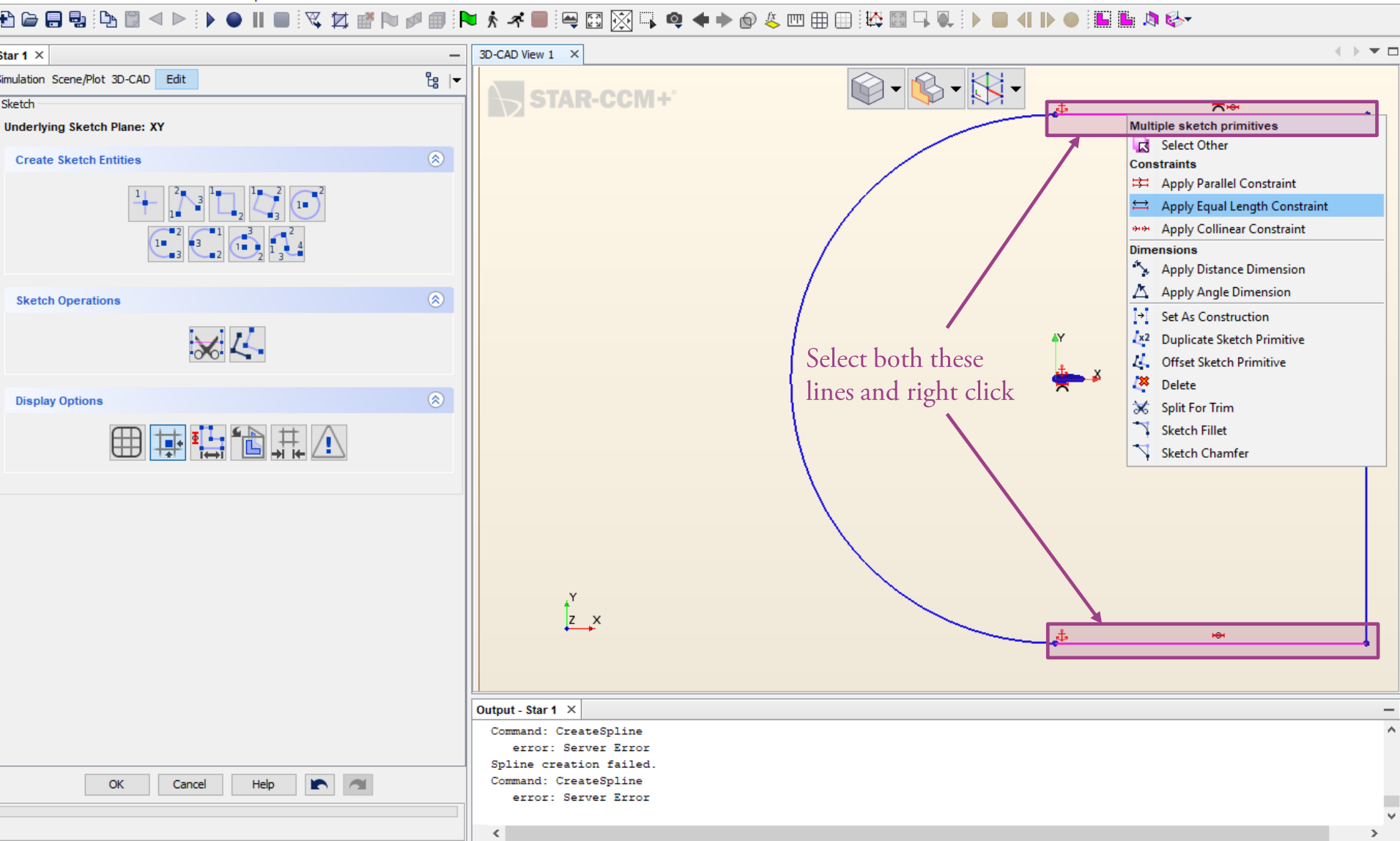
Output - Star 1 x

```
Command: CreateSpline
error: Server Error
Spline creation failed.
Command: CreateSpline
error: Server Error
```



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Star 1 x

Simulation Scene/Plot 3D-CAD Edit

Sketch

Underlying Sketch Plane: XY

Create Sketch Entities

Sketch Operations

Line Properties

	Start	End
X	0.0 m	11.776 m
Y	10.0 m	9.999999999999998 m

Length 11.776 m

Constraints

- TangentConstraint 2
- HorizontalConstraint 1
- EqualLengthConstraint 1

Display Options

3D-CAD View 1 x

STAR-CCM+

Right click on this line

Line 1

- Select Other
- Dimensions
- Apply Length Dimension
- Set As Construction
- Duplicate Sketch Primitive
- Offset Sketch Primitive
- Delete

Output - Star 1 x

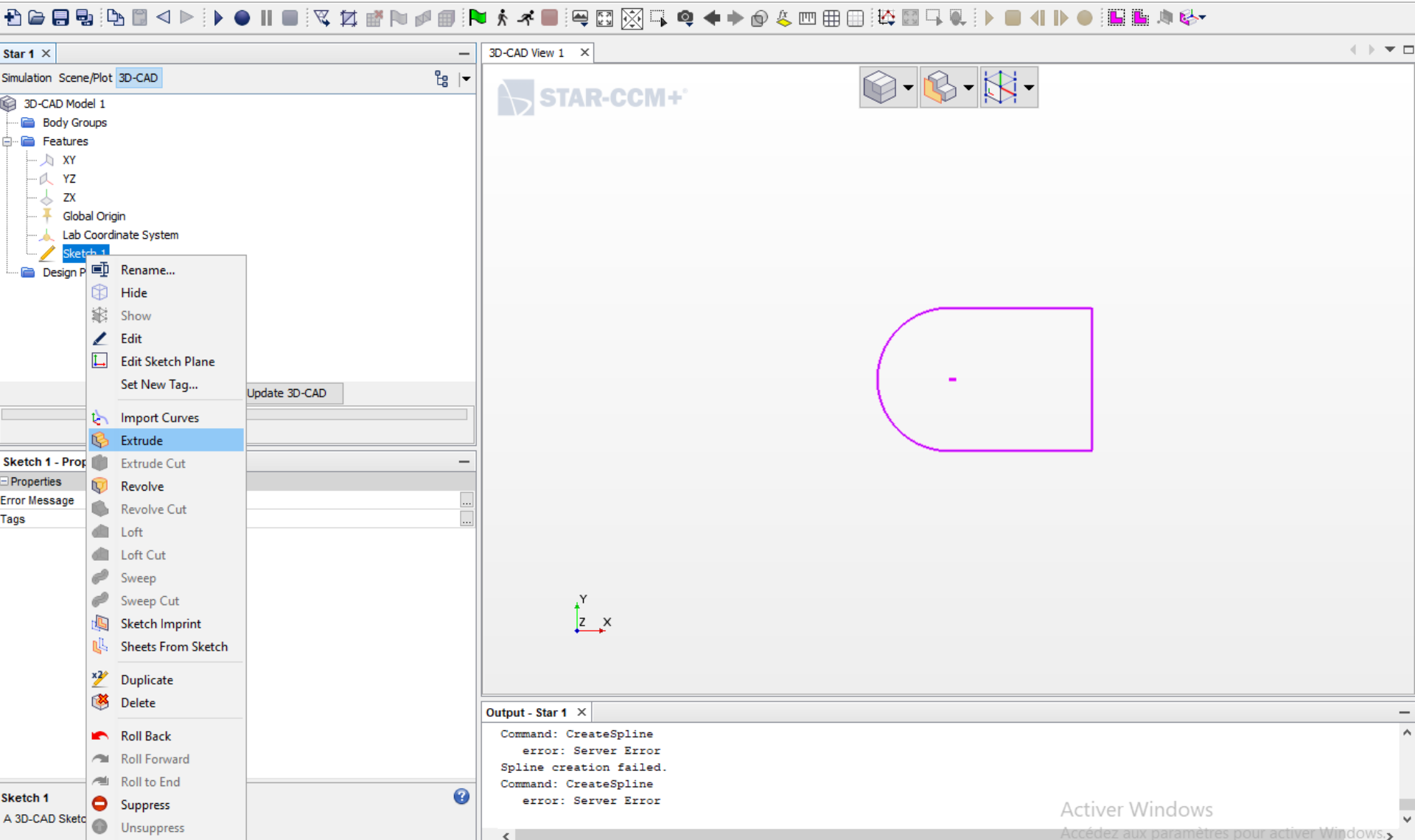
```
Command: CreateSpline
error: Server Error
Spline creation failed.
Command: CreateSpline
error: Server Error
```

Set up a length of 20 m (20 times the chord length) and click « OK » to close the « Edit »

CFD applied to Turbomachinery

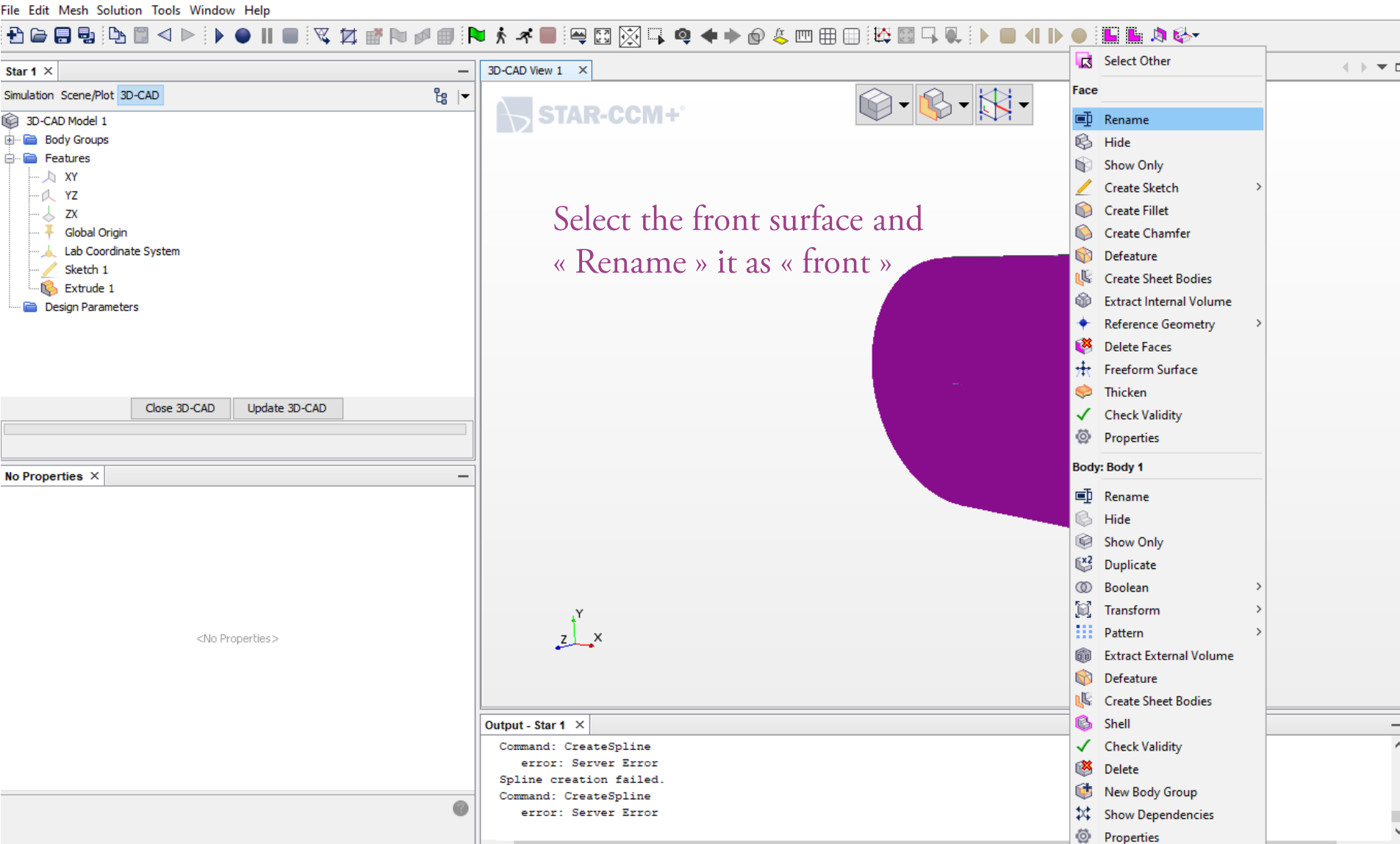
Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Extrude with a « Distance » of 1 m and click « OK » to close the « Edit »

Creating a 2D Mesh in StarCCM+



Create « front », « back », « external » and « airfoil », and click « Close 3D CAD »



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot shows the StarCCM+ software interface. The top menu bar includes File, Edit, Mesh, Solution, Tools, Window, and Help. Below the menu is a toolbar with various icons for file operations, viewing, and simulation. The main window is divided into several panes:

- Star 1** (top left): Contains the **3D-CAD Model 1** tree. The **Named Faces** list is highlighted, showing: airfoil, back, external, and front. The **Named Edges** list is also visible, showing: XY, YZ, ZX, Global Origin, and Lab Coordinate System. Below the tree are buttons for **Close 3D-CAD** and **Update 3D-CAD**.
- Properties** (bottom left): Shows **<No Properties>**.
- 3D-CAD View 1** (center): Displays a 3D model of a curved surface. A coordinate system (X, Y, Z) is visible in the bottom left corner of the view.
- Output - Star 1** (bottom right): Shows the command history and error messages:

```
Command: CreateSpline
error: Server Error
Spline creation failed.
Command: CreateSpline
error: Server Error
```

A text overlay in the center of the image reads: "Make sure that everything has been correctly renamed and click « Close 3D CAD »".



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Star 1 x

Simulation

Star 1

- Geometry
 - 3D-CAD Models
 - 3D-CAD Model 1
 - Body Groups
 - Body 1
- Design
 - Export...
 - New Geometry Part
- Parts
- Descriptions
- Contacts
- Operations
- Continua
- Regions
- Stopping Criteria
- Solution Histories
- Solution Views
- Monitors

Body 1 - Properties x

Properties

Tags

Body 1

Right click
on « Body 1 »

Part Creation Options

Parts Body Type: Solid Body

Mark Feature Edges: Sharp CAD edges

Sharp Edge Angle (deg): 30.0

☒ Create Part Contacts from Coincident Entities

Coincidence Tolerance: 1.0E-5

Tessellation Density: Very Fine

☐ Show Detailed Tessellation Parameters

OK Cancel Help

Output - Star 1 x

```
Command: CreateSpline
error: Server Error
Spline creation failed.
Command: CreateSpline
error: Server Error
```



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Star 1 x

Simulation

Star 1

- Geometry
 - 3D-CAD Models
 - 3D-CAD Model 1
 - Body Groups
 - Body 1
- Parts
 - Body 1

Right click on « Body 1 » of « Parts »

- Update
- Highlight
- Edit...
- Set New Tag...
- Create Mesh Operation
- Repair Surface...
- Edit in 3D-CAD...
- Repair CAD...
- Set New Region...
- Assign Parts to Regions...
- Delete Empty Entities
- Update Interfaces
- Check Validity
- Statistics...
- Select Inherited From
- Query Controls...
- Composite
- Duplicate
- Combine
- Transform
- Boolean
- Split by Surface Topology
- Split Non-Contiguous
- Re-tessellate...

Body 1 - Properties

- Properties
- Region
- Tags
- Expert
- Metadata
- Index
- Contacts
- Descriptions
- Face Count

Body 1

A CAD Part created

- Surface Preparation
- Boolean
- Mesh
 - Automated Mesh
 - Badge for 2D Meshing
 - Automated Mesh (2D)
 - Volume Extruder
 - Directed Mesh
 - Volume Mesh Pattern

Create Badge for 2D Meshing Operation

Parts

- Body 1

1 of 1 selected

☒ Execute Operation Upon Creation

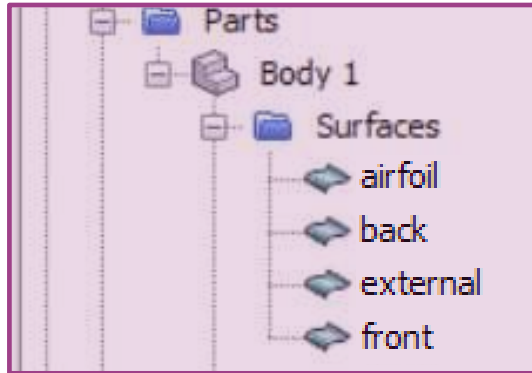
OK Cancel Help

Output - Star 1 x

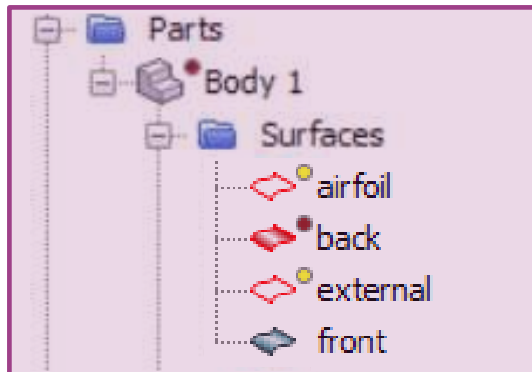
```
Spline creation failed.  
Command: CreateSpline  
error: Server Error  
No coincident faces or edges found.  
Total number of new parts created: 1
```



Creating a 2D Mesh in StarCCM+



Before: 3D domain (« Body1 »)
delimited by 4 boundaries:
airfoil, back, external, front

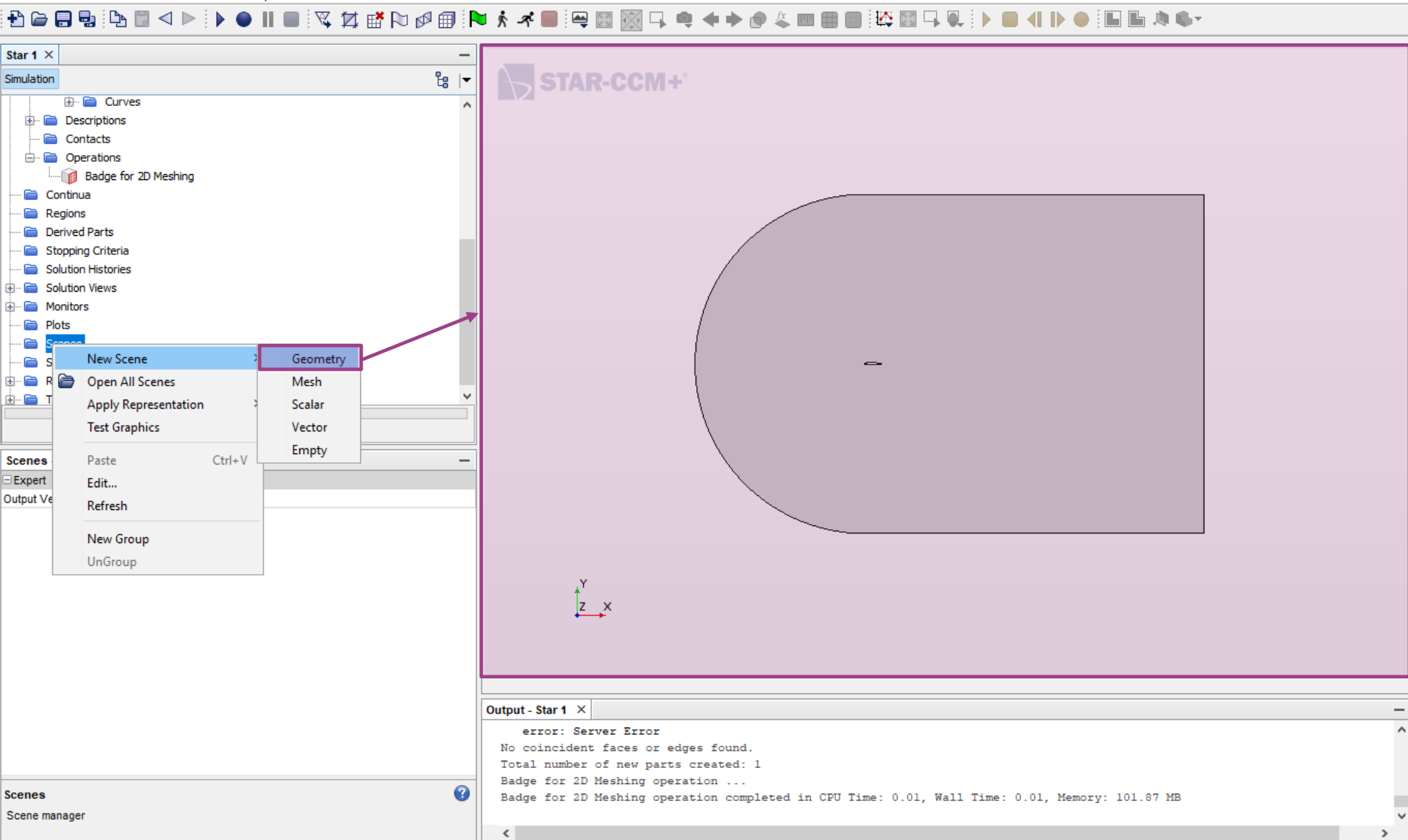


After: 2D domain (« Body1 »)
delimited by 2 boundaries:
airfoil, external



Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. On the left, the 'MeshAirfoil' tree shows the hierarchy: Simulation > Scene/Plot > MeshAirfoil > Geometry > 3D-CAD Models > 3D-CAD Model 1 > Body Groups > Body 1. A context menu is open for 'Body 1', with 'Create Mesh Operation' selected. This opens a sub-menu where 'Mesh' is selected, and then 'Directed Mesh' is chosen. The 'Create Directed Mesh Operation' dialog box is shown, with 'Body 1' listed under 'Parts'. A large blue arrow points from the 'Directed Mesh' option in the sub-menu to the 'OK' button in the dialog box. The 'Geometry Scene 1' window shows a 3D model of an airfoil. The 'Output - MeshAirfoil' window at the bottom displays the following text:

```
Total number of new parts created: 1
Badge for 2D Meshing operation ...
Badge for 2D Meshing operation completed in CPU Time: 0.01, Wall Time: 0.01, Memory: 101.87 MB
Saving: C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim
Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim (501.35KB in 0.088s).
```



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Simulation Scene/Plot

- 3D-CAD Model 1
 - Body Groups
 - Body 1
 - Design Parameters
 - Parts
 - Body 1
 - Surfaces
 - airfoil
 - back
 - external
 - front
 - Curves
 - Descriptions
 - Contacts
 - Operations
 - Badge for 2D Meshing
 - Direct Mesh**

Right click on « Direct Mesh »

Edit...

Execute

Set New Tag...

Copy Ctrl+C

Paste Ctrl+V

Delete Supprimer

Rename...

Directed Mesh - Properties

Properties

Input Parts

Generate Internal Surfaces

Tags

Directed Mesh

A user directed operation to generate a structured volume mesh

Geometry Scene 1

STAR-CCM+

Output - MeshAirfoil

Badge for 2D Meshing operation completed in CPU Time: 0.01, Wall Time: 0.01, Memory: 101.87 MB

Saving: C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim

Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim (501.35KB in 0.088s).

Loading module: StarSweptMesher

All input parts have been badged for 2D Meshing, the volume mesh will be automatically converted to 2D.



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

MeshAirfoil x

Simulation Scene/Plot Directed Mesh

Directed Mesh

Source Surfaces

Target Surface

Connected Parts

Body 1

Source Meshes

Mesh Distributions

Close Directed Mesh

Source Surfaces - Properties x

Properties

Source Surfaces

Source Surfaces

Starting surfaces from the swept volume mesh

Geometry Scene 1 x Directed Mesh 1 x

Source Surfaces

Expand/Contract Tree Expand/Contract Values

Nodes	Values
Source Surfaces	
Source Surfaces	

Source Surfaces

Starting surfaces from the swept volume mesh

Close Help

Source Surfaces - Source Surfaces

Show All Filter by Path

Parts > Body 1 > Surfaces

	Comment
front	
external	
back	
airfoil	

1 of 4 selected

OK Cancel Help

Output - MeshAirfoil x

Badge for 2D Meshing operation completed in CPU Time: 0.01, Wall Time: 0.01, Memory: 101.87 MB

Saving: C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim

Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim (501.35KB in 0.088s).

Loading module: StarSweptMesher

All input parts have been badged for 2D Meshing, the volume mesh will be automatically converted to 2D.



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

MeshAirfoil x Geometry Scene 1 x Directed Mesh 1 x

Simulation Scene/Plot Directed Mesh

Directed Mesh

- Source Surfaces
- Target Surfaces
- Connected Parts
- Body 1
- Source Meshes
- Mesh Distributions

Edit...

Close Directed Mesh

Target Surfaces - Properties x

Properties

Target Surfaces

Target Surfaces

Ending surfaces from the swept volume mesh

Target Surfaces

Ending surfaces from the swept volume mesh

Target Surfaces - Target Surfaces x

Expand/Contract Tree Expand/Contract Values

Nodes Values

Nodes	Values
Target Surfaces	

Target Surfaces

Ending surfaces from the swept volume mesh

Close Help

Parts > Body 1 > Surfaces

front

external

airfoil

1 of 3 selected

OK Cancel Help

Output - MeshAirfoil x

Badge for 2D Meshing operation completed in CPU Time: 0.01, Wall Time: 0.01, Memory: 101.87 MB

Saving: C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim

Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim (501.35KB in 0.088s).

Loading module: StarSweptMesher

All input parts have been badged for 2D Meshing, the volume mesh will be automatically converted to 2D.

Afterwards « Close Directed Mesh »

CFD applied to Turbomachinery



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. The top menu bar includes File, Edit, Mesh, Solution, Tools, Window, and Help. Below the menu is a toolbar with various icons for file operations, simulation, and visualization. The main window is divided into several panels:

- MeshAirfoil** (left sidebar): A tree view showing the simulation hierarchy. The 'Directed' item under 'Badges for 2D Meshing' is highlighted with a red box. A red arrow points to it with the text 'Right click on « Directed Mesh »'.
- Geometry Scene 1** (center): A 3D view of the geometry, which is a rectangular block with a semi-circular end. A coordinate system (X, Y, Z) is visible at the bottom left of the scene.
- Directed Mesh - Properties** (bottom left): A panel showing the properties of the selected mesh. It includes fields for 'Input Parts' (set to '[Body 1]'), 'Generate Internal Surfaces' (unchecked), and 'Tags' (empty).
- Output - MeshAirfoil** (bottom right): A text area showing the results of the meshing operation. The text reads: 'Badge for 2D Meshing operation completed in CPU Time: 0.01, Wall Time: 0.01, Memory: 101.87 MB. Saving: C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim. Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim (501.35KB in 0.088s). Loading module: StarSweptMesher. All input parts have been badged for 2D Meshing, the volume mesh will be automatically converted to 2D.'



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

MeshAirfoil x Geometry Scene 1 x Directed Mesh 1 x

Simulation Scene/Plot Directed Mesh

Directed Mesh

- Source Surfaces
- Target Surfaces
- Connected Parts
- Body 1
- Source Meshes
- Mesh Di

Right click on « Source Meshes »

New Source Mesh Patch Mesh

Paste Ctrl+V Use Existing Mesh Automated Source Mesh

Close Directed Mesh

Source Meshes - Properties x

<No Properties>

Part Collection For This Source Mesh

Operations > Directed Mesh > Connected Parts

- Body 1

0 of 1 selected

OK Cancel Help

Output - MeshAirfoil x

Badge for 2D Meshing operation completed in CPU Time: 0.01, Wall Time: 0.01, Memory: 101.87 MB

Saving: C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim

Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim (501.35KB in 0.088s).

Loading module: StarSweptMesher

All input parts have been badged for 2D Meshing, the volume mesh will be automatically converted to 2D.



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. The main window shows a 3D model of an airfoil geometry. A context menu is open, showing the 'Views' option selected, with a sub-menu showing the '-Z' view selected. A purple arrow points to the 'Up +Y' option in the sub-menu. The left sidebar shows the 'MeshAirfoil' tab with the 'Edit' button. The bottom status bar shows the output of the 2D meshing operation.

MeshAirfoil x Geometry Scene 1 x Directed M

Simulation Scene/Plot Directed Mesh Edit

Mode Patch Topology v

Create/Edit Patch Entities

Store Current View

Restore View >

Projection Mode >

Views >

Standard Views >

View Coordinate System >

+X >

-X >

+Y >

-Y >

+Z >

-Z >

+X +Y +Z >

-X +Y +Z >

+X -Y +Z >

-X -Y +Z >

+X +Y -Z >

+X -Y -Z >

-X +Y -Z >

-X -Y -Z >

Up +Y

Up -Y

Up +X

Up -X

Output - MeshAirfoil x

Badge for 2D Meshing operation completed in CPU Time: 0.01, Wall Time: 0.01, Memory: 101.87 MB

Saving: C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim

Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\MeshAirfoil.sim (501.35KB in 0.088s).

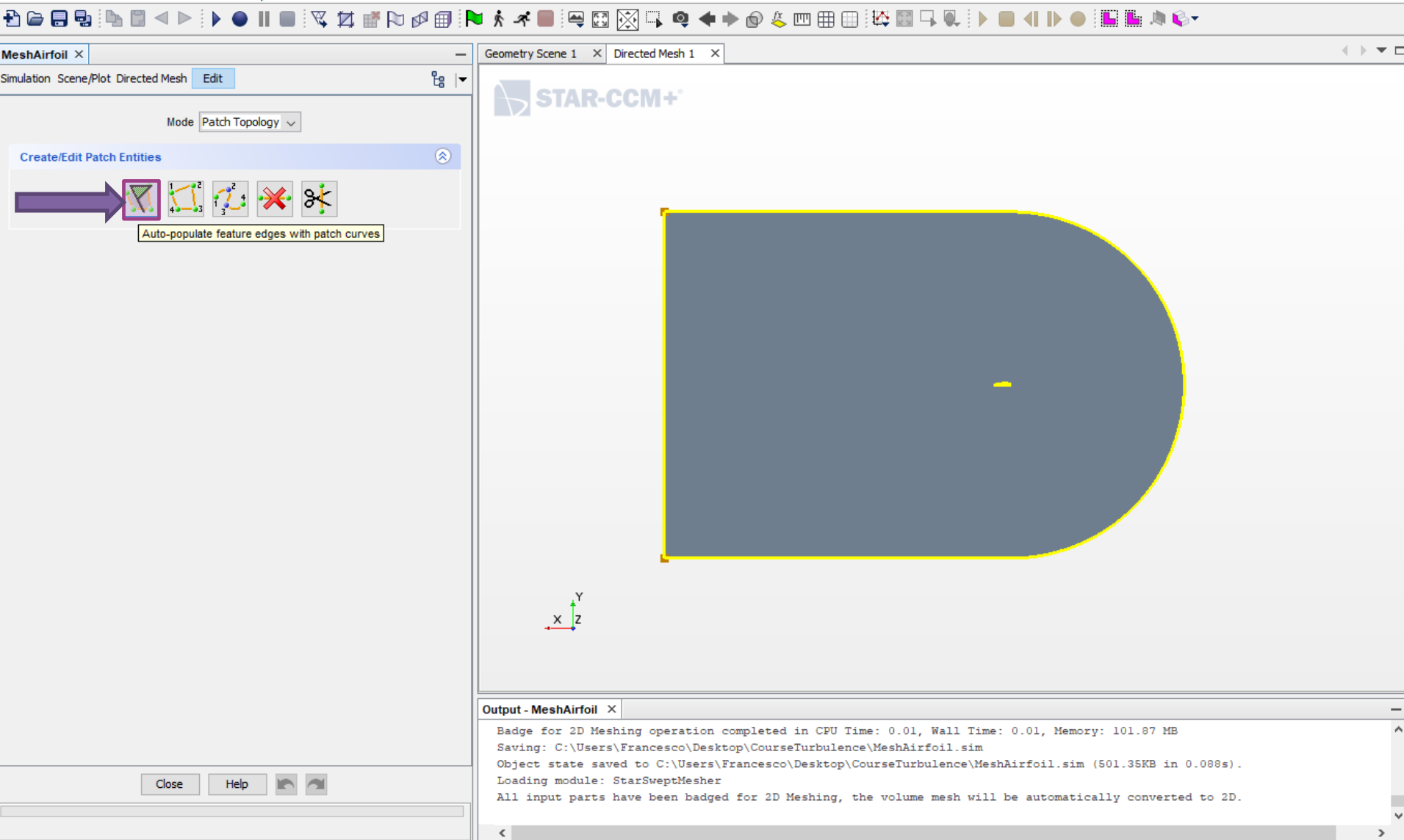
Loading module: StarSweptMesher

All input parts have been badged for 2D Meshing, the volume mesh will be automatically converted to 2D.



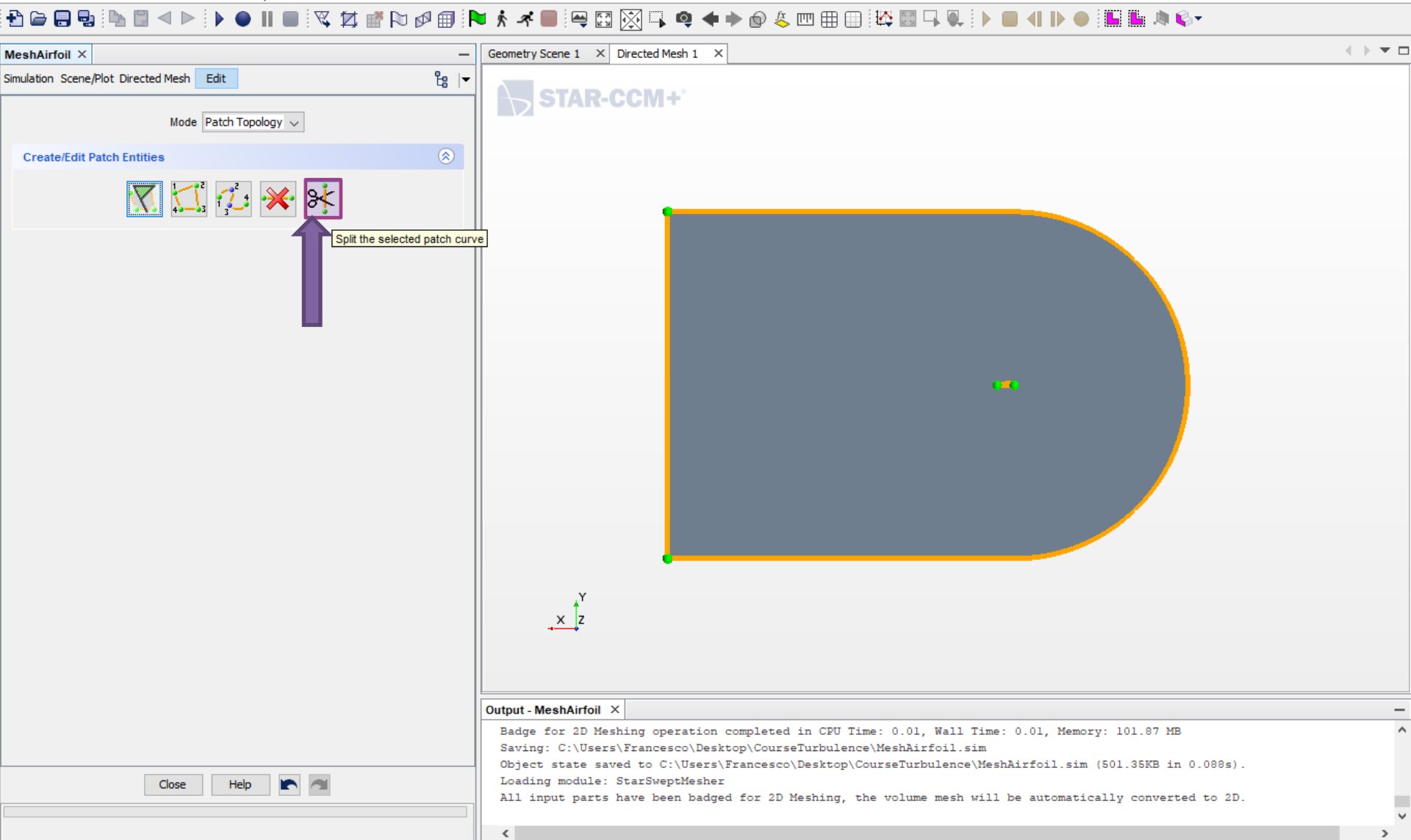
Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

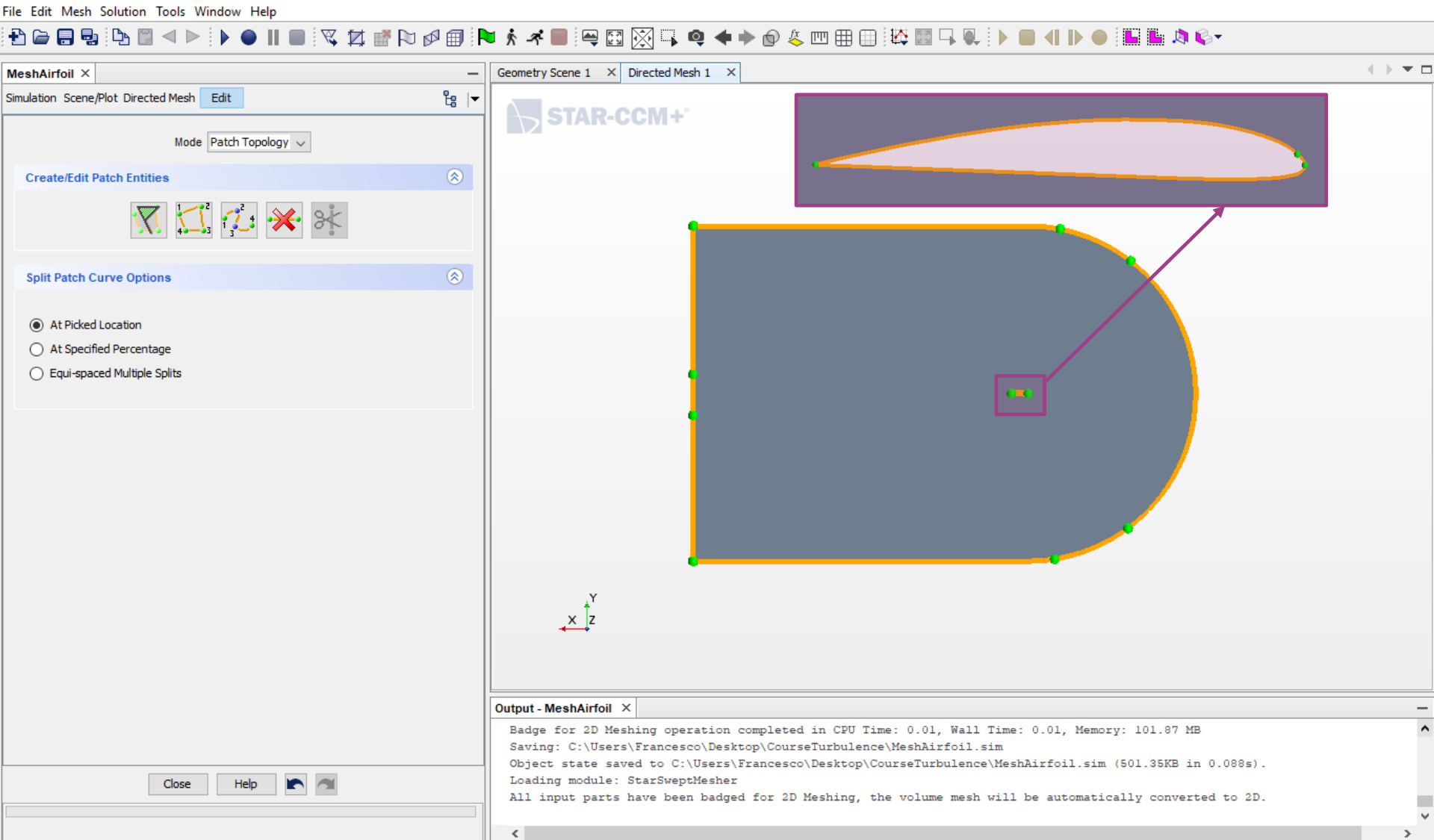


Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Creating a Structured Block 2D Mesh in StarCCM+



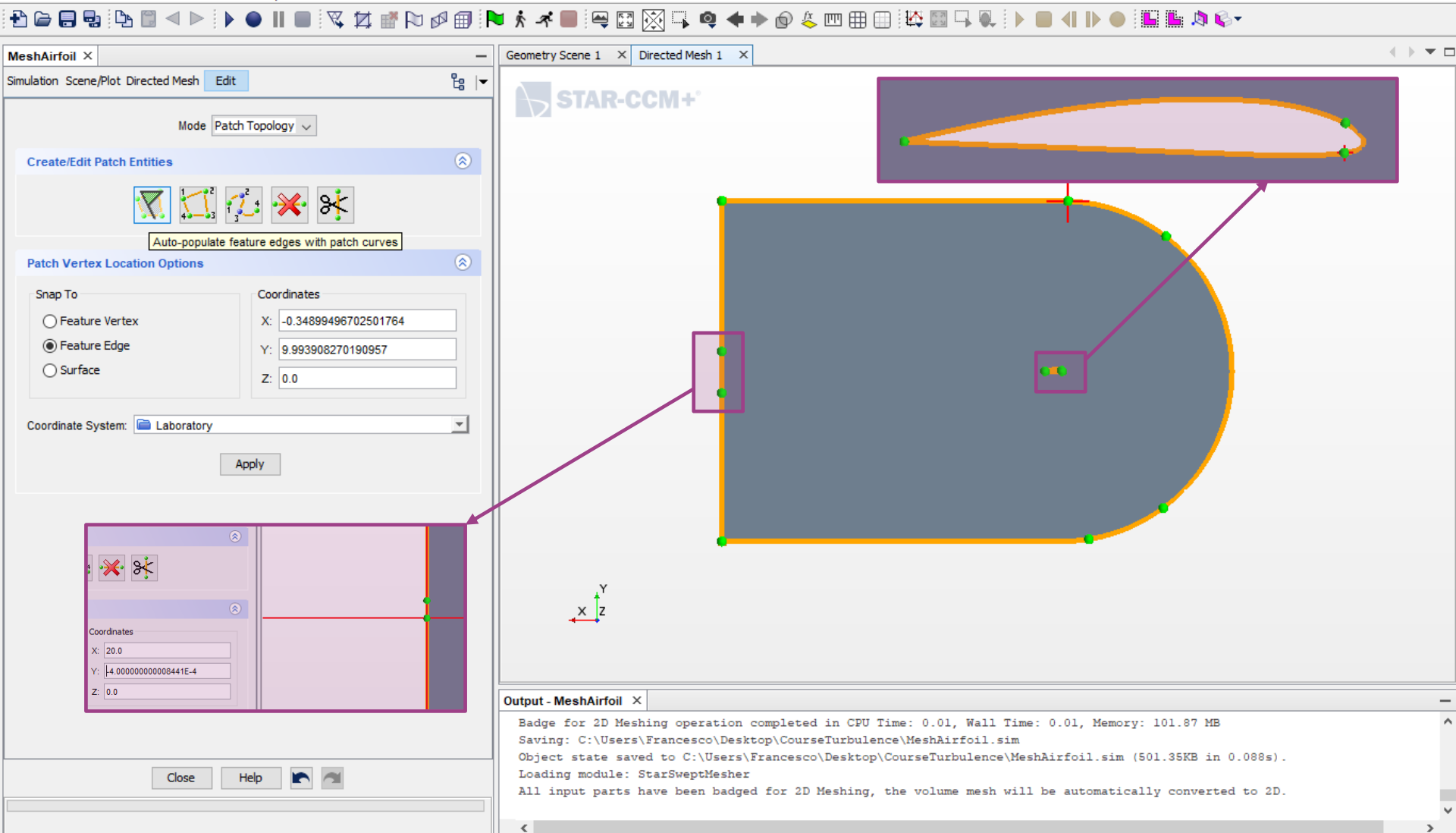
Create the green dots by clicking on the orange boundaries

CFD applied to Turbomachinery



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Click on the green dots and relocate them to better distribute the mesh blocks

Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

MeshAirfoil ×

Simulation Scene/Plot Directed Mesh **Edit**

Mode: Patch Topology

Create/Edit Patch Entities

Patch Vertex Location Option

Snap To

- ☐ Feature Vertex
- ☒ Feature Edge
- ☐ Surface

Coordinates

X: 20.0

Y: -4.000000000008441E-4

Z: 0.0

Coordinate System: Laboratory

Apply

Close Help

Geometry Scene 1 × Directed Mesh 1 ×

Output - MeshAirfoil ×

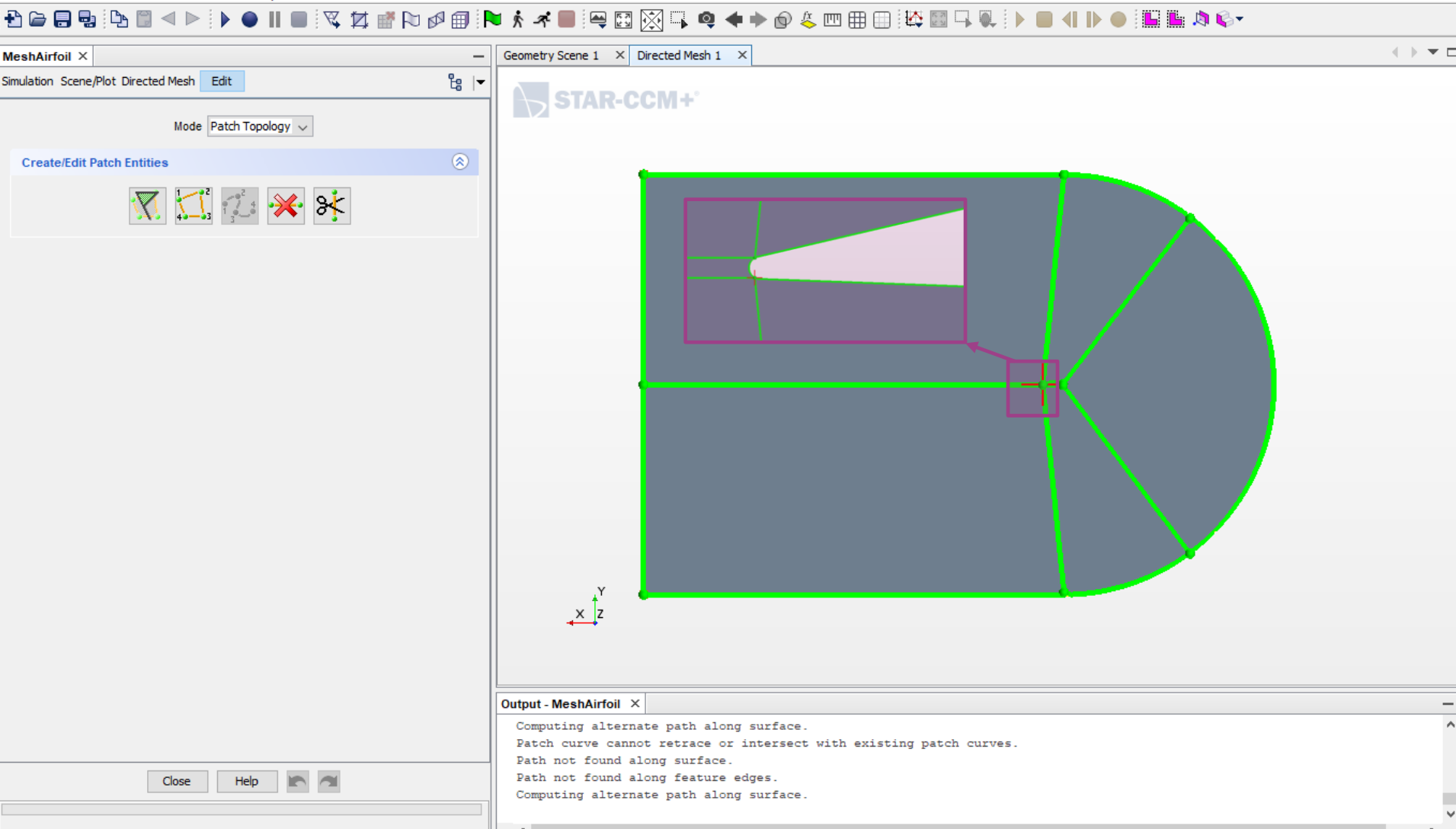
```
User specified coordinates : 20.0, 4.0E-4, 0.0
Coordinates obtained after projection : 20.0, 4.000000000008441E-4, 0.0
Coordinate System : Laboratory
User specified coordinates : 20.0, -4.0E-4, 0.0
Coordinates obtained after projection : 20.0, -4.000000000008441E-4, 0.0
```

Click on the green dots and relocate them to better distribute the mesh blocks



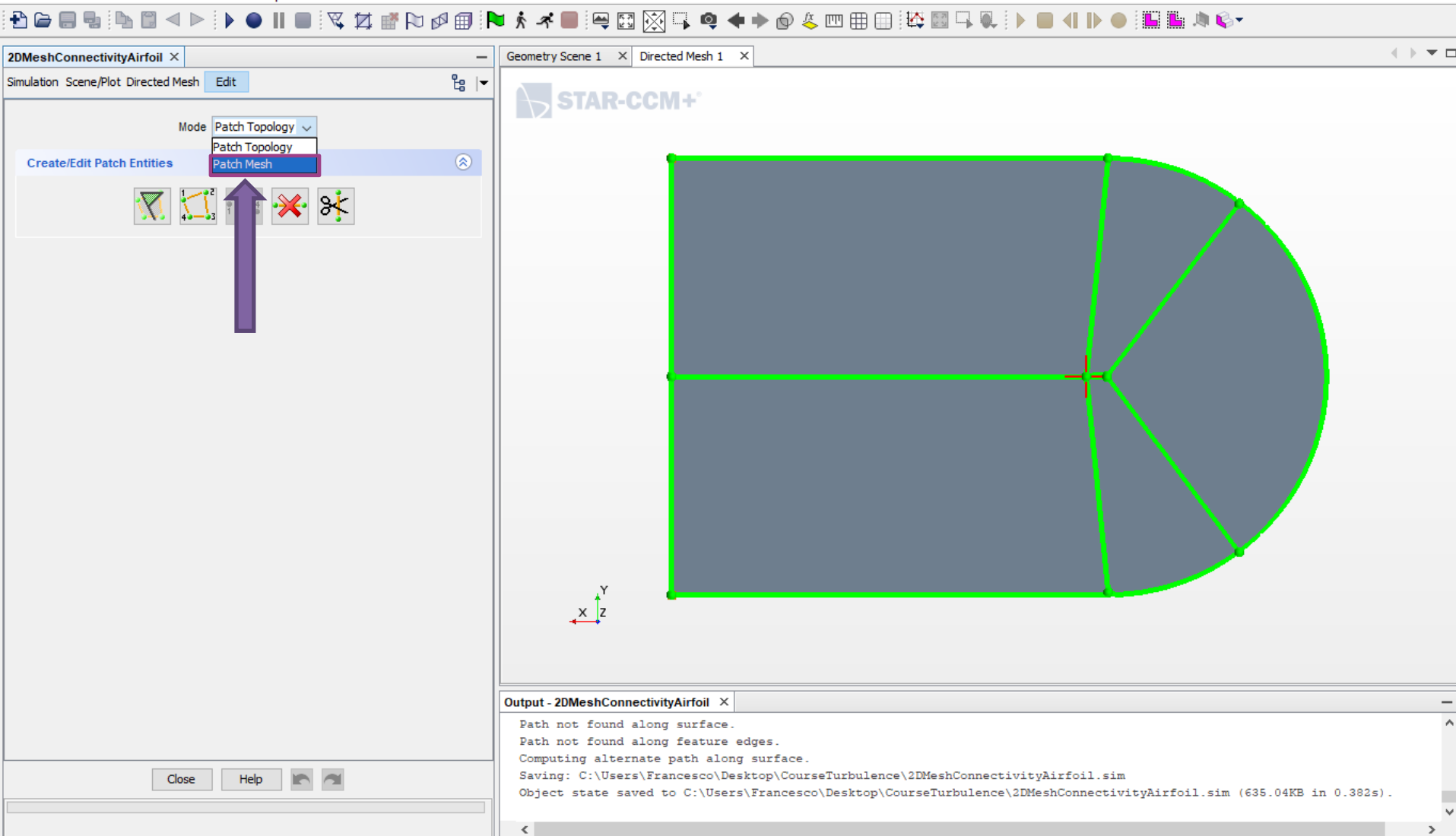
Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. On the left, the **2DMeshConnectivityAirfoil** window is open, showing the **Mesh Properties** tab. The **Mode** is set to **Patch Mesh**. The **Number of Divisions** is 50. The **Distribution** type is **One Sided Geometric**, with **Reverse Direction** unchecked. The **Spacing at Start** is 1.0 mm and the **Spacing at End** is 0.1 m. The **Smooth** section shows **Number of Iterations** as 0 and **Apply Distribution after Smoothing** as unchecked. The **Output - 2DMeshConnectivityAirfoil** window at the bottom shows the following text:

```
Computing alternate path along surface.  
Saving: C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim  
Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim (635.04KB in 0.382s).  
Patch curve being created can meet the previously created patch curves at start/end vertices only.  
Patch curve being created can meet the previously created patch curves at start/end vertices only.
```

The main **Geometry Scene 1** window shows a 2D mesh of an airfoil. The mesh is composed of several rectangular blocks, with the top and bottom surfaces highlighted in green. A red arrow points to the top surface. The bottom surface is highlighted in magenta. The mesh is structured, with a higher density of divisions near the trailing edge. A coordinate system (X, Y, Z) is visible in the bottom left corner of the scene.



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. On the left, the '2DMeshConnectivityAirfoil' window is open, showing the 'Mesh Properties' tab. The 'Mode' is set to 'Patch Mesh'. Under 'Distribution', the 'Type' is 'Constant', 'Number of Divisions' is 50, 'Spacing at Start' is 1.0 mm, and 'Spacing at End' is 0.1 m. The 'Smooth' section shows 'Number of Iterations' as 0. The 'Geometry Scene' on the right shows a 2D mesh of an airfoil. The mesh is composed of several rectangular blocks. The top and bottom boundaries are highlighted in magenta, and the right boundary is highlighted in green. The left boundary is a straight vertical line. The mesh is shown in a gray color. The 'Output - 2DMeshConnectivityAirfoil' window at the bottom shows the following text:

```
Computing alternate path along surface.  
Saving: C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim  
Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim (635.04KB in 0.382s).  
Patch curve being created can meet the previously created patch curves at start/end vertices only.  
Patch curve being created can meet the previously created patch curves at start/end vertices only.
```

Use the same « Constant Type Distribution » for the other boundaries



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. The top menu bar includes File, Edit, Mesh, Solution, Tools, Window, and Help. Below the menu is a toolbar with various icons for file operations, meshing, and simulation. The main window is divided into several panes. On the left, the '2DMeshConnectivityAirfoil' window is open, showing the 'Edit' tab. The 'Mesh Properties' section is expanded, displaying the following settings:

- Mode: Patch Mesh
- Number of Divisions: 100
- Distribution Type: Constant
- Reverse Direction: ☐
- Spacing at Start: 1.0 mm
- Spacing at End: 0.1 m
- Apply button
- Smooth Number of Iterations: 0
- Apply Distribution after Smoothing: ☐
- Apply button

A large purple arrow points from the 'Apply' button in the 'Mesh Properties' section to the 'Close' button at the bottom of the window. The 'Close' button is highlighted with a red box. The 'Help' button and two circular icons are also visible at the bottom of the window.

The main window displays the 'Geometry Scene 1' and 'Directed Mesh 1' tabs. The 'Directed Mesh 1' tab is active, showing a structured block 2D mesh of an airfoil. The mesh is composed of a grid of quadrilateral elements, with a higher density of elements near the airfoil's leading edge and trailing edge. The mesh is colored black, and the airfoil's outline is highlighted in green. A coordinate system (X, Y, Z) is visible in the bottom left corner of the main window.

The bottom pane shows the 'Output - 2DMeshConnectivityAirfoil' window, displaying the following text:

```
Computing alternate path along surface.  
Saving: C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim  
Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim (635.04KB in 0.382s).  
Patch curve being created can meet the previously created patch curves at start/end vertices only.  
Patch curve being created can meet the previously created patch curves at start/end vertices only.
```

Further adjustments to the nodes number might be required to produce a good-quality mesh

Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface with the following components:

- Top Panel:** Tabs for "2DMeshConnectivityAirfoil", "Geometry Scene 1", and "Directed Mesh 1". The "Directed Mesh" tab is active, showing a tree view with "Directed Mesh", "Source Surfaces", "Target Surfaces", "Connected Parts", "Body 1", "Source Meshes", and "Mesh Distributions". A context menu is open over "Mesh Distributions" with options "New Volume Distribution" (highlighted), "Paste", and "Ctrl+V".
- Central View:** A 3D visualization of a green structured block mesh. A purple arrow points from the "New Volume Distribution" menu item to this mesh.
- Right Panel:** A dialog box titled "Parts for creating a new mesh distribution". It shows a tree view with "Operations > Directed Mesh > Connected Parts" and "Body 1". A purple arrow points from the "Body 1" item to the "OK" button at the bottom right of the dialog.
- Bottom Panel:** An "Output" window for "2DMeshConnectivityAirfoil" showing the following text:

```
Computing alternate path along surface.
Saving: C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim
Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim (635.04KB in 0.382s).
Patch curve being created can meet the previously created patch curves at start/end vertices only.
Patch curve being created can meet the previously created patch curves at start/end vertices only.
```



Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

2DMeshConnectivityAirfoil x

Simulation Scene/Plot Directed Mesh

Directed Mesh

- Source Surfaces
- Target Surfaces
- Connected Parts
- Body 1
- Source Meshes
- Mesh Distributions
- Volume Distribution
- Default Controls
 - Number of Layers
 - Stretching Function

Close Directed Mesh

Number of Layers - Properties x

Properties

Number of Layers 1

Geometry Scene 1 x Directed Mesh 1 x

STAR-CCM+

X Y Z

Output - 2DMeshConnectivityAirfoil x

Computing alternate path along surface.
Saving: C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim
Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim (635.04KB in 0.382s).
Patch curve being created can meet the previously created patch curves at start/end vertices only.
Patch curve being created can meet the previously created patch curves at start/end vertices only.

After setting « Number of Layers » to 1 (2D mesh) click on « Close Directed Mesh »

Creating a 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Right click on « Body 1 » under « Parts »

Assign Parts to Regions

1 of 1 selected

Create a Region for Each Part

Create a Boundary for Each Part Surface

Create a Feature Curve for Each Part Curve

Do Not Create Interfaces From Contacts

Apply Close Help

Regions

- Body 1
 - Boundaries
 - airfoil
 - external
 - Feature Curves
- Derived Parts
- Stopping Criteria
- Solution Histories

Output - 2DMeshConnectivityAirfoil

Computing alternate path along surface.
Saving: C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim
Object state saved to C:\Users\Francesco\Desktop\CourseTurbulence\2DMeshConnectivityAirfoil.sim (635.04KB in 0.382s).
Patch curve being created can meet the previously created patch curves at start/end vertices only.
Patch curve being created can meet the previously created patch curves at start/end vertices only.

After setting « Number of Layers » to 1 (2D mesh) click on « Close Directed Mesh »

Creating a Structured Block 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. On the left, the '2DMeshConnectivityAirfoil' tree shows the 'Directed Mesh' operation selected. A context menu is open over 'Directed Mesh' with 'Execute' highlighted. Below the tree, the 'Directed Mesh - Properties' panel shows 'Input Parts' set to '[Body 1]', 'Generate Internal Surfaces' unchecked, and 'Tags' empty. The main 'Geometry Scene 1' window shows a 2D model of an airfoil. At the bottom, the 'Output - 2DMeshConnectivityAirfoil' console displays an error message.

Directed Mesh - Properties

Input Parts	[Body 1]
Generate Internal Surfaces	☐
Tags	

Output - 2DMeshConnectivityAirfoil

```
Command: ExecuteDirectedMeshOperation
error: Server Error
Patch topology should be complete before entering patch mesh
Patch topology should be complete before entering patch mesh
Patch topology should be complete before entering patch mesh
-----
```



Creating an Unstructured 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. The main window, titled 'MeshAirfoil-Geometry Scene 1', shows a 2D airfoil geometry. The left sidebar contains a tree view with 'Body 1' expanded, showing 'Surfaces' (airfoil, back, external, front) and 'Curves'. The 'Operations' menu is open, showing options like 'New', 'Execute All', 'Reorder...', 'Paste', and 'Refresh'. The 'Mesh' option is selected, and a sub-menu is visible with options: 'Automated Mesh', 'Badge for 2D Meshing', 'Automated Mesh (2D)', 'Volume Extruder', 'Directed Mesh', and 'Volume Mesh Pattern'. The 'Automated Mesh (2D)' option is highlighted. The bottom panel shows the 'Output' window with the following text:

```
Star1 X Star2 X MeshAirfoil X
One or more volume of interest failed.
Command: GenerateSurfaceMesh
error: Server Error
```

The 'Operations - Properties' panel at the bottom left shows '<No Properties>'. The 'Operations' panel at the bottom center shows 'Mesh operations on Geometry'.



Creating an **Unstructured** 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Star 2 MeshAirfoil x MeshAirfoil-Geometry Scene 1 x

Simulation Scene/Plot

- Body 1
 - Surfaces
 - airfoil
 - back
 - external
 - front
 - Curves
 - Descriptions
 - Contacts
 - Operations
 - Badge for 2D Meshing
 - Continua
 - Regions
 - Derived Parts
 - Stopping Criteria
 - Solution Histories

Operations - Properties x

<No Properties>

1 of 1 selected

Select Meshers

Enabled Meshers:

- ☒ Polygonal Mesher
- ☒ Prism Layer Mesher

OK Cancel Help

One or more volume of interest failed.
Command: GenerateSurfaceMesh
error: Server Error

Operations
Mesh operations on Geometry



Creating an Unstructured 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. The main window shows the 'MeshAirfoil' model. The 'Assign Parts to Regions' dialog is open, showing a table with 'Parts' and 'Comment' columns. A purple arrow points to the 'Body 1' part in the table. Another purple arrow points to the 'Apply' button at the bottom of the dialog. A third purple arrow points to the 'Close' button. The 'Regions' tree on the right shows the hierarchy of the mesh, including 'Body 1', 'Boundaries', 'airfoil', 'external', 'Feature Curves', 'Derived Parts', 'Stopping Criteria', and 'Solution Histories'. The 'Output' window at the bottom shows the command 'GenerateSurfaceMesh' and the error message 'error: Server Error'.

Star 2 MeshAirfoil x

Simulation Scene/Plot

MeshAirfoil

Geometry

3D-CAD Models

3D-CAD Model 1

Parts

Body 1

Update

Highlight

Edit...

Set New Tag...

Create Mesh Operation

Repair Surface...

Edit in 3D-CAD...

Repair CAD...

Set New Region...

Assign Parts to Regions...

Delete Empty Entities

Update Interfaces

Check Validity

Statistics...

Select Inherited From

Query Controls...

Composite

Duplicate

Combine

Transform

Boolean

Split by Surface Topology

Split Non-Contiguous

Re-tessellate...

Export...

Body 1 - Properties

Properties

Region

Tags

Expert

Metadata

Index

Contacts

Descriptions

Face Count

Assign Parts to Regions

Parts

Body 1

Comment

1 of 1 selected

Create One Region for All Parts

Create a Boundary for Each Part Surface

Create One Feature Curve for All Part Curves

Create Boundary-mode Interfaces From Contacts

Region

Select...

Feature Curve

Apply

Close

Help

Regions

Body 1

Boundaries

airfoil

external

Feature Curves

Derived Parts

Stopping Criteria

Solution Histories

Output

Star 1 x Star 2 x MeshAirfoil x

Command: GenerateSurfaceMesh

error: Server Error

Loading module: StarTwodmesher



Creating an **Unstructured** 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

Star 2 MeshAirfoil x

Simulation Scene/Plot

- Badge for 2D Meshing
- Automated Mesh (2D)
 - Meshers
 - Polygonal Mesher
 - Prism Layer Mesher
 - Default Controls
 - Base Size**
 - CAD Projection
 - Target Surface Size
 - Minimum Surface Size
 - Surface Curvature
 - Surface Proximity
 - Surface Growth Rate
 - Number of Prism Layers
 - Prism Layer Stretching
 - Prism Layer Total Thickness

Base Size - Properties x

Properties

Base Size 0.2 m

Base Size ?
Specifies the reference length value for all relative size controls.

MeshAirfoil-Geometry Scene 1 x

STAR-CCM+

Y
Z X

Output x

Star 1 x Star 2 x MeshAirfoil x

error: Server Error
Loading module: StarTwodmesher
No Interfaces were created



Creating an **Unstructured** 2D Mesh in StarCCM+

File Edit Mesh Solution Tools Window Help

The screenshot displays the StarCCM+ software interface. The left sidebar shows the 'MeshAirfoil' tree structure. Under 'Default Controls', the 'Number of Prism Layers' property is highlighted with a red box. Below this, the 'Number of Prism Layers - Properties' dialog is open, showing the 'Number of Prism Layers' set to 20. The main window shows a 2D mesh of an airfoil geometry. The bottom right corner contains an 'Output' window with the following text:

```
Star 1 x Star 2 x MeshAirfoil x
error: Server Error
Loading module: StarTwodmesher
No Interfaces were created
```

Below the 'Number of Prism Layers' property, a tooltip explains: 'Number of Prism Layers Specifies the number of cell layers within the prism mesh.'



Creating an **Unstructured** 2D Mesh in StarCCM+

