SOLIDWORKS WORLD 2016

HAVE A SEAT

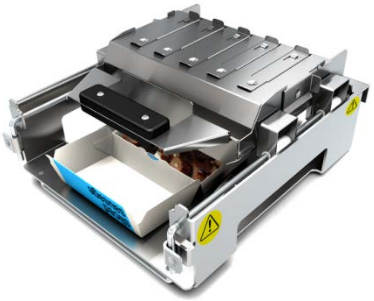
CRAFTY MODELING WORKFLOWS EXAMINED THROUGH ICONIC CHAIR DESIGNS

Andrew Lowe
Industrial Designer
DiMonte Group Inc

DIMONTE GROUP

And Who Am I?

Industrial Designer at the DiMonte Group, builder of furniture, collector of Mid- Century Design.



“The details are not the details. They make the design.”

-Charles Eames

Eames LCW

Eames LCW

Eames LCW

During the second World War, the husband and wife team of Charles and Ray Eames developed processes to mold plywood into compound shapes. They initially used this process to manufacture medical splints and aircraft parts.

Eames LCW

The Eames' early lessons in molded plywood lead them design multiple furniture prototypes, culminating in the LCW chair, released in 1946.

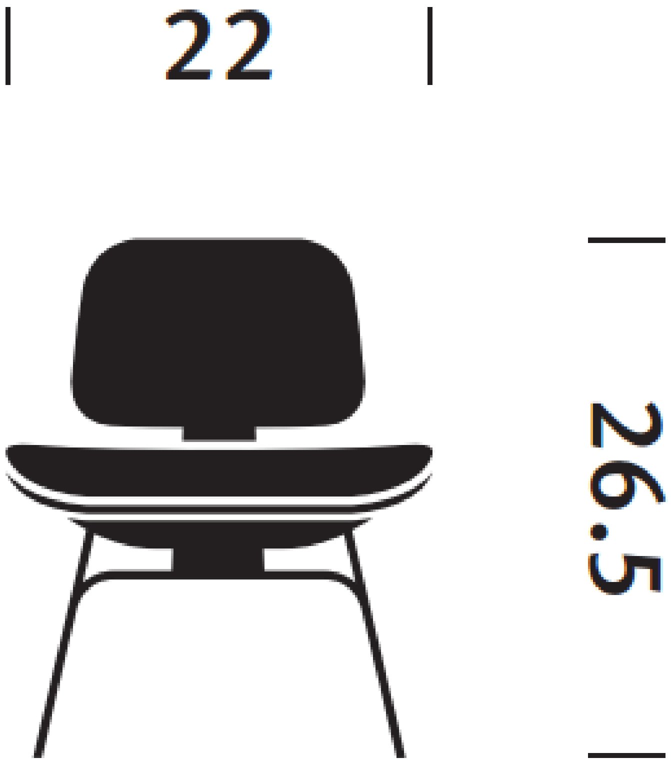
Constructed of 5 pieces of molded plywood, the seat pan and seat back are connected to the chair spine with rubber "shockmounts", which allow the chair to move with the user.

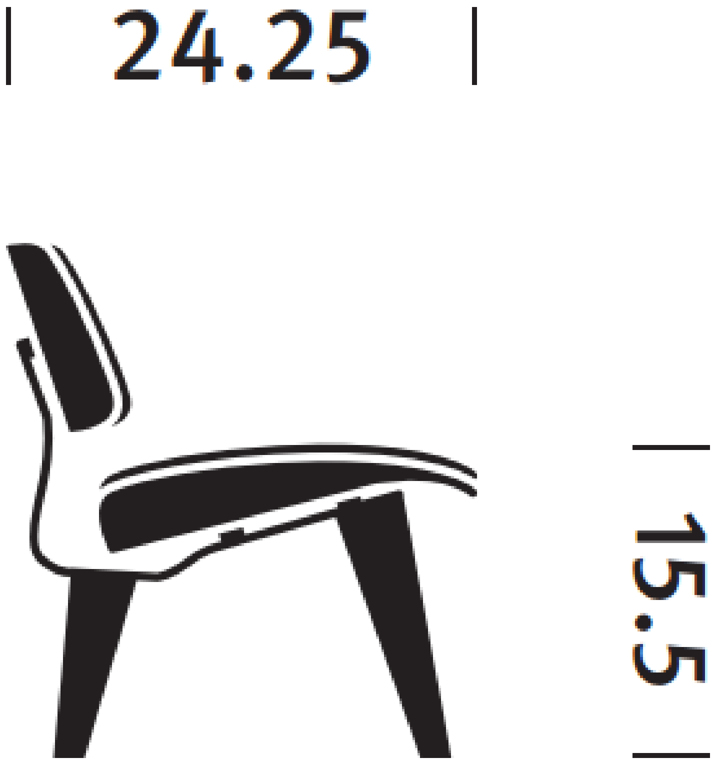
The gentle curves of the chair were hand sculpted in an era before CAD. More than extrudes , revolves and fillets will be required to model the chair.

Reverse Modeling

It's helpful to have the object to model available. If not, dimensions will have to be estimated from available dimensions and images online.

Beware of fakes, many overseas manufacturers have copied classic Mid Century designs, often to not so perfect results. Gather dimensions from manufacturer's websites.





Reverse Modeling

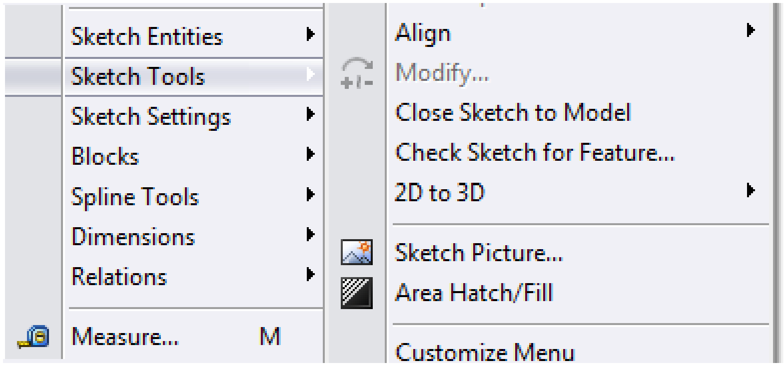
If the original item is unavailable, try to find similar references that share common details.

DCW, a table height version of the LCW

LCM, identical to the LCW except with metal legs

SOLIDWORKS Setup

Use reference photographs as a basis for modeling.



Tools>Sketch Tools> Sketch Picture

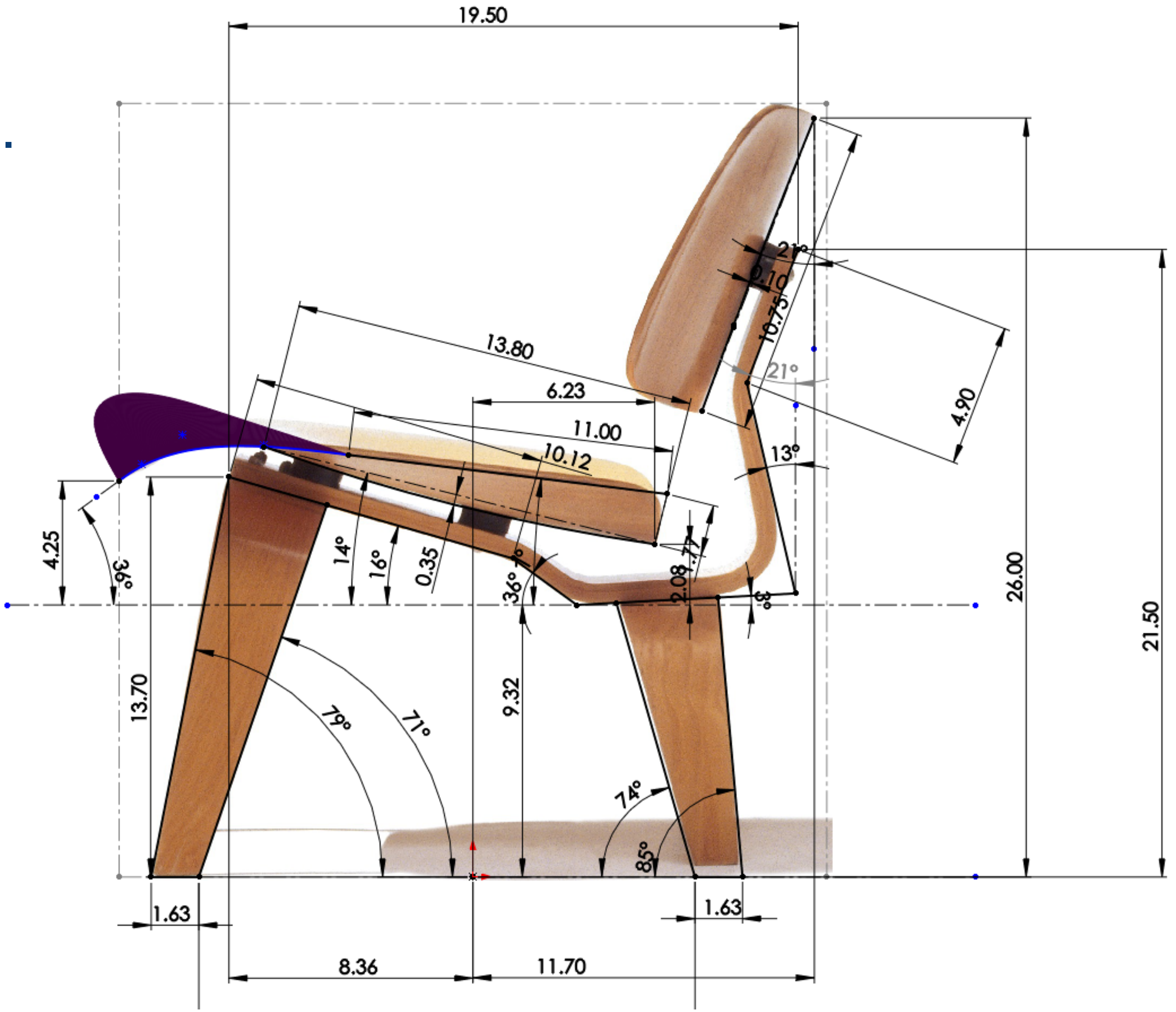
Create a new sketch on the right plane. Insert a sketch picture. Create a construction line with a dimension and scale the sketch picture.

SOLIDWORKS Setup

Capture what you can from the photograph. Due to camera foreshortening guess work may be required.

The style spine tool was used to sketch the outside edge of the front pan.

It was easier to sketch the underside of the spine due to having a straight edge and not fighting the camera's perspective. Also note the foreshortening happening to the rear leg. The leg is not shorter, just inset from the front leg.



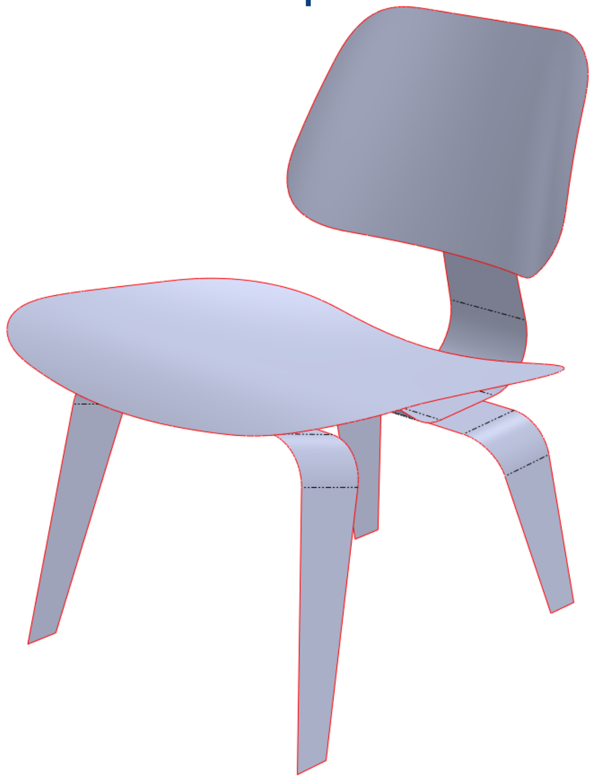
SOLIDWORKS Setup

Capture available information from the photograph. Due to camera foreshortening guess work may be required.

The front view photograph was other another example of the chair, taken at wildly different angles. However, the photograph is useful for determine the angle and width of the legs.

Master Model Workflow

When modeling complex shapes that have to fit together a Master Model work flow can simplify modeling and relationships between parts.



The chair will be modeled with surfaces. Surfaces have advantages when working with molded plywood or laminates.

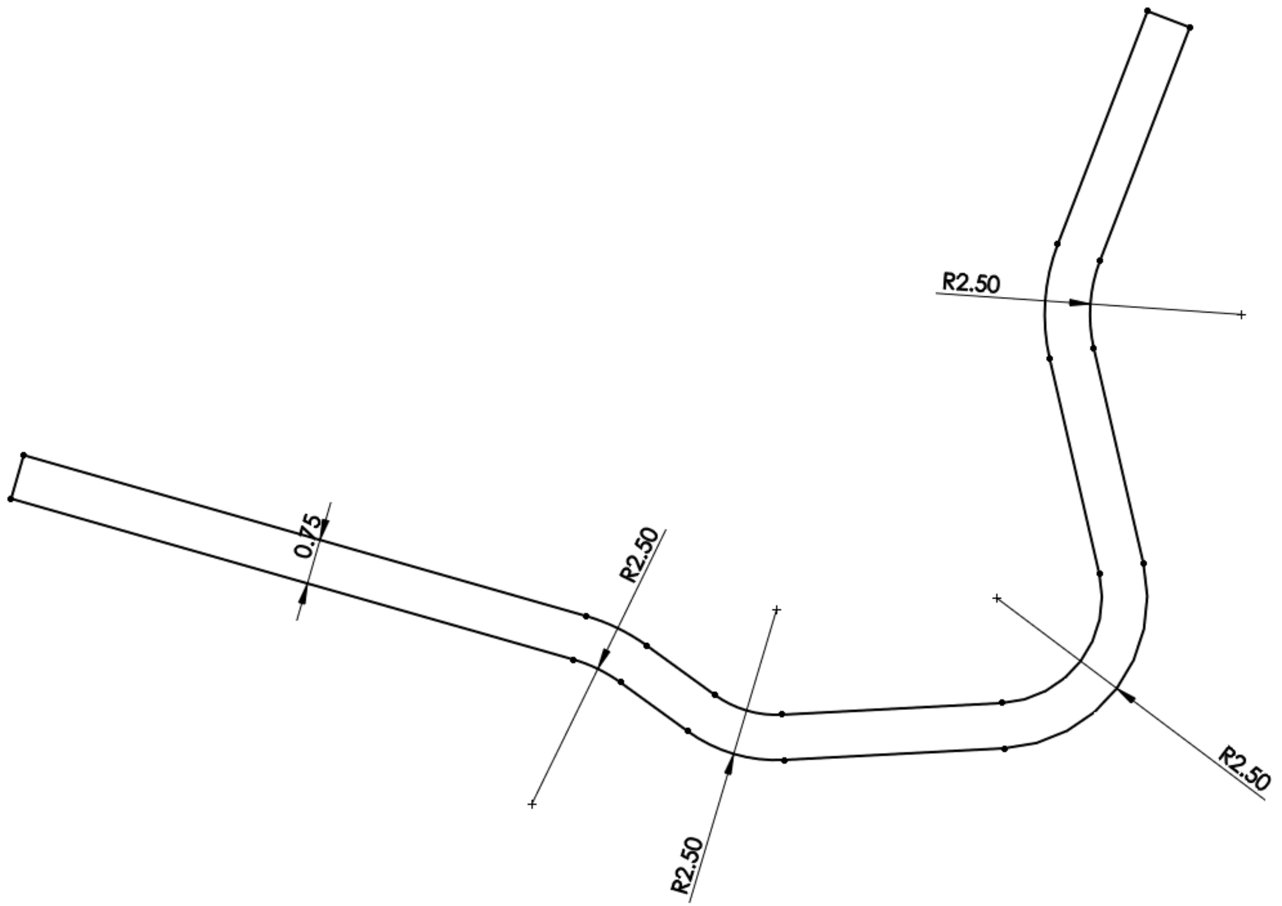
The surface bodies are used to populate child parts. Then the surfaces can be solidified and detailed.

Begin Sketching

A reference sketch was created that captured the fillet radii and overall width of the molded plywood spine. This simplified sketching the initial profile by drawing to virtual sharps.

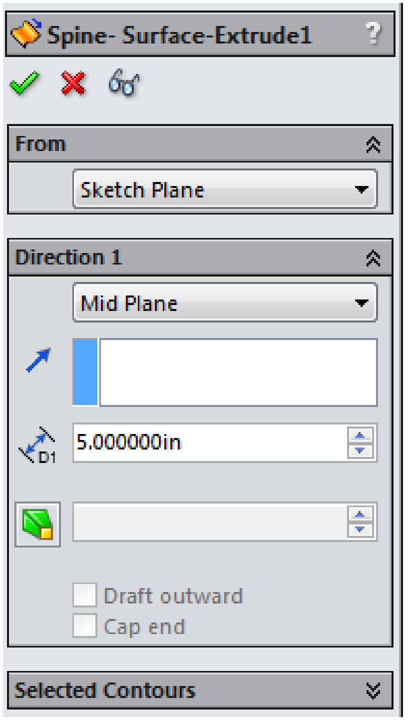
Adding fillets at this stage made it easier to trace the straight portions of the spine from the reference image.

This reference sketch won't be used for creating geometry. Instead, future sketches will reference this sketch by using covert entities to capture sketch geometry.

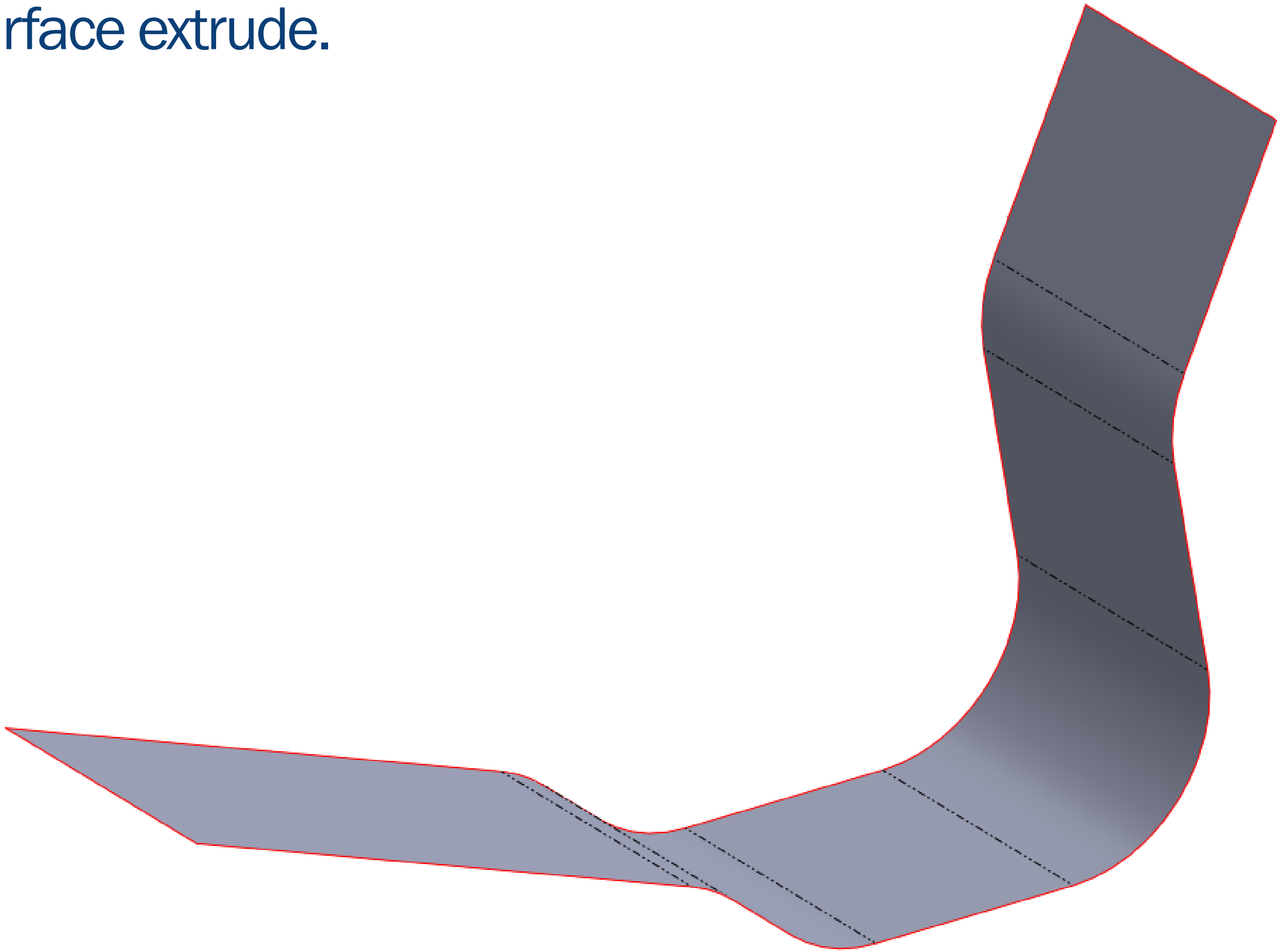


Initial Geometry

The initial spine shape is created with a surface extrude.

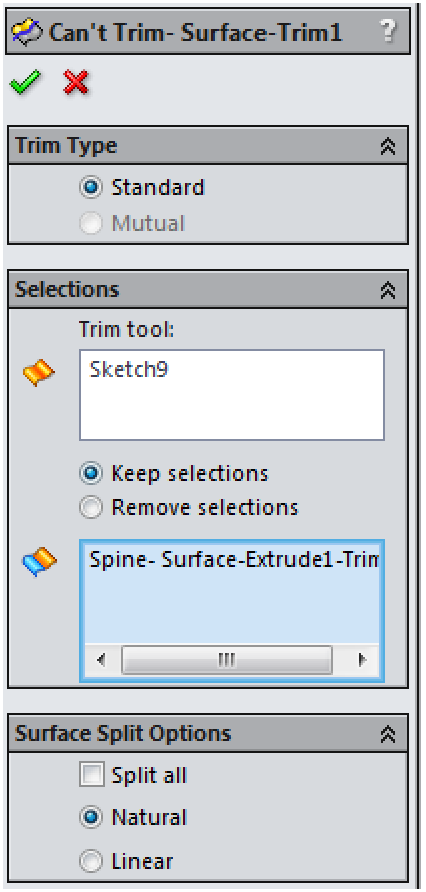


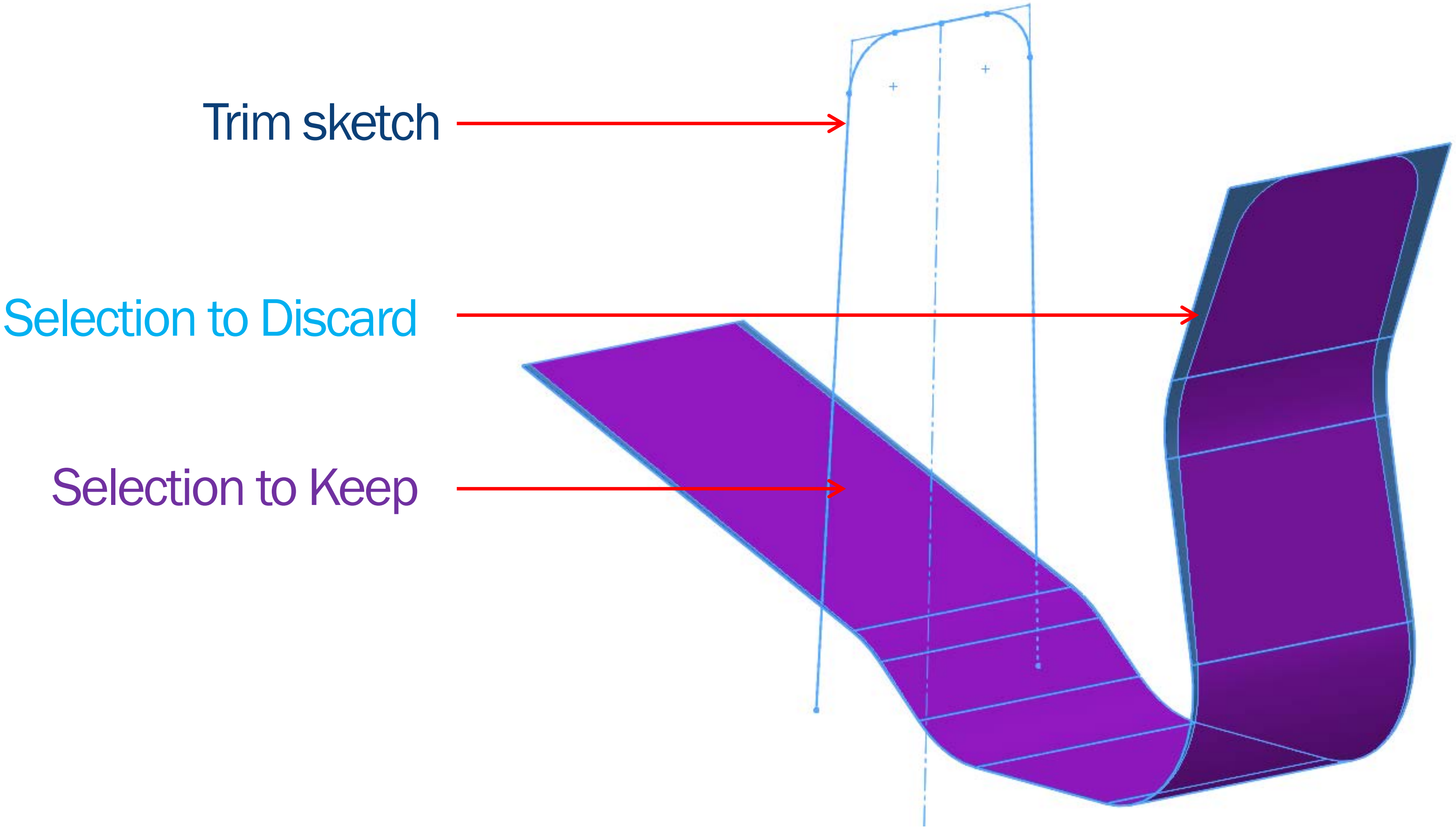
Surface geometry has no thickness, and open surfaces edges appear in color (here changed to **RED**).



Modifying Surfaces

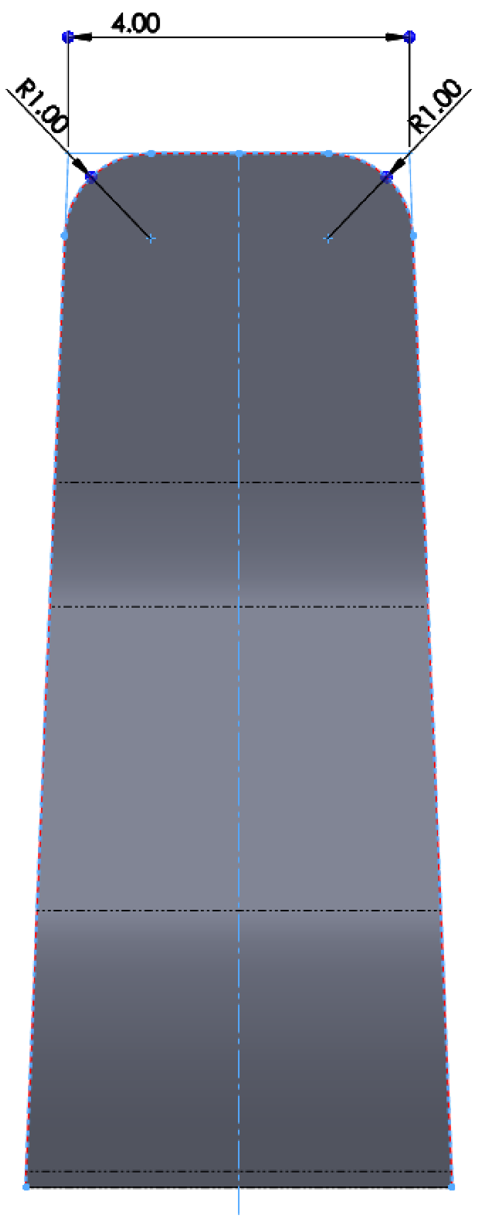
Surfaces are shaped with the trim tool, which functions similarly to the Cut-Extrude Tool.





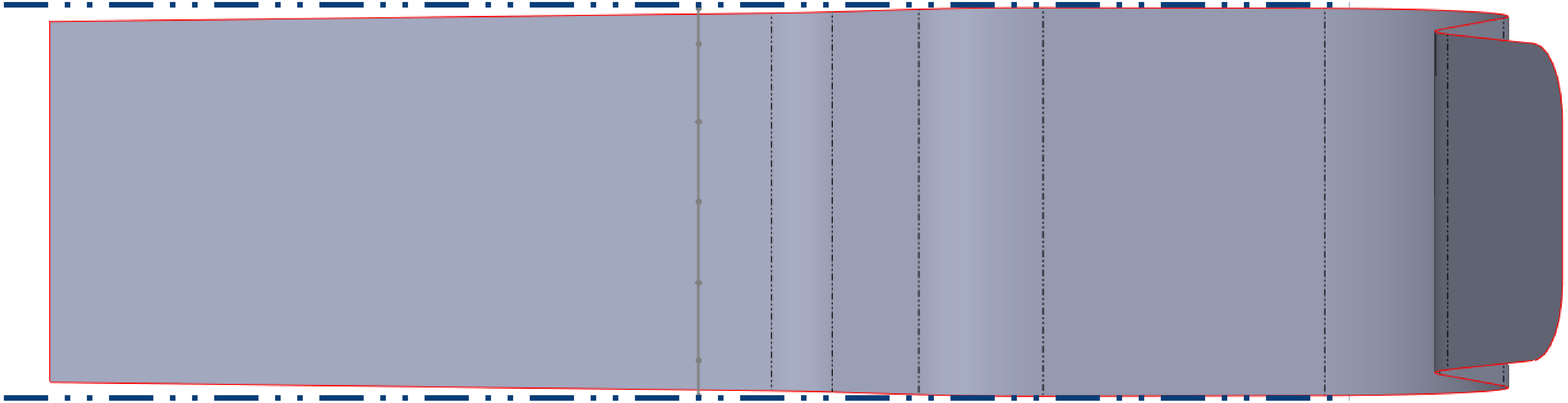
Verify Results

The shaped back of the spine looks perfect, but when viewed from the top...



Verify Results

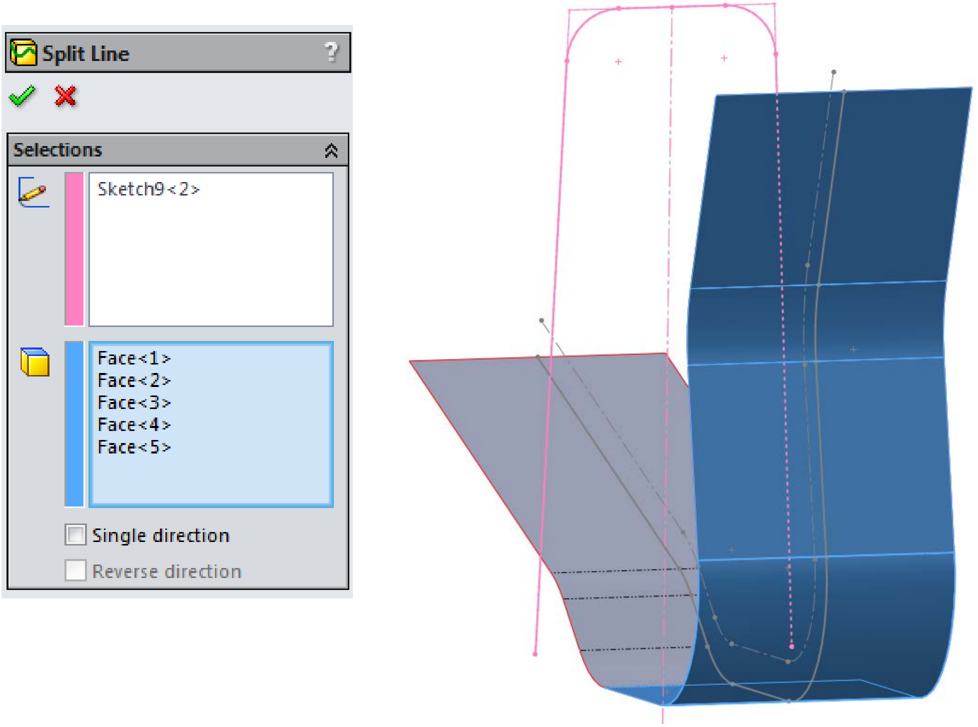
When viewed from the top, the Surface Trim has removed material from the front of the spine (which should be straight).

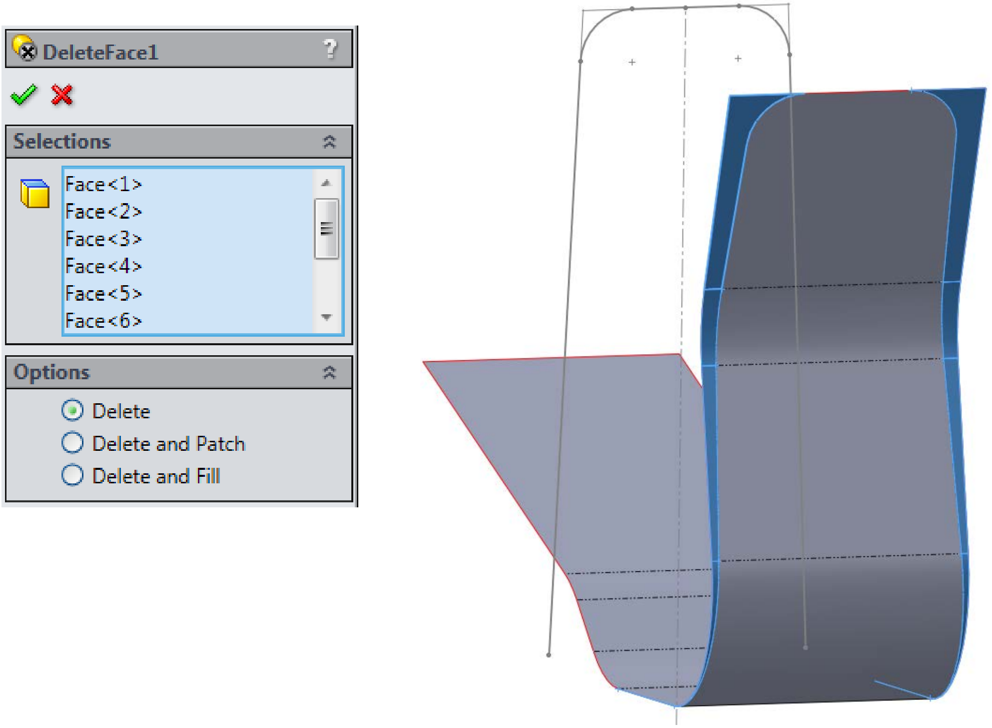


A direction for Surface Trim cannot be specified. Instead the trim cuts through the entire surface body, creating the non-horizontal edges towards the front of the spine.

Workaround

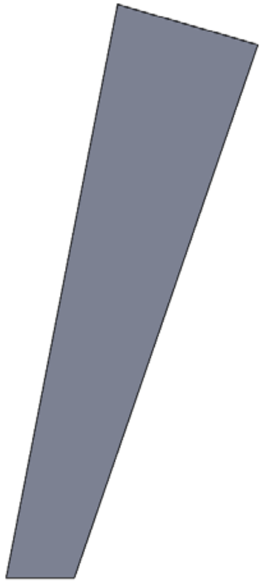
The work around is to split the required faces, and then use delete face to remove them from the surface body.





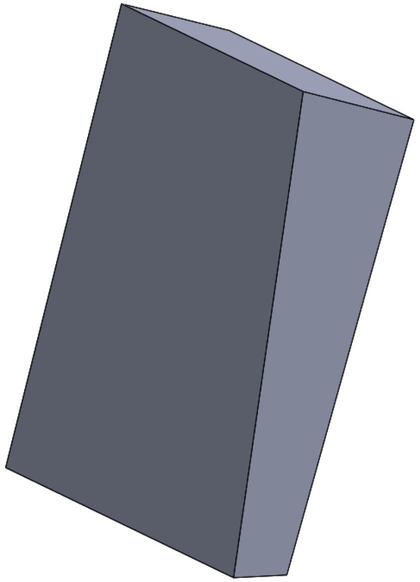
Solids to Surfaces

The legs are started as solids and will later be converted into surfaces. This will speed up modeling and use less features.



Extruded from Right Plane

Shaped from Front Plane

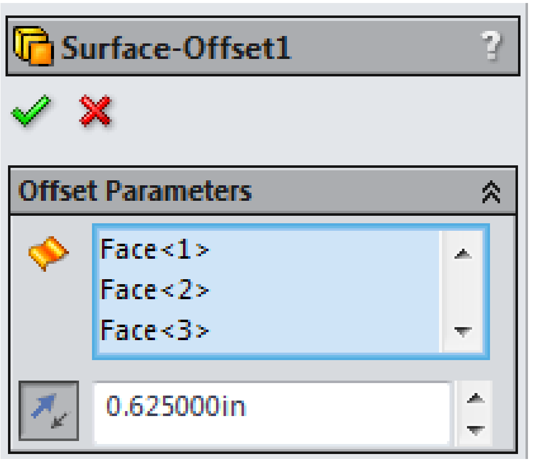


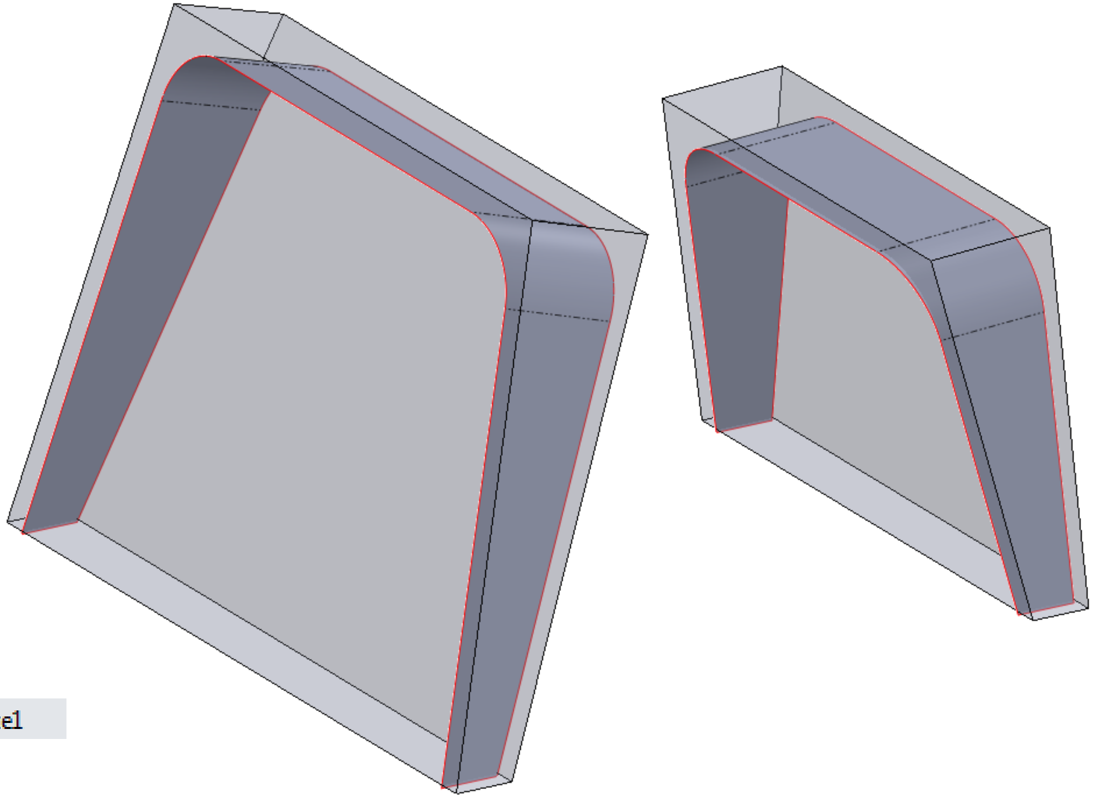
Completed form

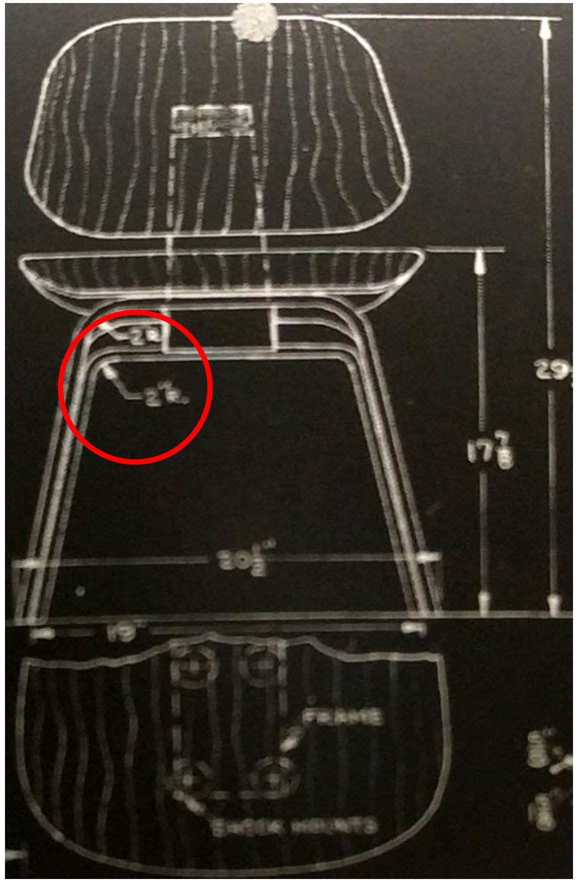
Solid features generate more faces than surface features. Here the top face of the legs was generated with a solid extrude. A separate surface would have been required to create the face.

Offset Surface Geometry.

Surface Offset is used to crate the inside faces of the legs. The outside faces were easier to model from the photograph; a reference image shows a 2” inside radius.



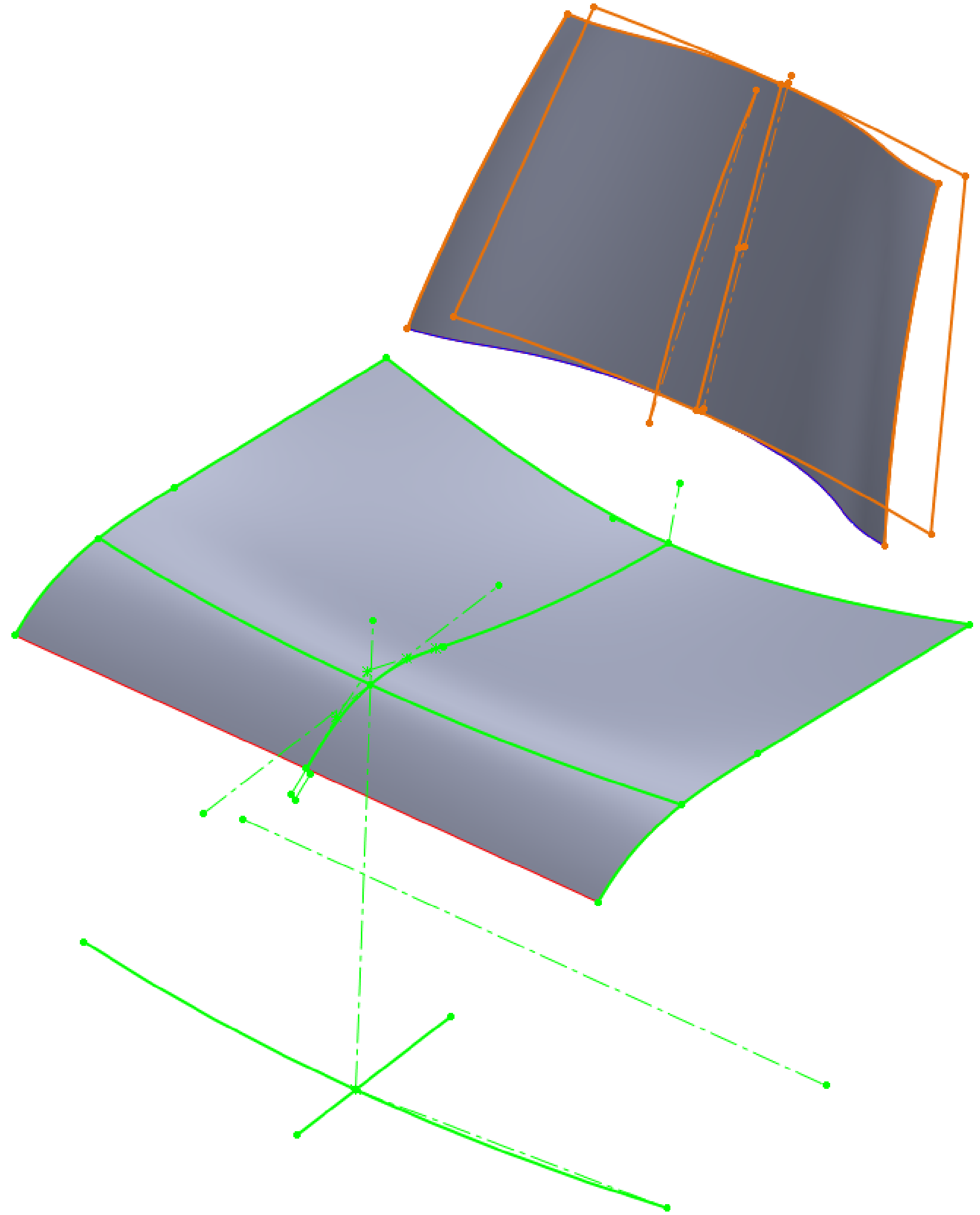




TIP: Remove the now un-needed solid bodies with a Body Delete Feature. Body-Delete1

Seat Set Up

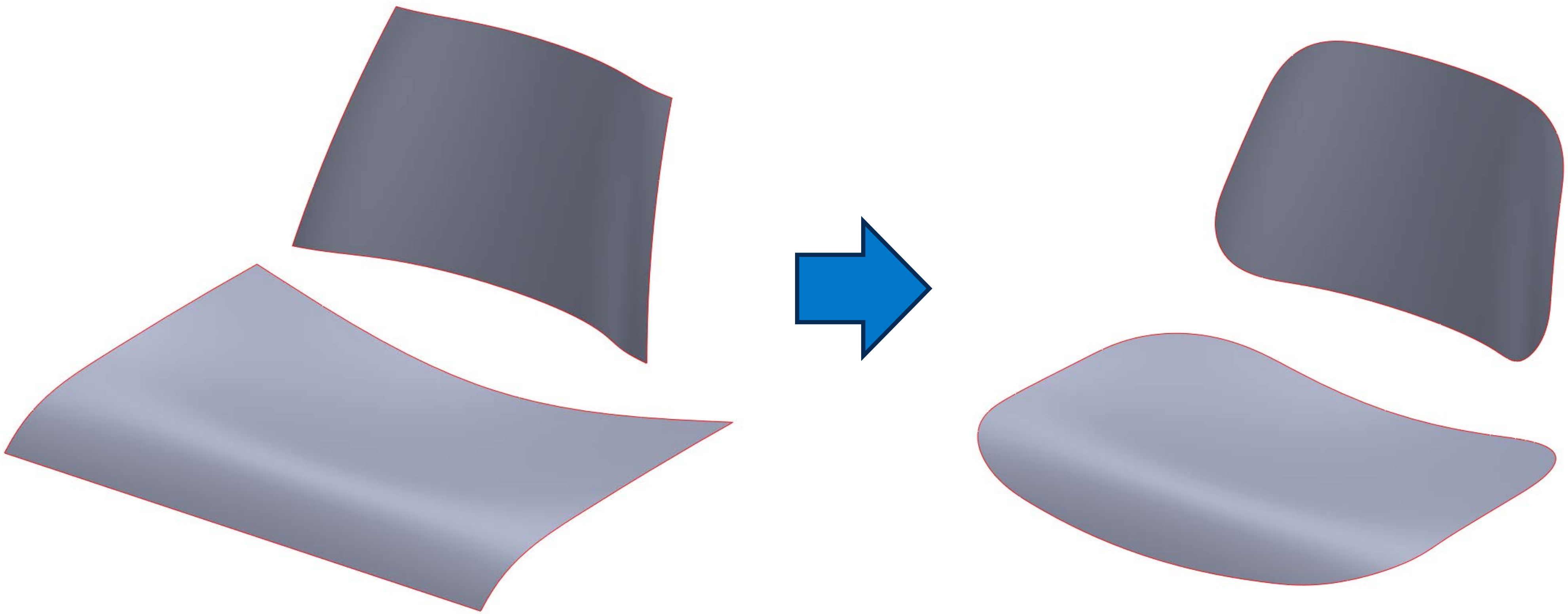
Creating the chair's spine and legs is straight forward. The seat pan and back feature compound surfaces that will require extensive set up in order to ensure the shapes are correct.



2D sketches, 3D sketches and project curves are used to define section profiles of the seat pan and back. They will be used to create surface geometry with the Boundary Surface feature.

Model for Manufacture

In mass production, the seat components are molded oversized and then hand routed via jig (then) or CNC cut to shape (now). Following this same process in SOLIDWORKS has benefits.



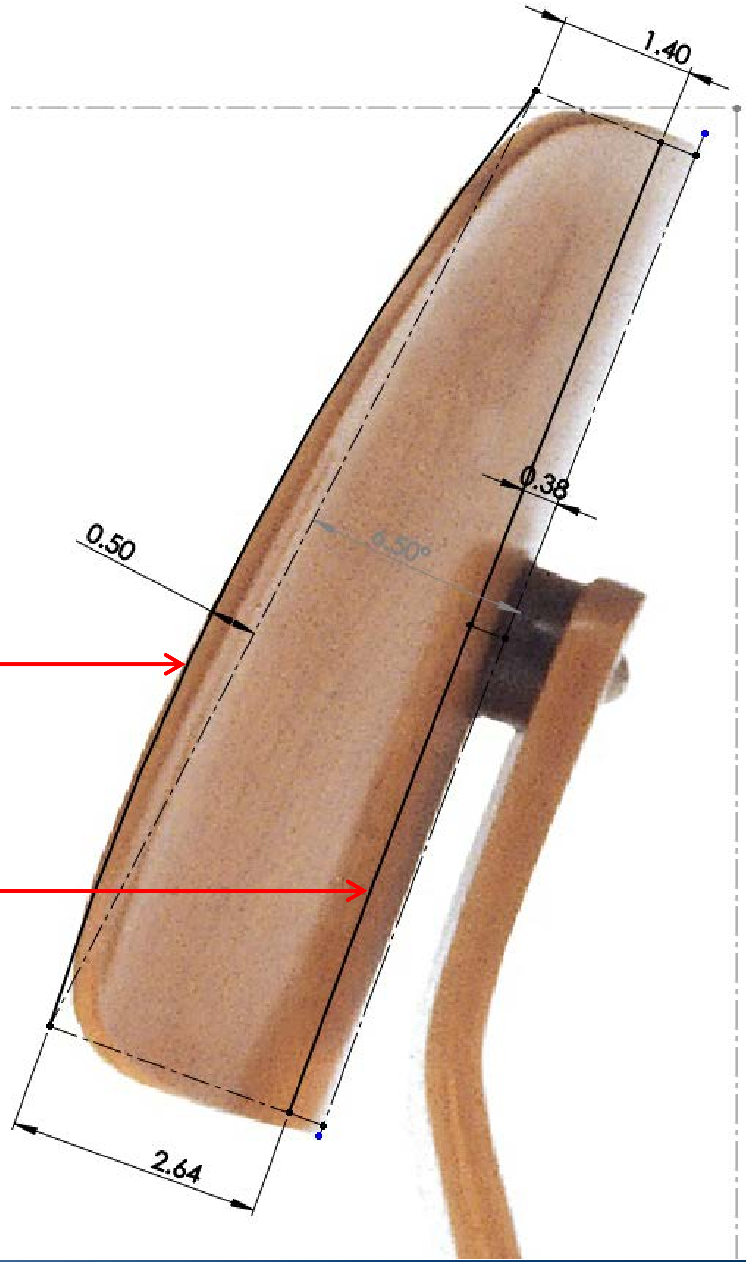
Boundary surfaces are typically best created between a framework of 4 curves with junctions of roughly 90 degrees. When the corners are rounded, its impossible to determine where the curves in the two different directions start and end.

Seat Back Side Layout

The side profile of the seat back image provides the most information as to its size and shape. What was the outside middle profile is offset to represent the seat surface middle profile.

Wherever possible define curves with **single** sections of an arc. These can be easier to control than splines. If two tangent arcs are required to sketch a shape, switch to a spline.

Even though this segment looks straight, its sketched with a 3 point arc. This gives more flexibility if the shape needs to be modified in the future.



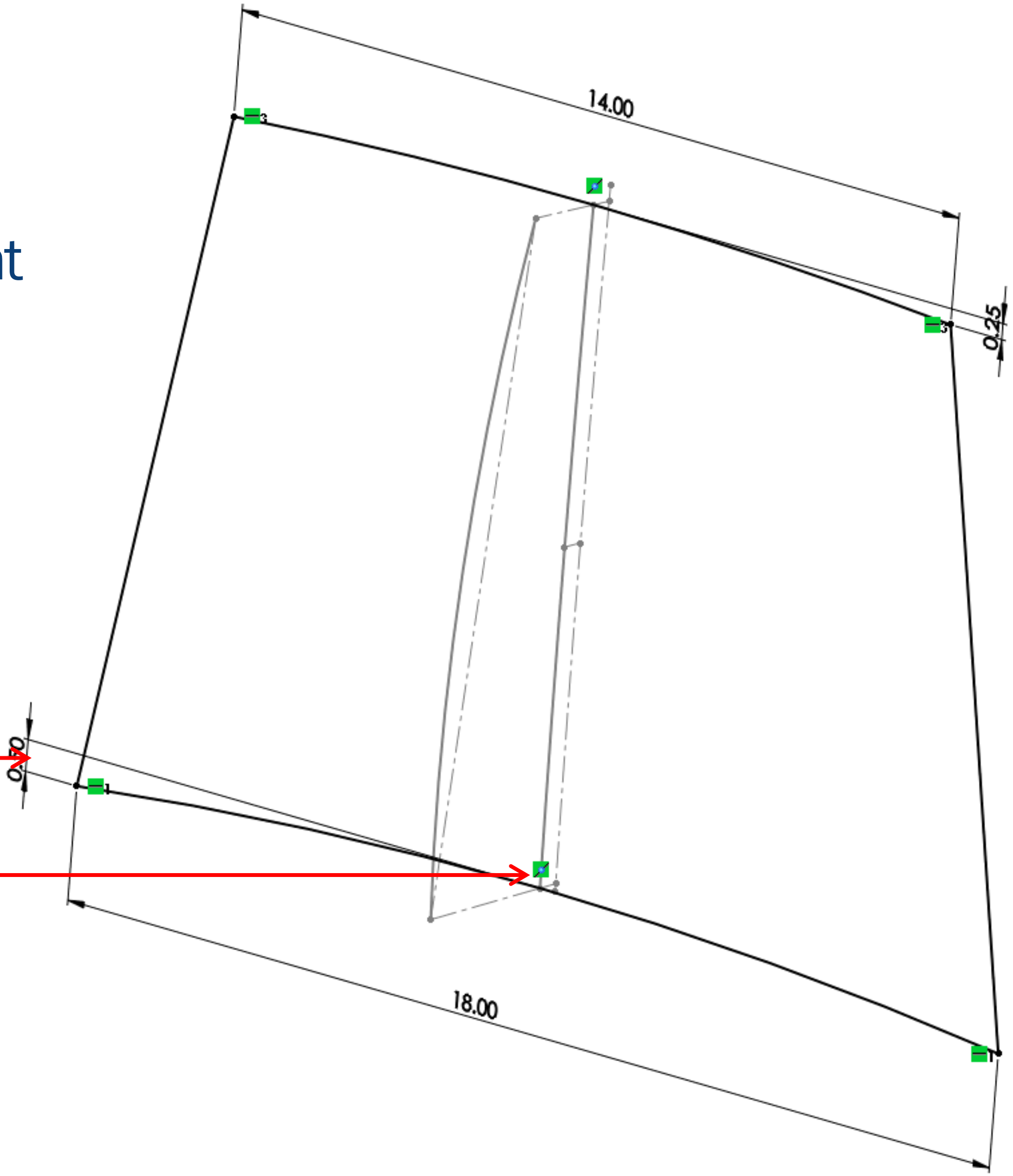
Seat Back Front Layout

The front layout is created on a plane normal to the side layout. It is imperative to align the front and right layout sketches for later curve creation.

The reference photography did not provide any views of the seat back shape from this angle. It was guessed from the LCM reference chair.

Capturing shapes by dimensioning arcs with their cord length heights can be more intuitive than dimensioning with a radius.

Midpoint relations are used to ensure symmetry and coincidence to the right layout sketch.

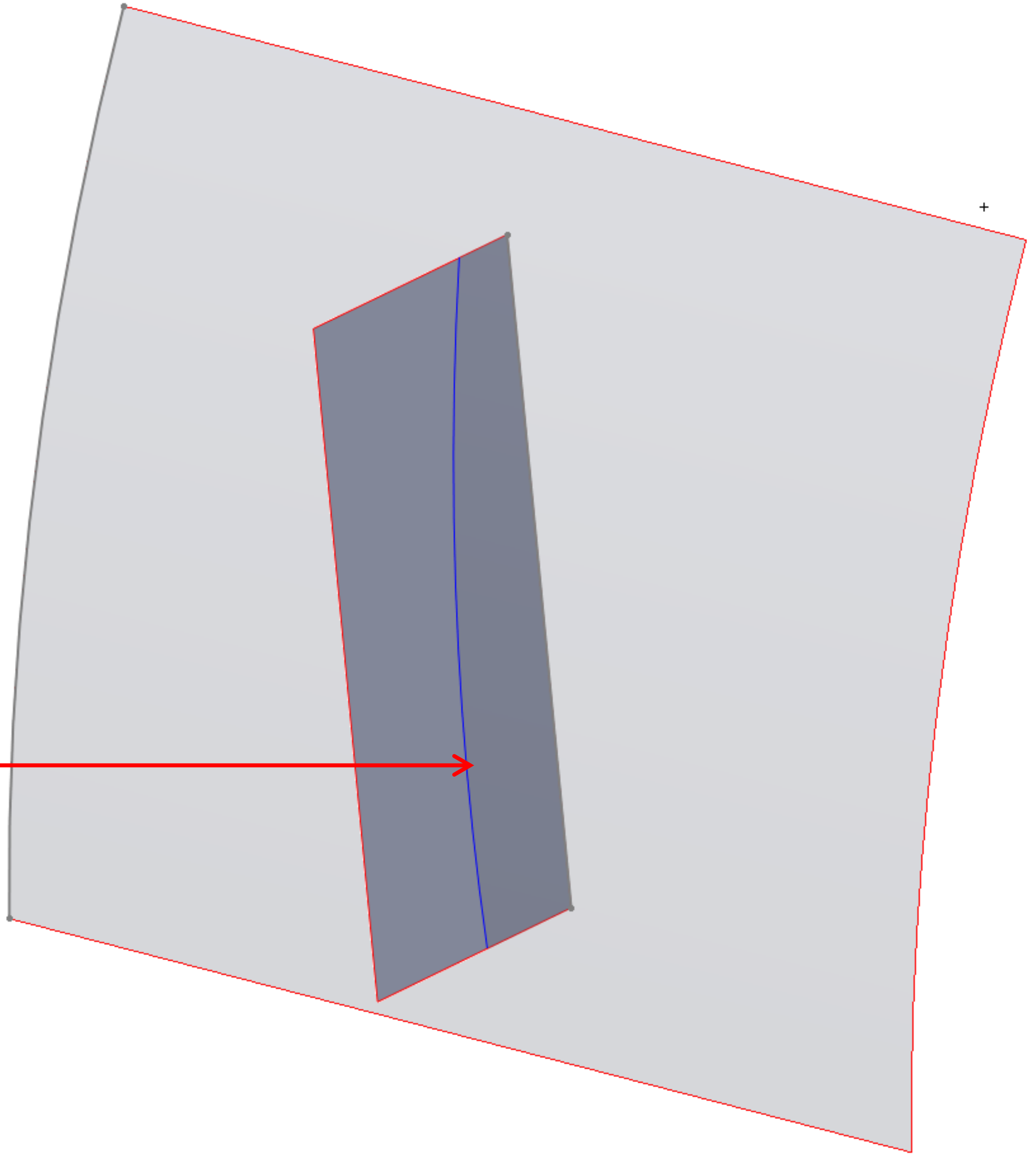


Seat Back 3D Layout

The vertical seat back profiles are created with Project Curve features. This allows two 2D sketches to create a 3D curve.

A Sketch on Sketch Project Curve can be imagined by the virtual intersections of two surfaces.

The resultant curve appears a blue "edge" in the graphics window.



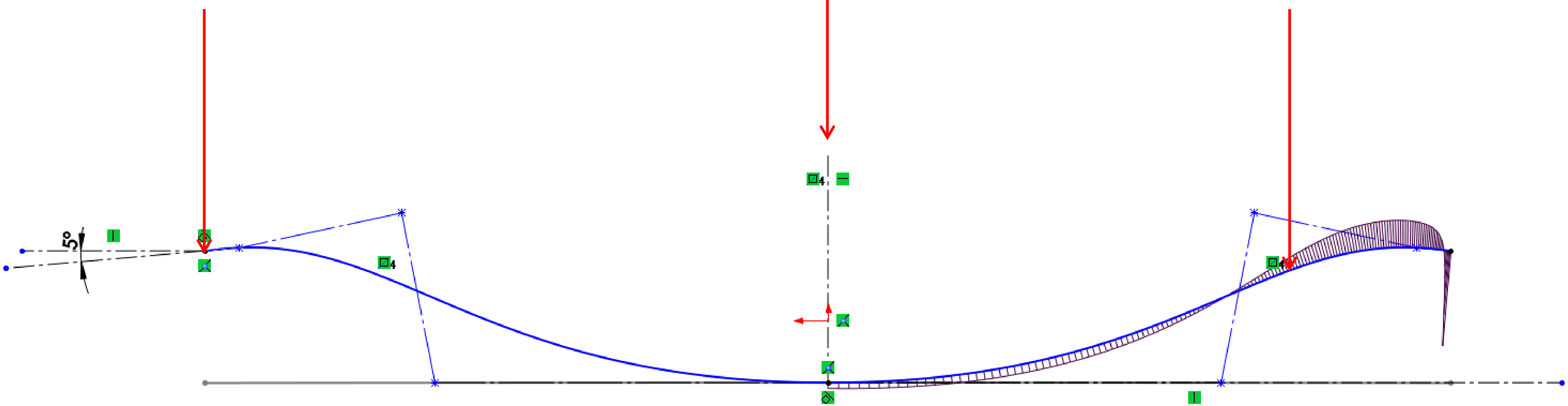
Seat Back 3D Layout

Project Curve features are also used to the create horizontal seat back profiles.

End point of spline is coincident to end point of vertical Project Curve.

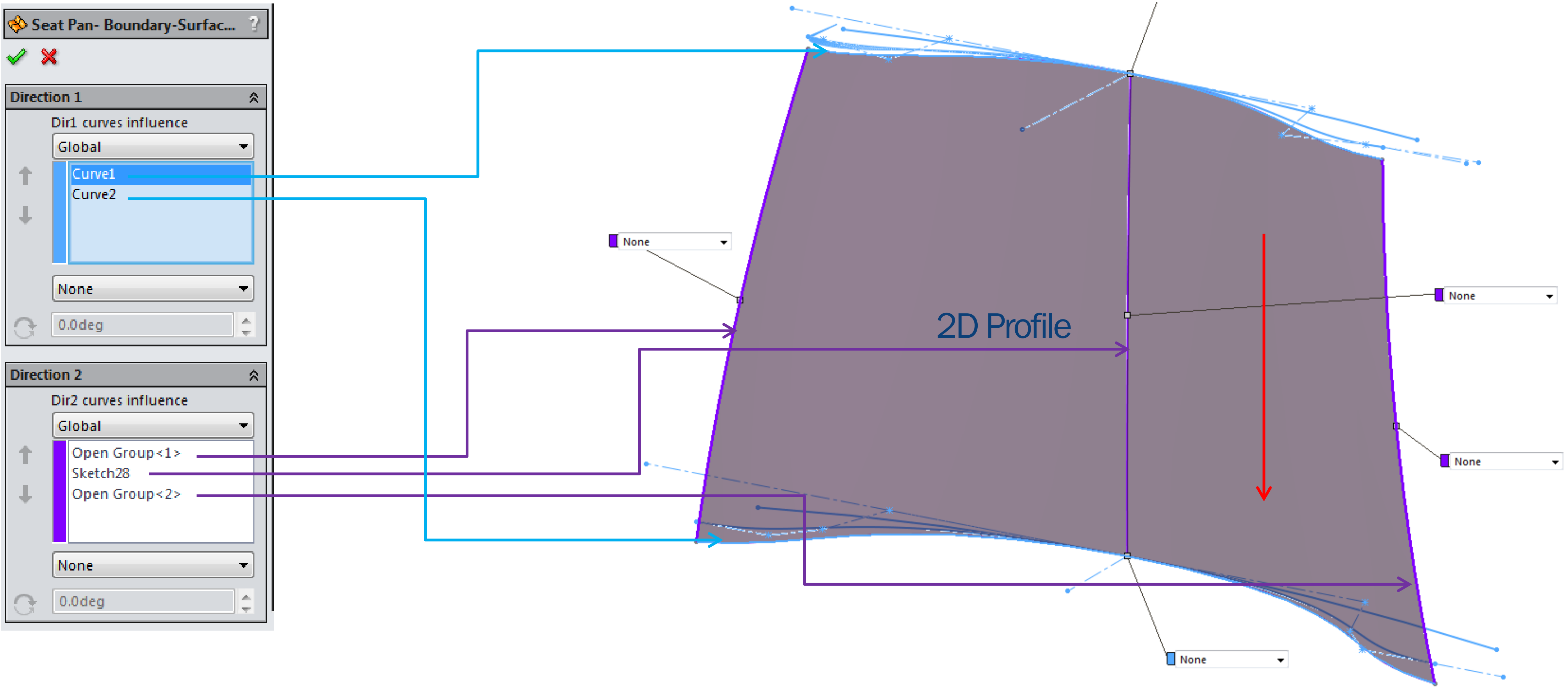
One half of the spline is sketched and then mirrored.

A style spline offers smoother results than the traditional spline tool but is less intuitive



Seat Back Boundary Surface

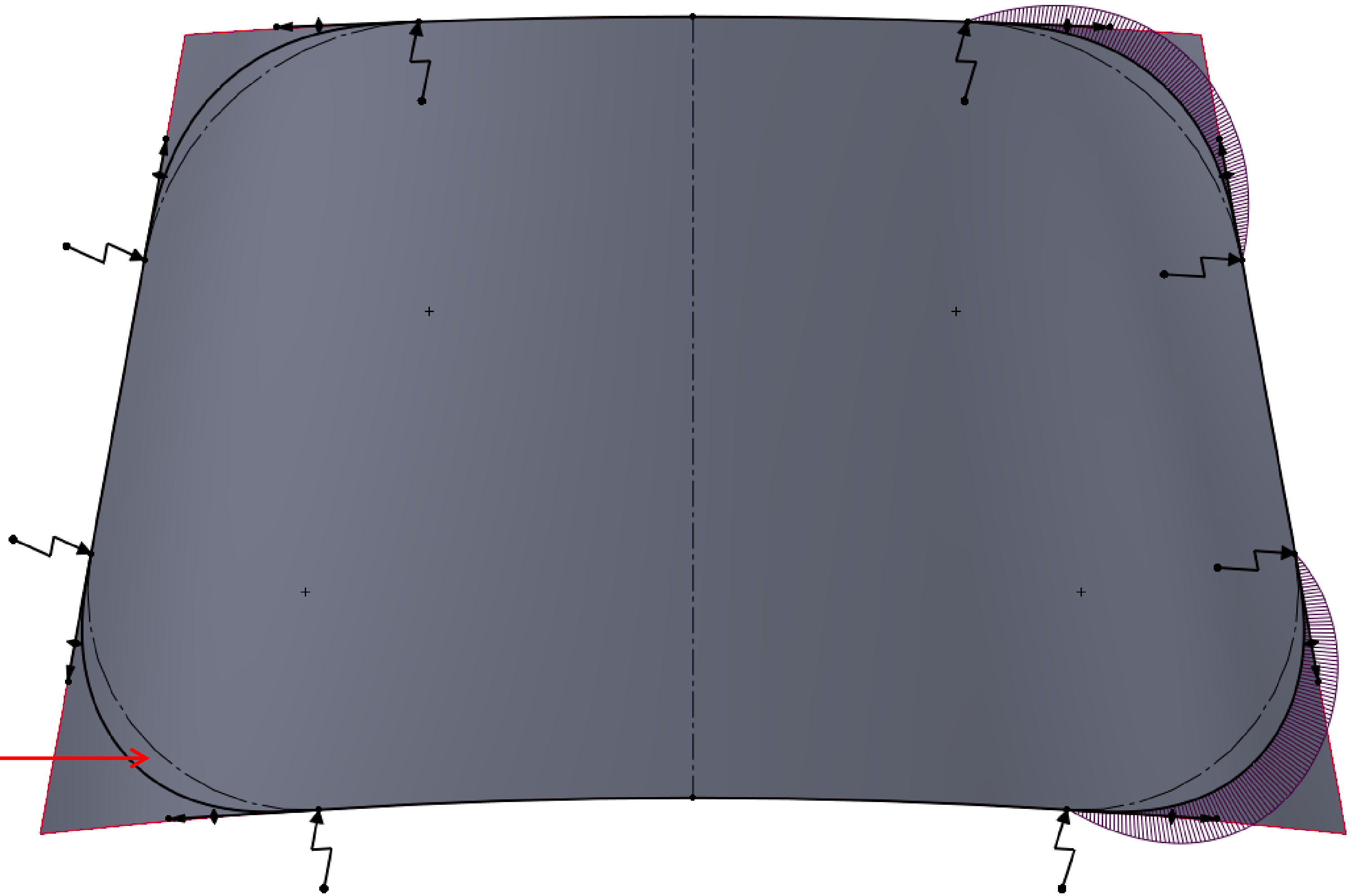
Boundary Surface creates the seat through the 3D profiles and a 2D profile on the right plane.



Seat Back Shape

The seat back is trimmed to form the final shape seat. Two sketches are used, the first converting the edges of the seat shape and adding sketch fillets, the second with splines over the fillets.

Adding sketch fillets allows easy control over the size the curvature continuous splines.

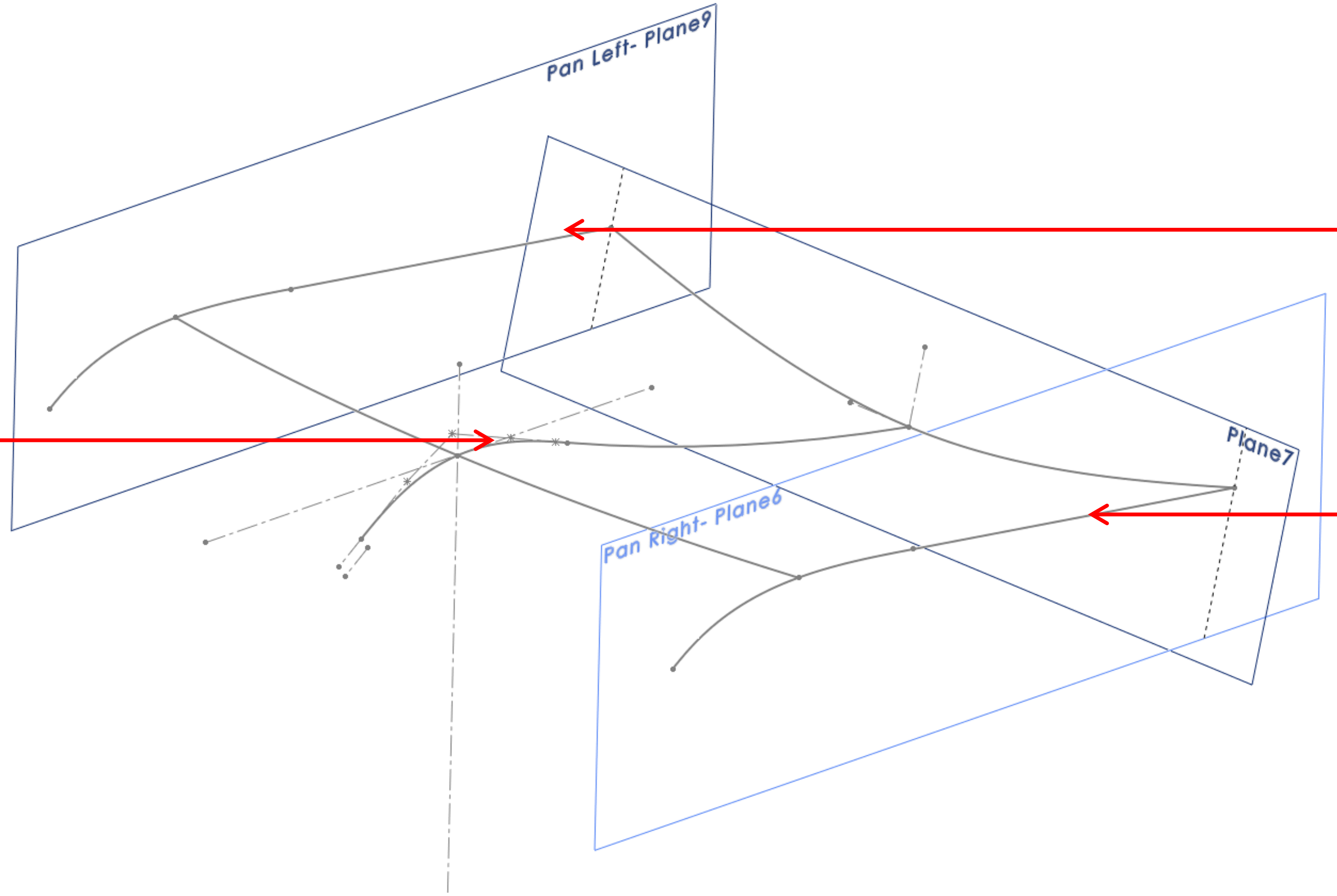


Adding the splines and fillets in the same sketch tend to over define the sketch. Instead, add the fillets in one sketch, then convert into a new sketch and set the fillets as construction. This simplifies the sketch for the solver.

Seat Pan Setup

The setup of the seat pan is simpler than the seat back. All but one of the profiles are 2D sketches on planes.

Sketched on right plane

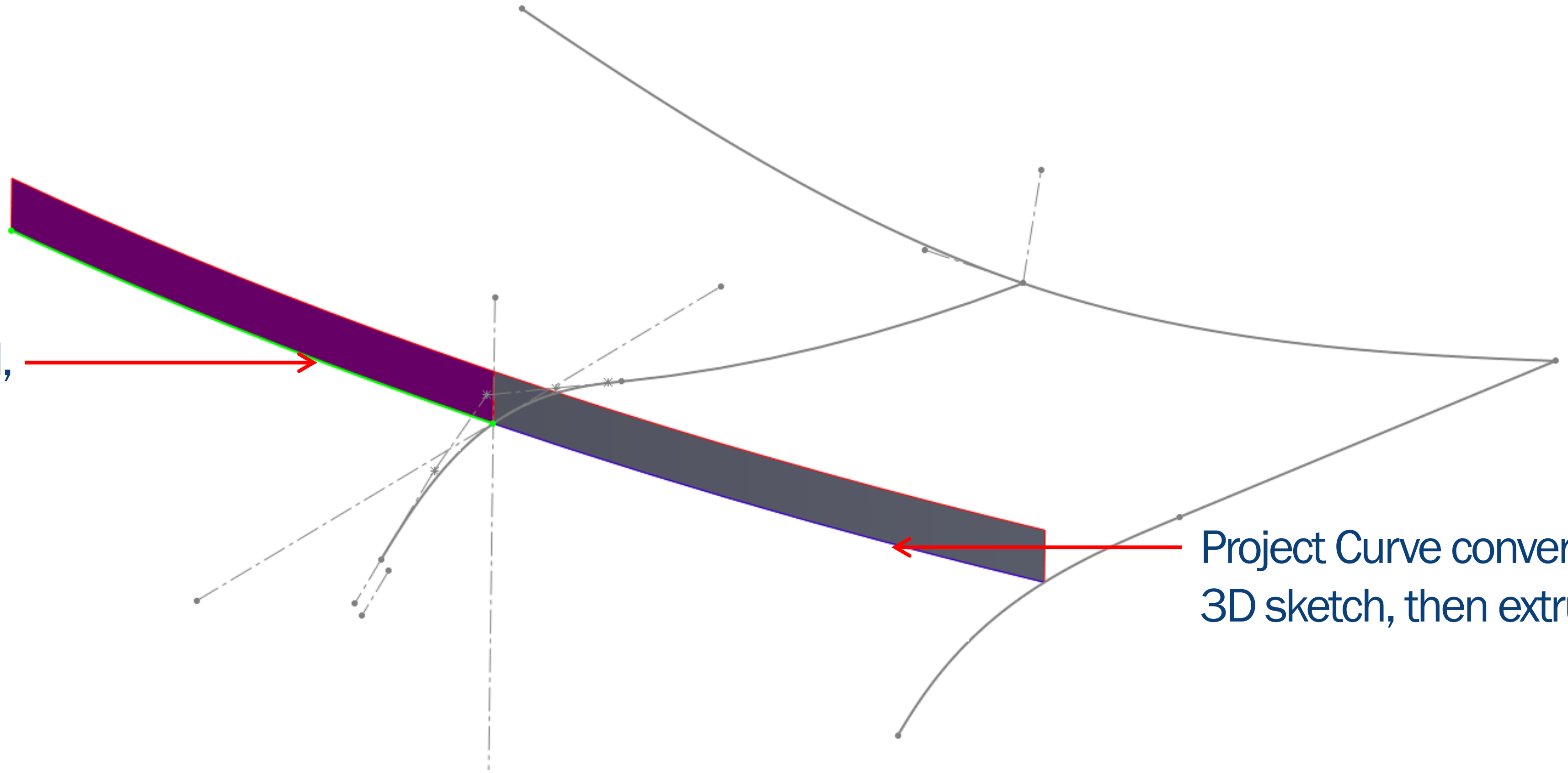


Converted from original layout

Mirroring Project Curves

Occasionally, a Project Curve may need to be mirrored. The feature itself cannot be mirrored, but it can be used to create a surface body, and the surface body mirrored.

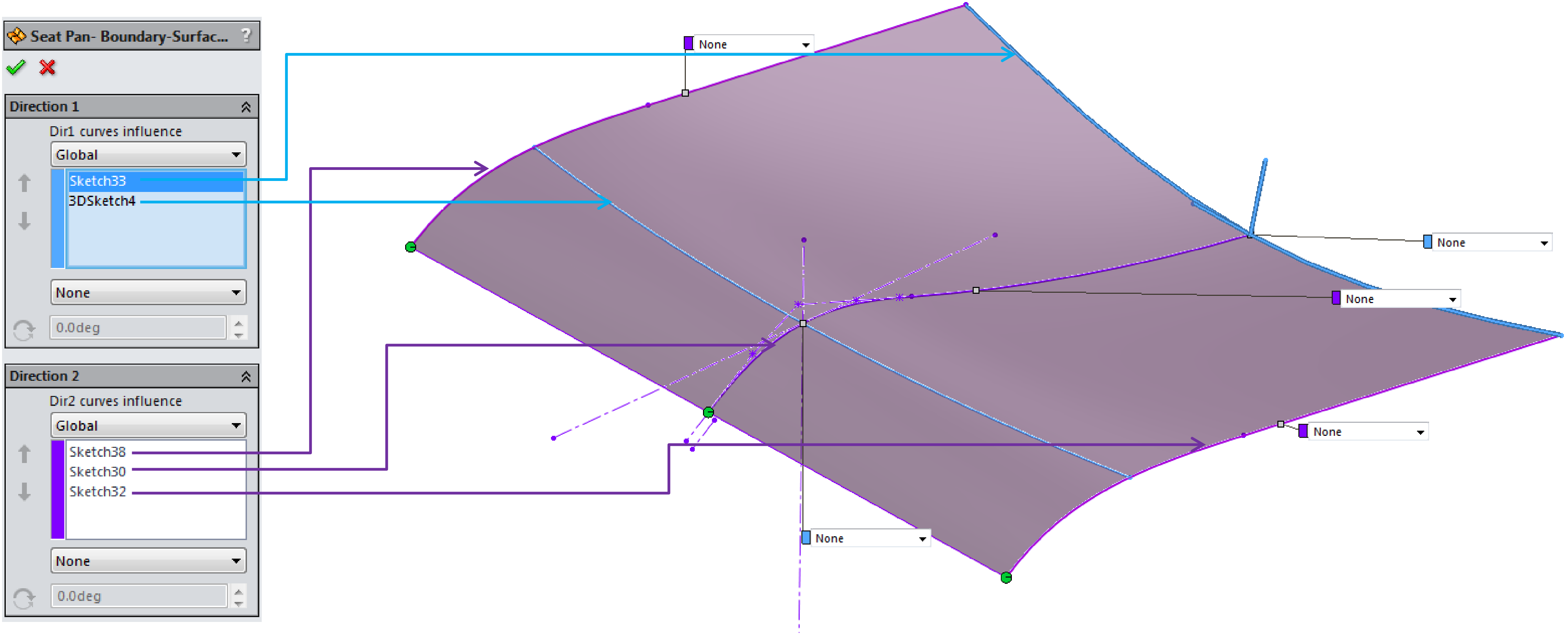
Surface body mirrored, 3D sketch converted from surface edge.



Project Curve converted into 3D sketch, then extruded.

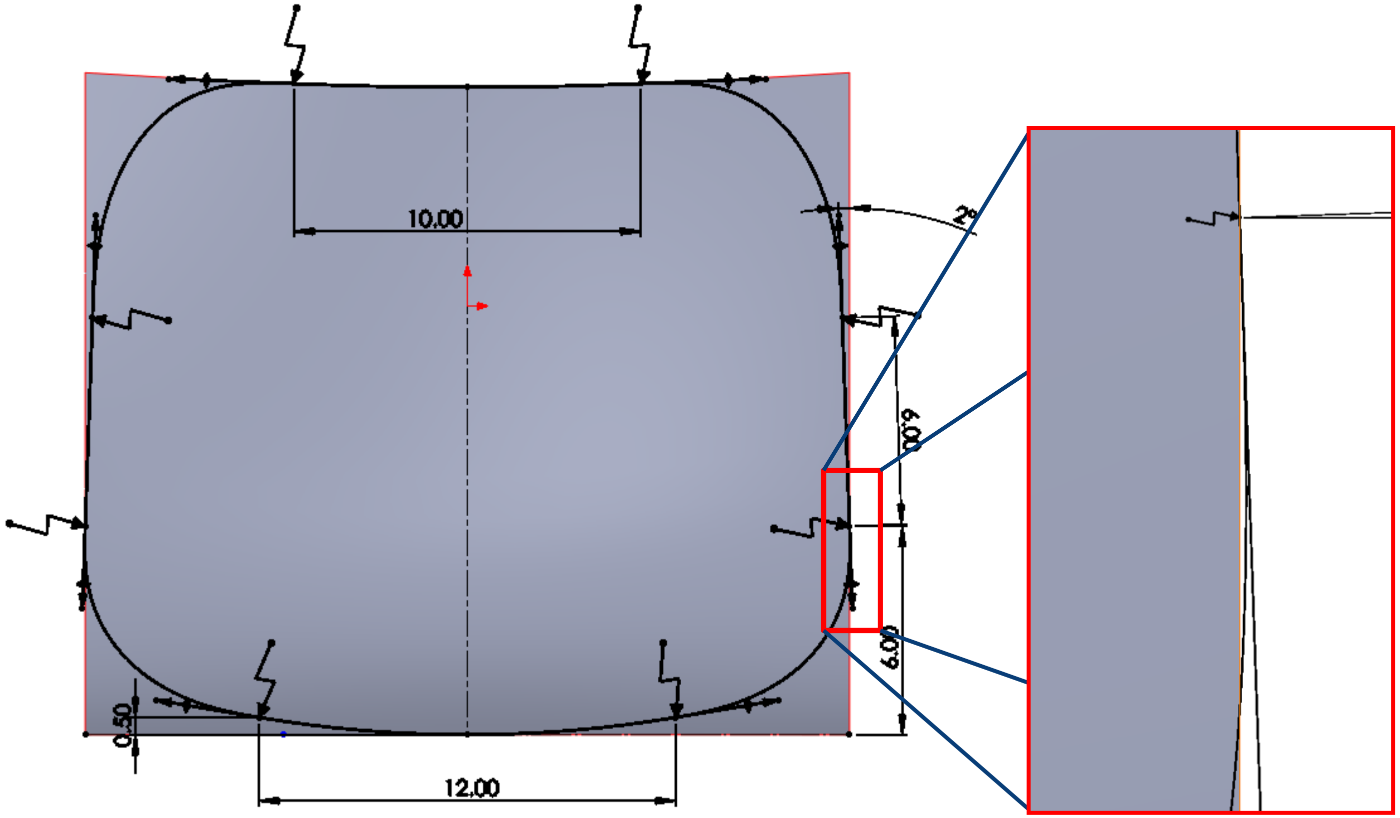
Seat Pan Boundary Surface

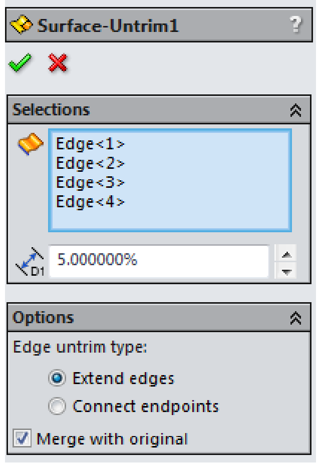
Boundary Surface creates the seat through 2D profiles and single 3D profile controlling the front of the set before it dips down.

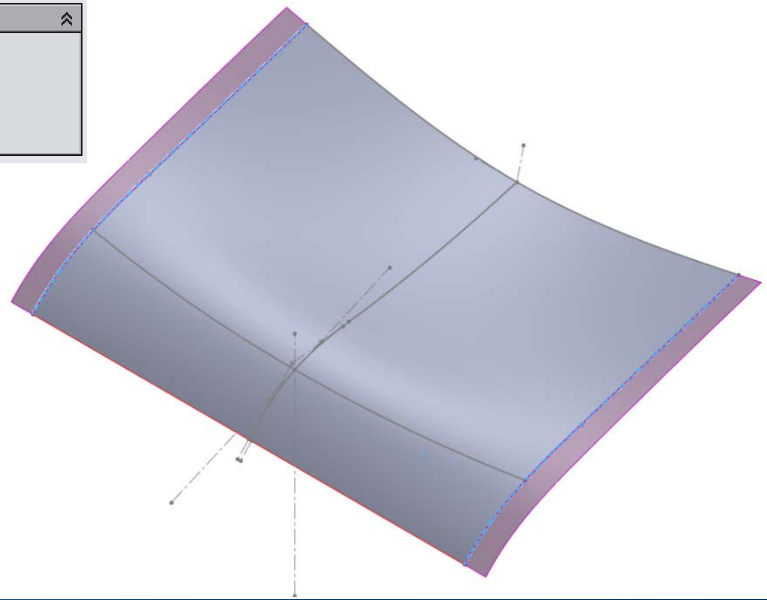


Seat Pan Trim

The seat pan is trimmed to shape. The trim sketch is slightly larger than the completed surface body; Surface Un-Trim is used to slightly extend the surface.





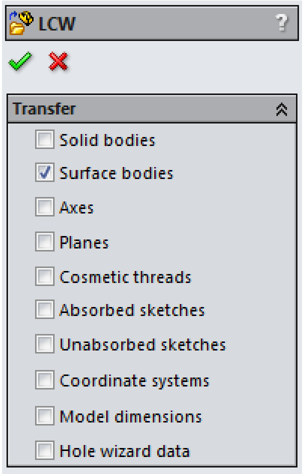


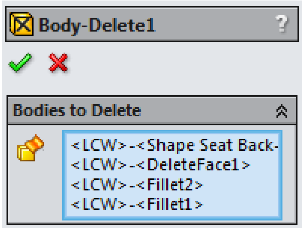
Completed Master Part

The completed master seat surfaces will be propagated to child parts for solidification and detailing.

Propogate Children

Insert part is used to populate the child parts with the surface data from the parent part. Delete Body removes all but one of the surfaces.

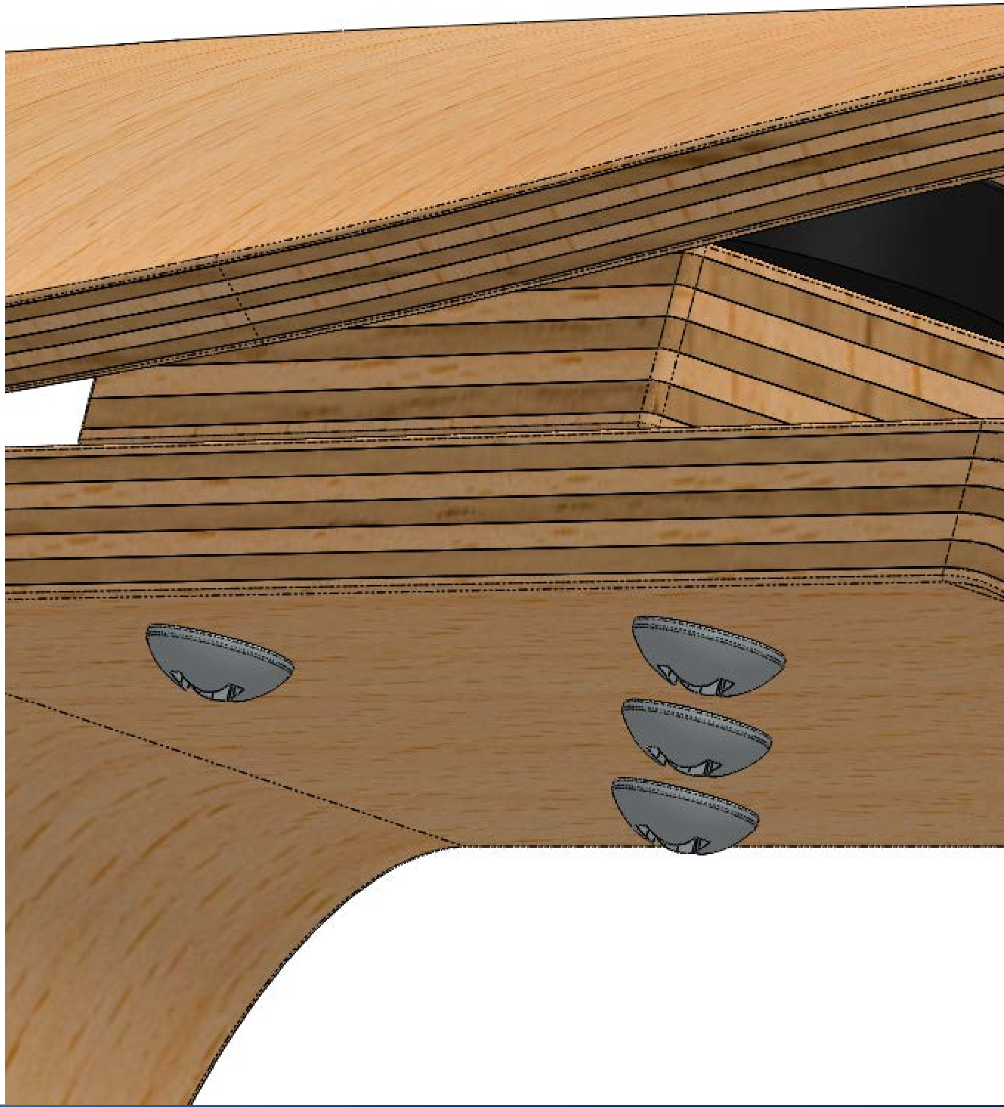




Surface Body Benefits

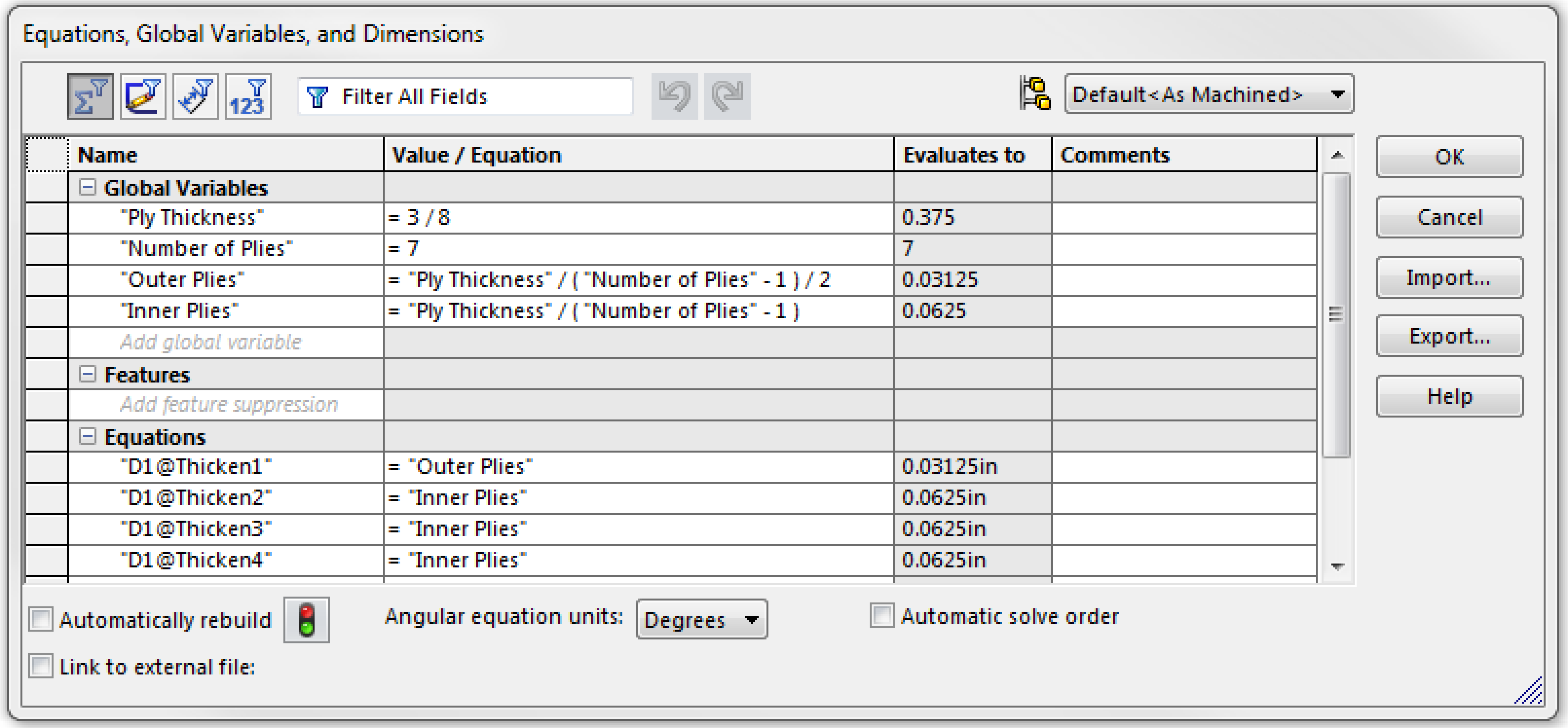
This method of creating molded plywood has three benefits:

- Thickening a surface body creates an edge that is normal to the surface. This mimics a trim router cutting the panel to shape.
- A distinct body is created for each ply by thickening offsets of the surface and not merging the result. This allows each body to have it's own appearance for realistic renderings.
- A molded panel can be considered an assembly of multiple veneers of wood. Multiple bodies allows for tracking of each ply with the weldments functionality.



Set Up Ply Thicknesses

Equations are used to control the thickness of the various plies. Outer plies are typically higher quality veneers than the inner plies, thus they are thinner (more yield per log).

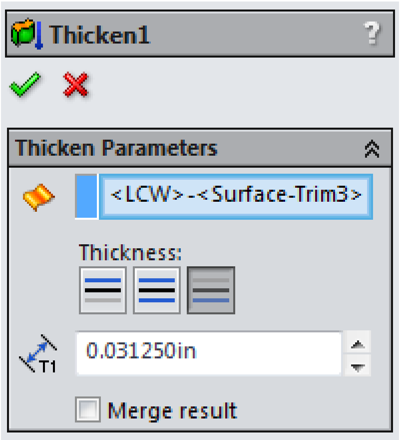


Name	Value / Equation	Evaluates to	Comments
⊟ Global Variables			
"Ply Thickness"	= 3 / 8	0.375	
"Number of Plies"	= 7	7	
"Outer Plies"	= "Ply Thickness" / ("Number of Plies" - 1) / 2	0.03125	
"Inner Plies"	= "Ply Thickness" / ("Number of Plies" - 1)	0.0625	
Add global variable			
⊟ Features			
Add feature suppression			
⊟ Equations			
"D1@Thicken1"	= "Outer Plies"	0.03125in	
"D1@Thicken2"	= "Inner Plies"	0.0625in	
"D1@Thicken3"	= "Inner Plies"	0.0625in	
"D1@Thicken4"	= "Inner Plies"	0.0625in	

The seat pan is 3/8” thick, with 5 inner plies and 2 outer plies. The formulas calculate the thickness of inner and outer plies based on the overall thickness and number of plies in the stack.

Create the First Ply

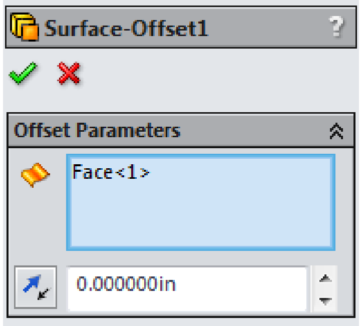
The first ply of the seat pan is created with a Thicken feature. After creation, the thicken value is linked to the global variable for outer ply.

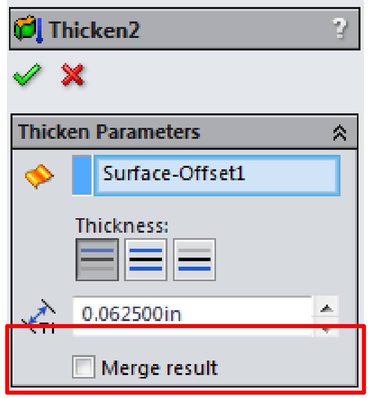


TIP: The thicken value cannot be directly linked to the global variable in the property manager. Instead, double click the feature, find the dimension on-screen, and link that to the variable.

Create the Remaining Plys

Copy the bottom surface of the first ply with a Surface Offset of 0.00”. Then thicken the copied surface and link to the inner ply global variable. Do not merge the result.

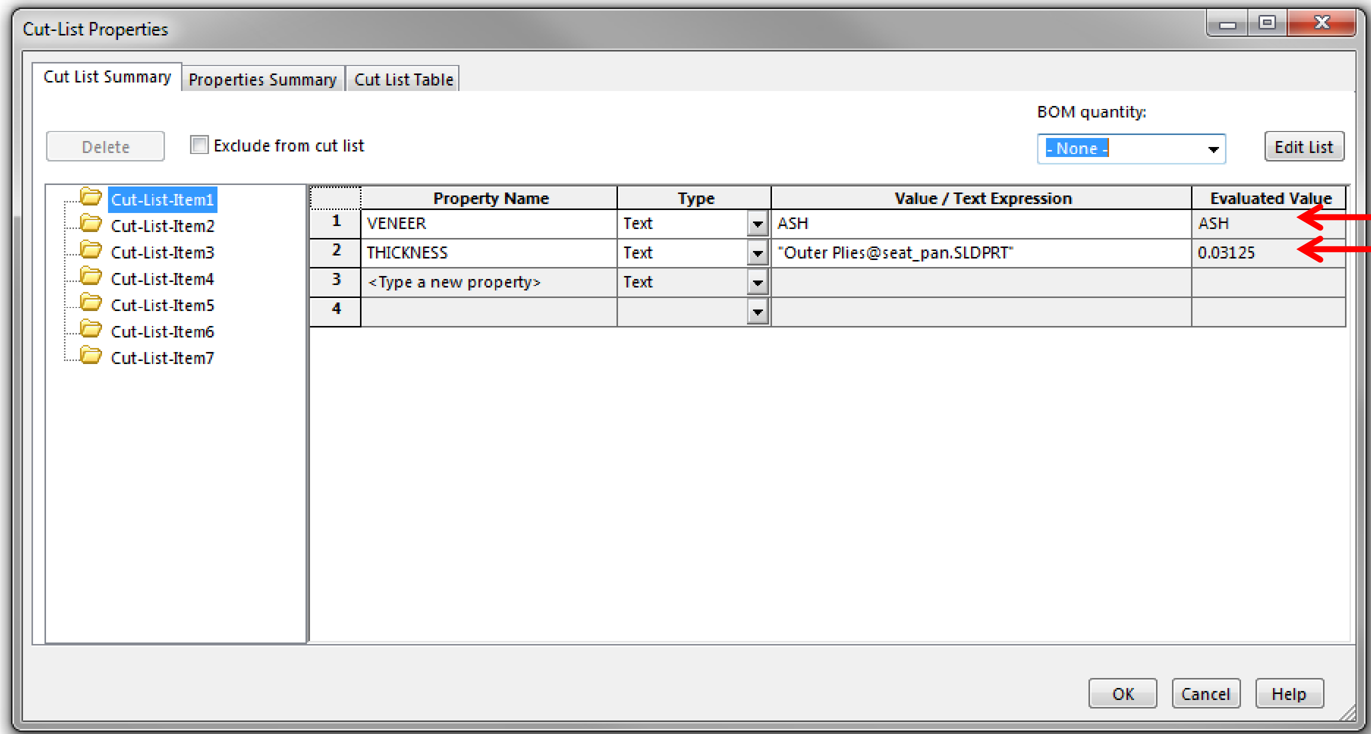




Note the grain perpendicular to the first ply. Veneers are stacked 90 degrees to each to increase rigidity of the final panel.

Create A Weldment

By the turning the part into a Weldment, SOLIDWORKS automatically generates a cut list table. The cut list table shows each individual body, and allows for custom properties to be added to each body.



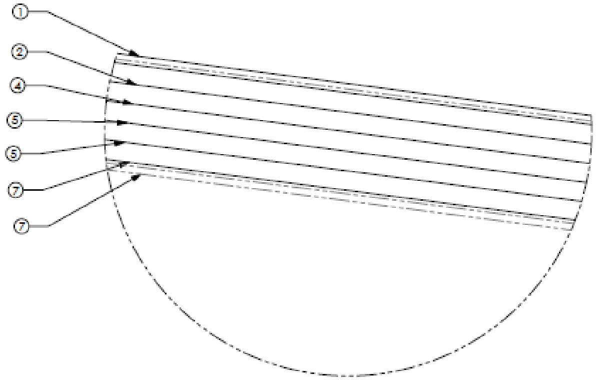
The species of veneer can be populated to a custom property field.

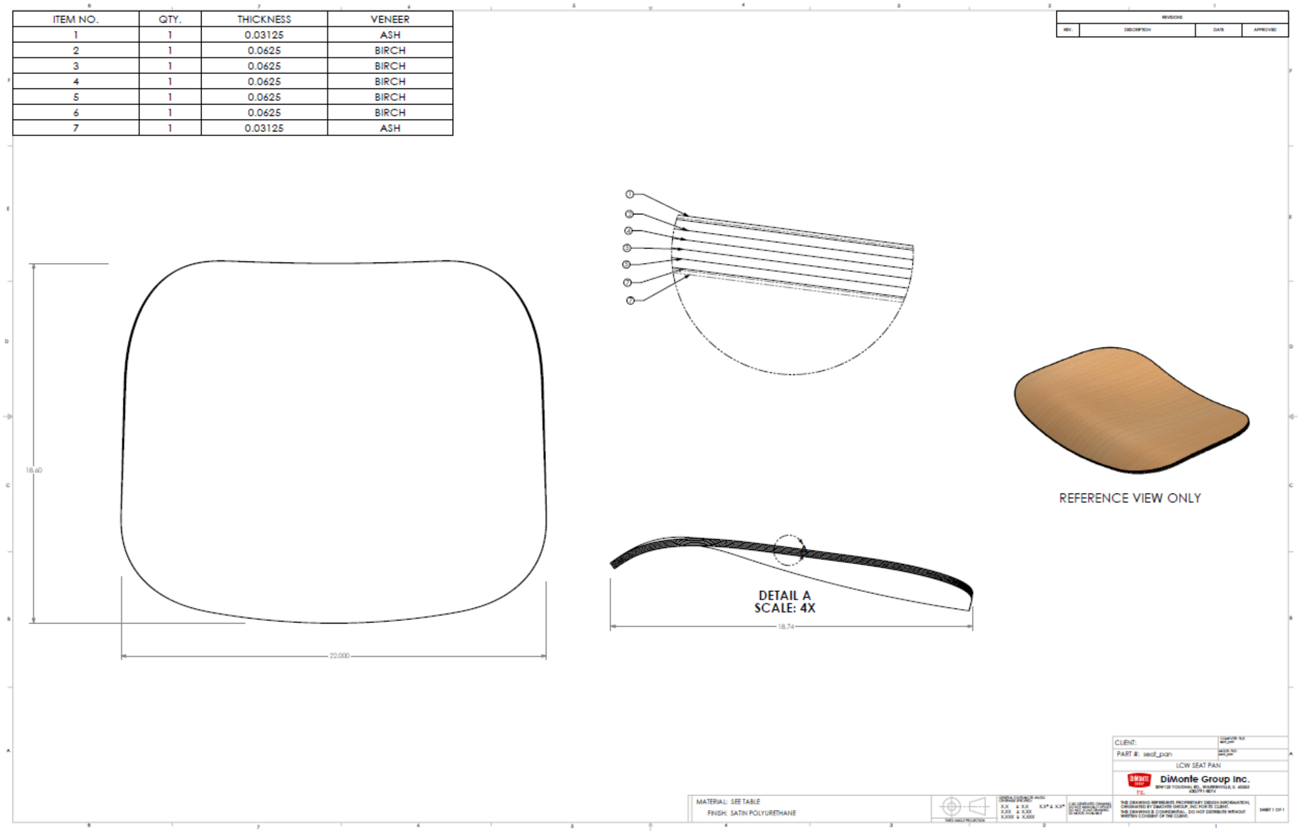
The thickness of each ply can be linked to the matching global variable.

Publish the Cut List to a Drawing

The cut list properties can now be published to a drawing of the part. The Cut List table will show the thickness and species of each veneer. Orientation could also be added.

ITEM NO.	QTY.	THICKNESS	VENEER
1	1	0.03125	ASH
2	1	0.0625	BIRCH
3	1	0.0625	BIRCH
4	1	0.0625	BIRCH
5	1	0.0625	BIRCH
6	1	0.0625	BIRCH
7	1	0.03125	ASH





“Getting the most of the best to the greatest number of people for the least.”

-Charles Eames

Eames Fiberglass Shell Chair

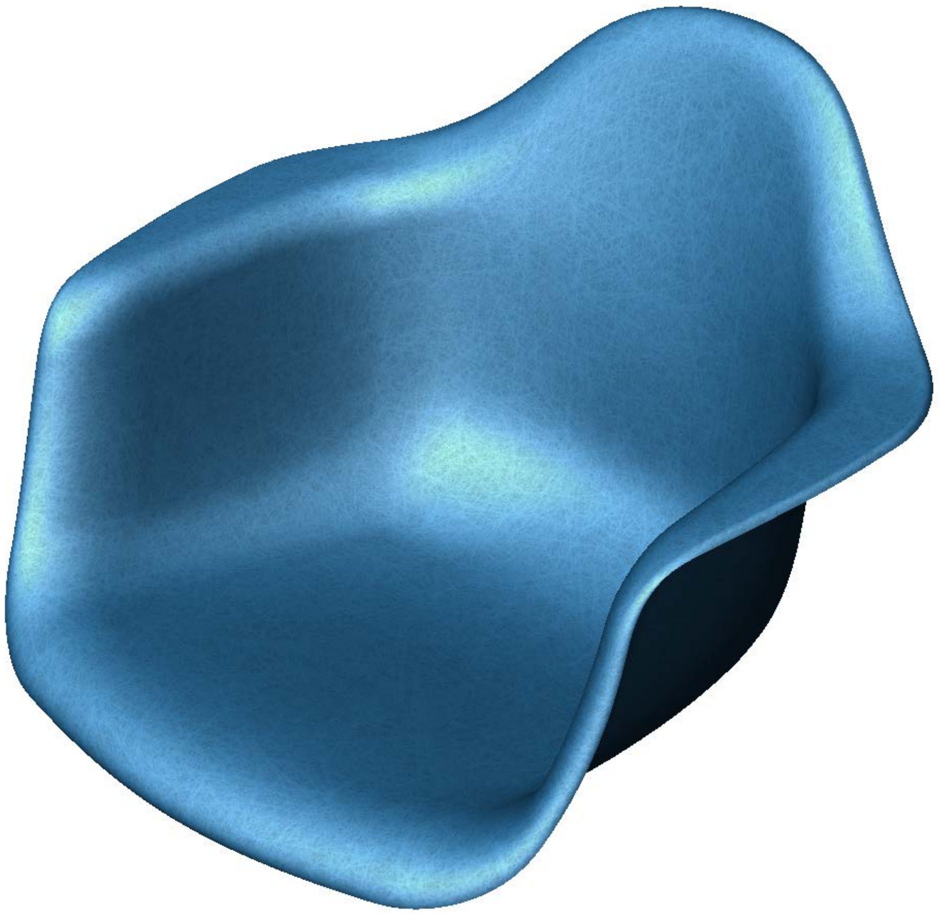
Eames Fiberglass Shell Chair

Eames Fiberglass Shell Chair

The Eames' strove to design modern, functional and reasonably priced furniture. Their Fiberglass Shell Chairs arguably come closest to achieving this vision.

First manufactured in glass fiber reinforced polyester in 1950, the chair was the first one piece plastic chair not covered in upholstery. Instead, the chopped glass fibers contribute to the look and authenticity of the chair .

The chairs were produced by impregnating a glass fiber mat with resin and then forming in a core-cavity steel mold mounted in a hydraulic press.



Reverse Engineering

The fiberglass chair appears as one large sculptural shape. During the design process, Eames Office employees would hand sculpt plaster molds to produce prototypes.

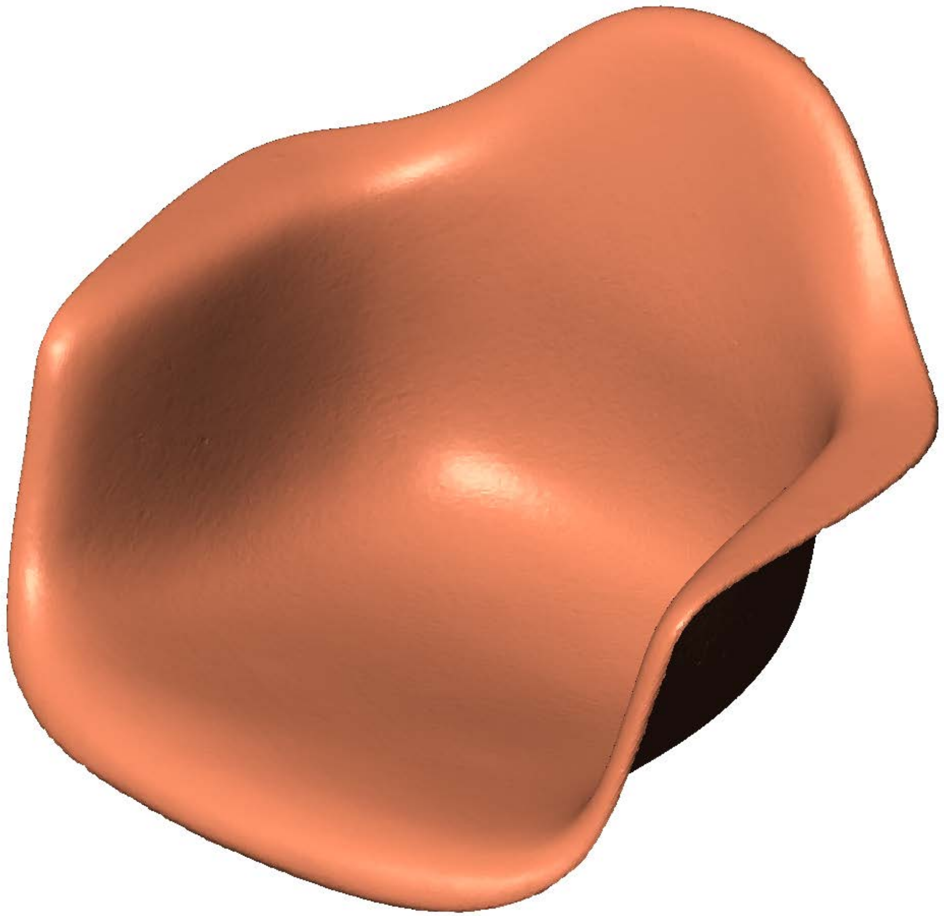
The organic nature of the chair is free from the influence of CAD. While modern CAD systems have revolutionized the design process, something must be said for the purity of form developed by human hands, versus the technical nature of extrudes, revolves and fillets.

Reverse Engineering

To accurately reverse engineer the chair, photographs and measurements will not be sufficient.

Instead, the chair will be 3D scanned and this 3D scan used as a basis for modeling.

3D scan data is point cloud data that can be post processed into a STL file that can be opened in SOLIDWORKS.

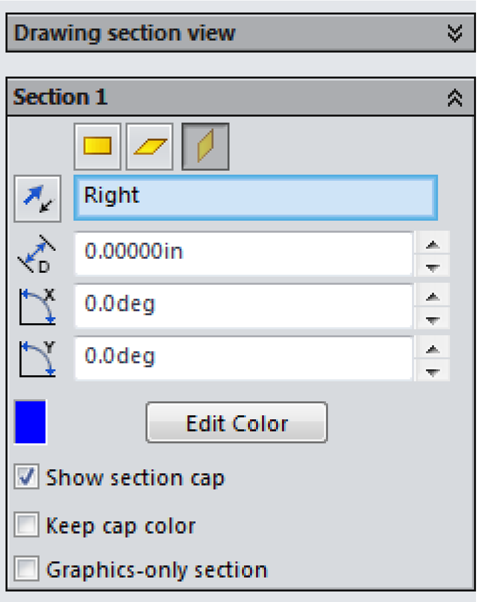


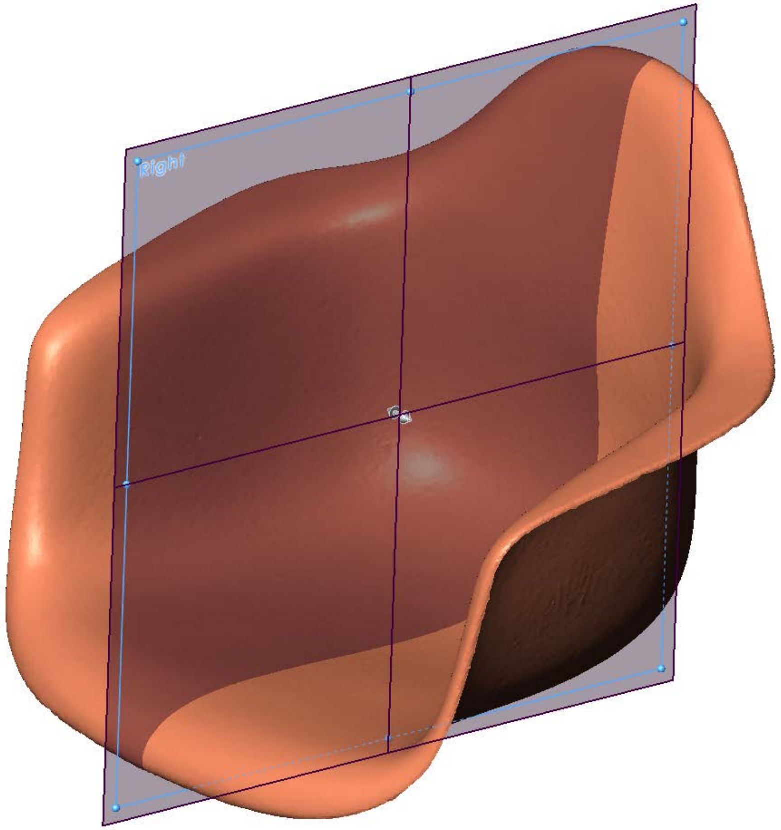
For more information on 3D scanning, check out the 3D Scanning Short Course on the DiMonte Group Website.

STLs In SOLIDWORKS

STL data is extremely limited in SOLIDWORKS. The data comes in as a STL graphics body. Which is just that, graphical data. Unlike geometric data, graphic data cannot be manipulated.

STL graphics cannot be sectioned. This will make the modeling of the chair next to impossible, without sections to reference for curves that will construct surfaces.



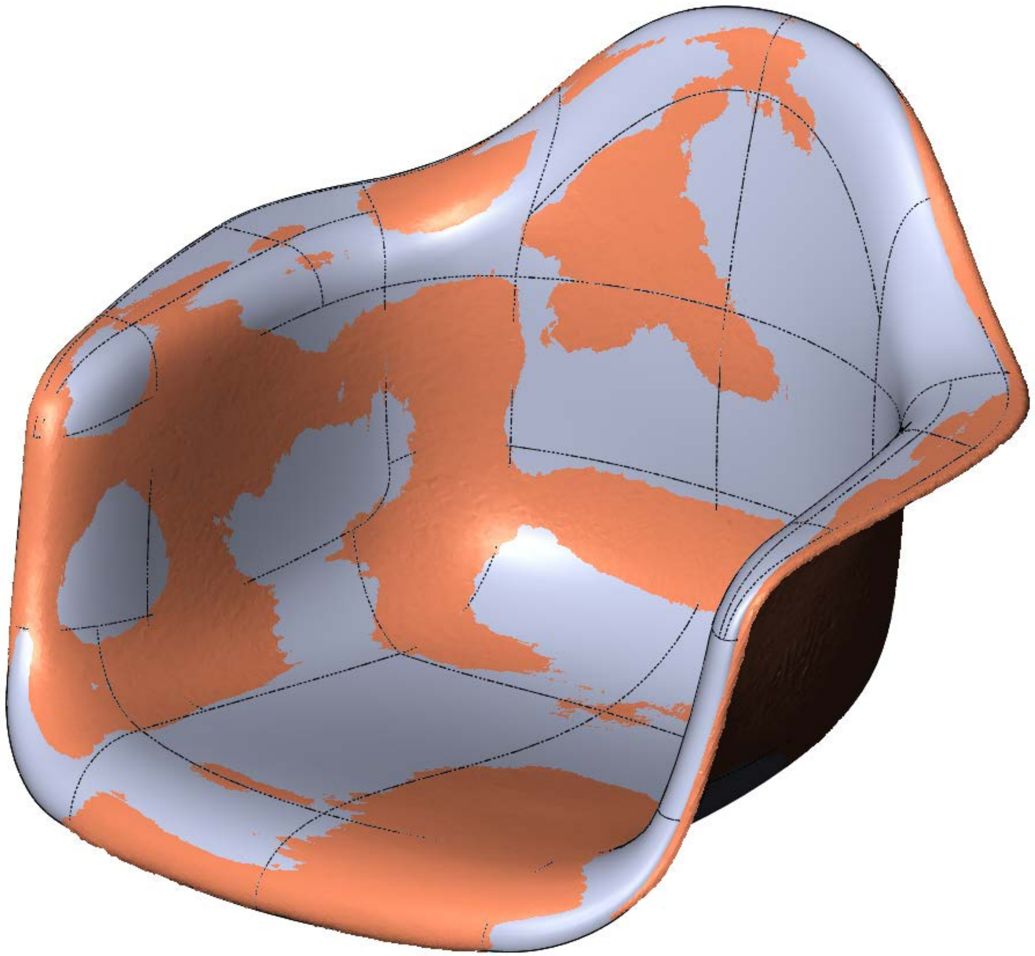


Create A Comparison Assembly

Instead of modeling the part in the same file as the STL file, create a comparison assembly with both STL file and new SOLIDWORKS model.

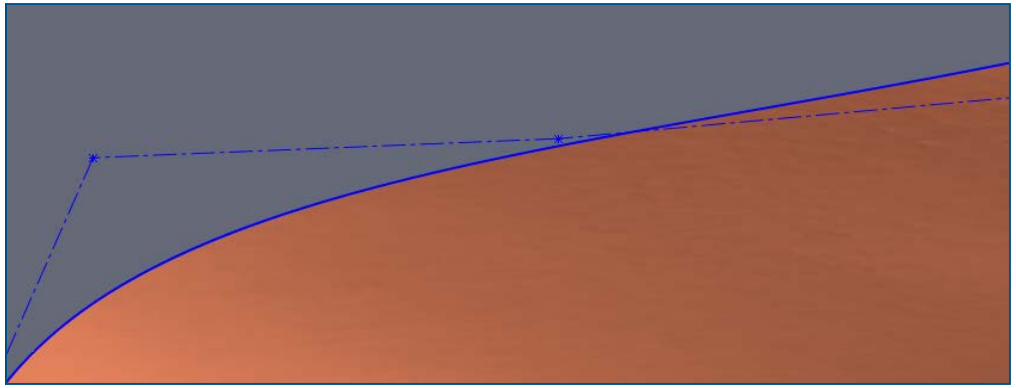
This allows for easy showing/ hiding of the STL reference.

The SOLIDWORKS model matches the 3D scan when a molted appearance is seen. This represents the model passing in out of the STL graphics body.

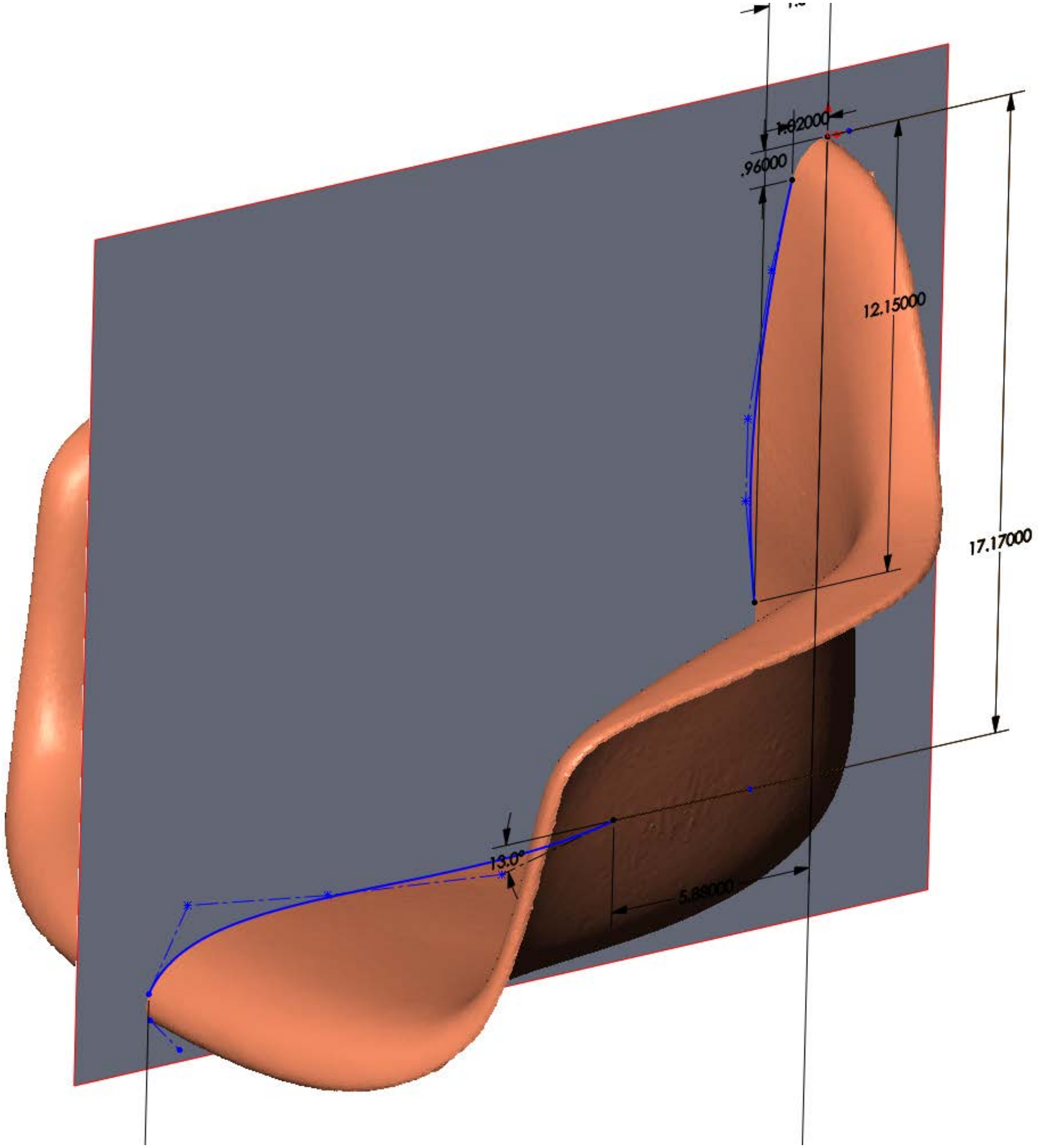


Sectioning STL Graphics

Instead of working with section views, surfaces can be used to visually see the intersection of the surface and STL. This can then be used as a reference to trace sketches over.

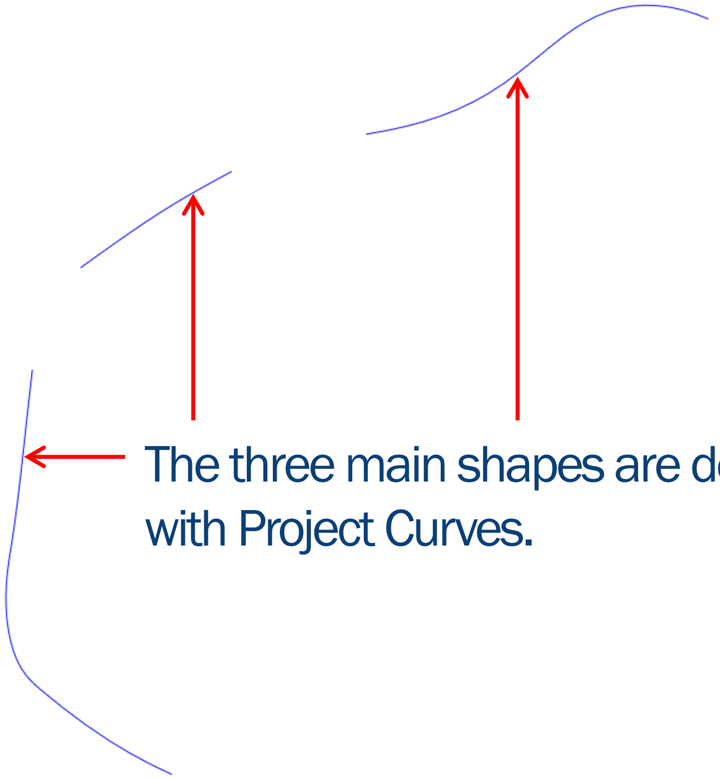


Style spline points are manipulated until the spline matches the visual intersection. Often this needs to happen in a 3D view.

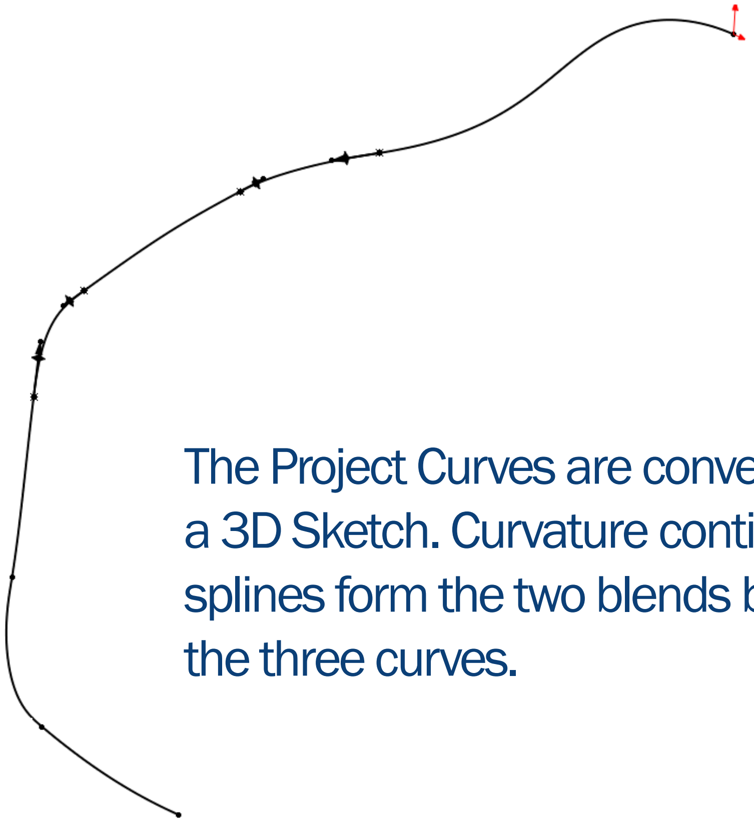


Define the Perimeter

The perimeter of the chair sweeps up and down, in and out. It would be difficult to define in a single 3D Sketch or Project Curve. Instead the shape is broken down into component parts and defined with multiple Project Curves and 3D sketches.

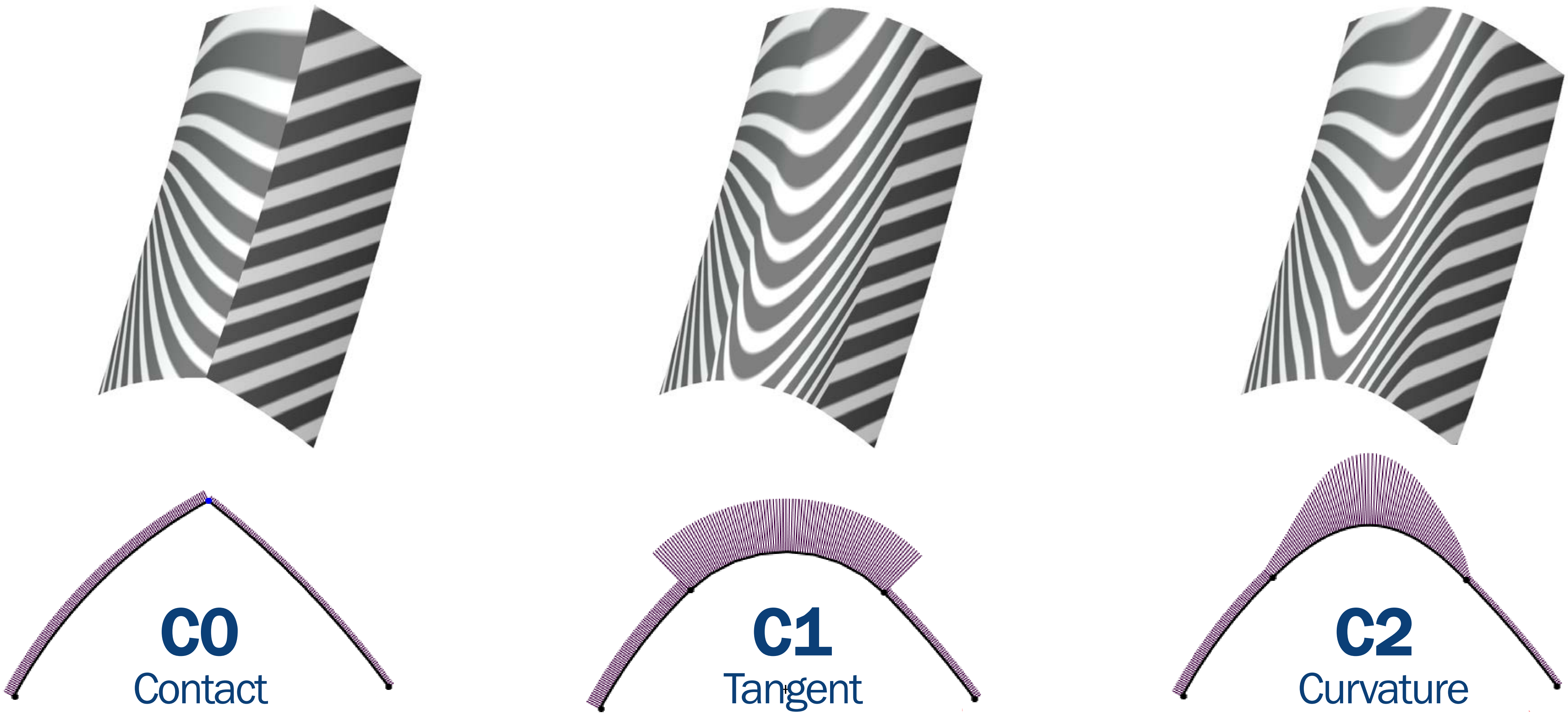


The three main shapes are defined with Project Curves.

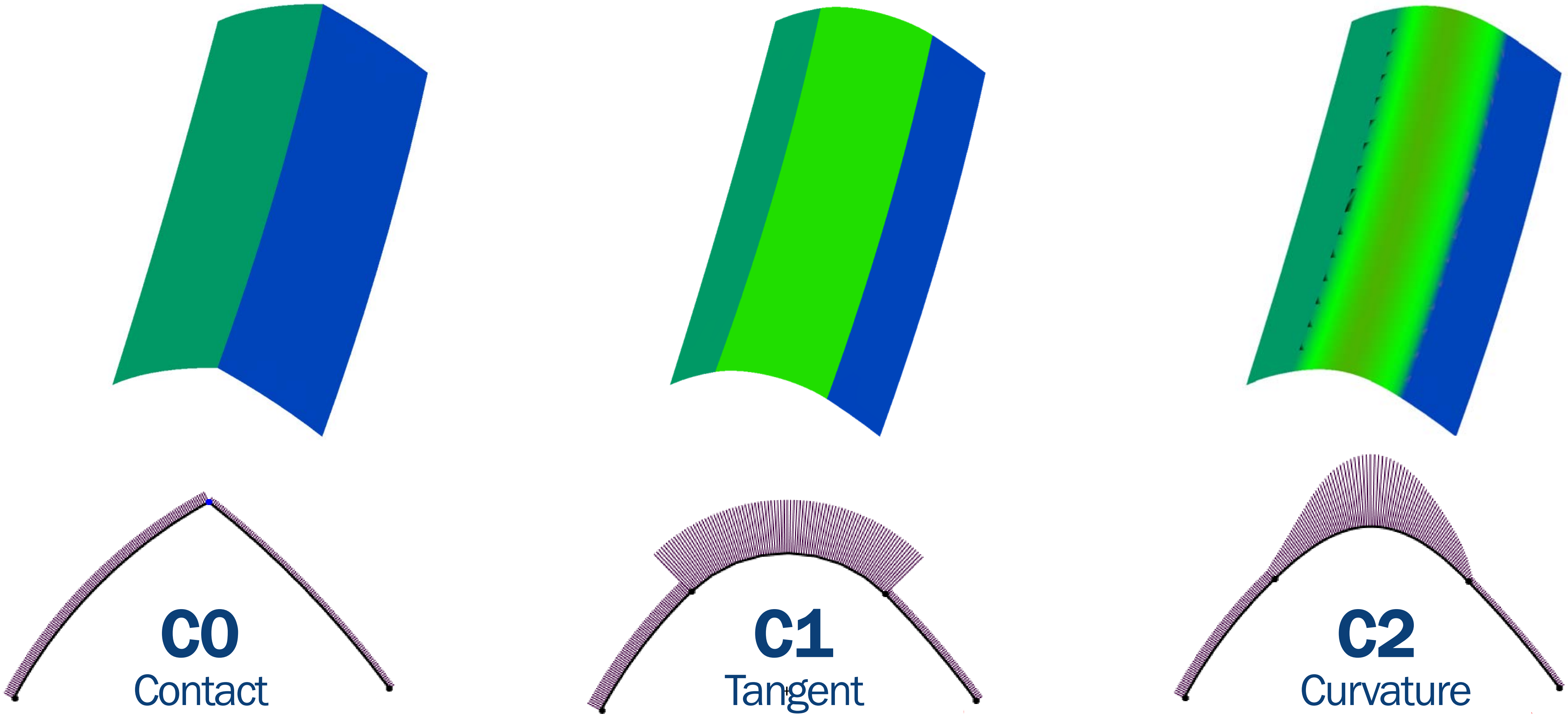


The Project Curves are converted into a 3D Sketch. Curvature continuous splines form the two blends between the three curves.

Surface Continuity



Surface Continuity



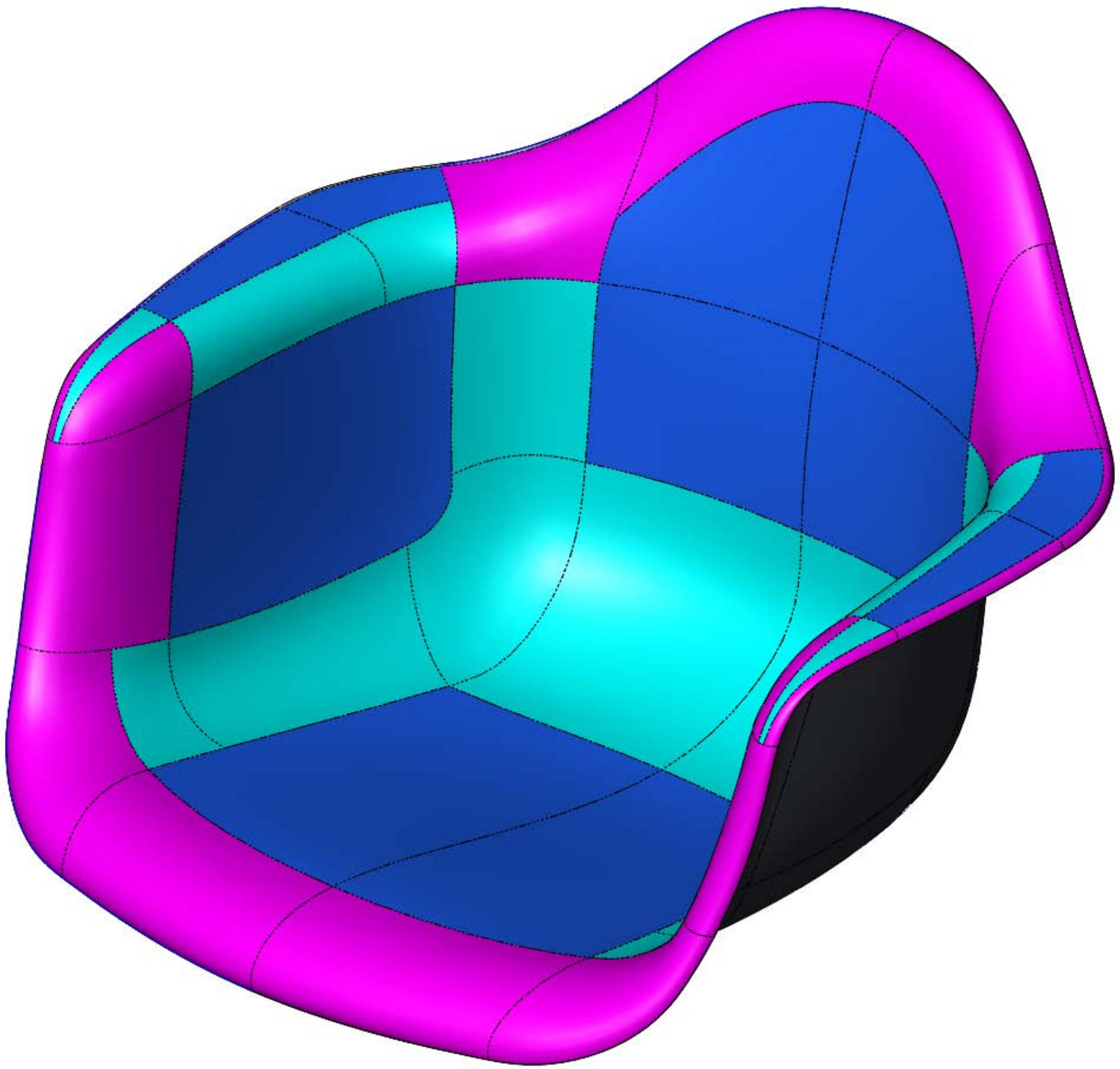
Surface Layout

Break up the form of the chair into 3 types of surfaces. This forms the basis for the Patch Layout that will dictate where surface sections and 3D curves are generated.

Primary Surfaces are large and relatively flat.

Blend Surfaces connect Primary Surfaces together.

Transition Surfaces complete the areas between regions of the chair.

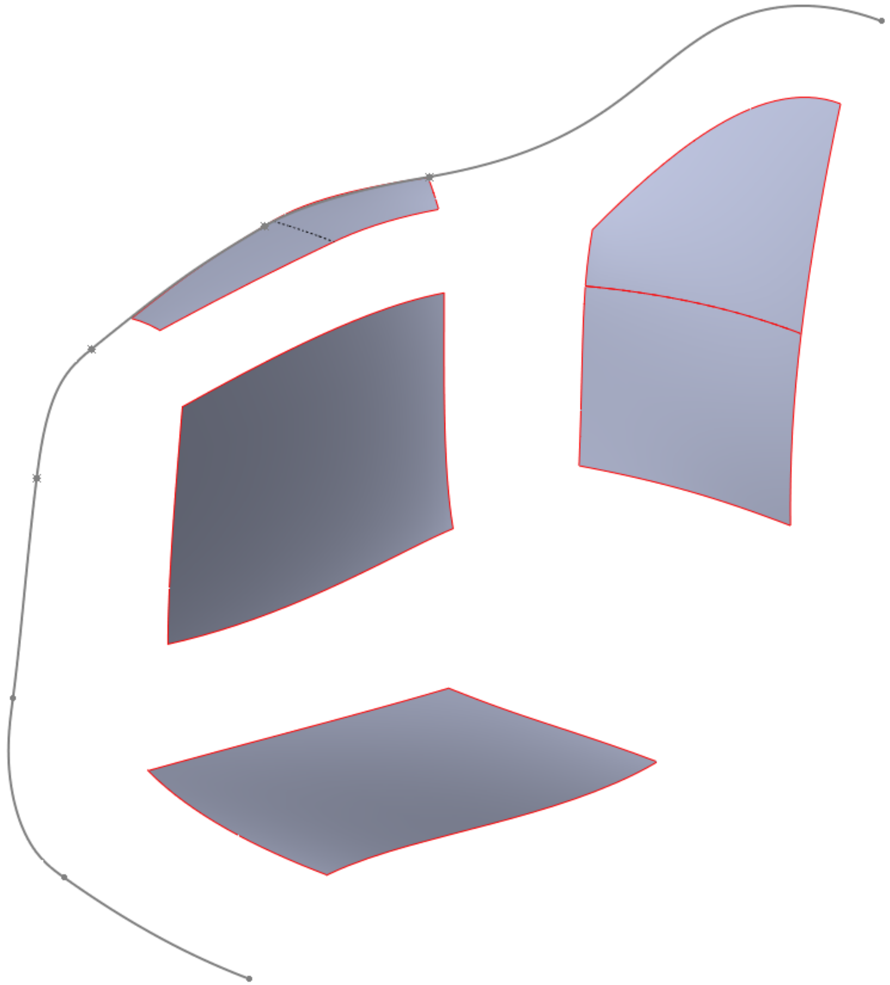


Primary Surfaces

Primary Surfaces consist of 4 sided Boundary Surfaces constructed from 2D sketches, 3D sketches and Project Curves.

Section surfaces will be used to help trace sketches over the scan data.

Because the chair is symmetric, one half will be modeled and then mirrored.

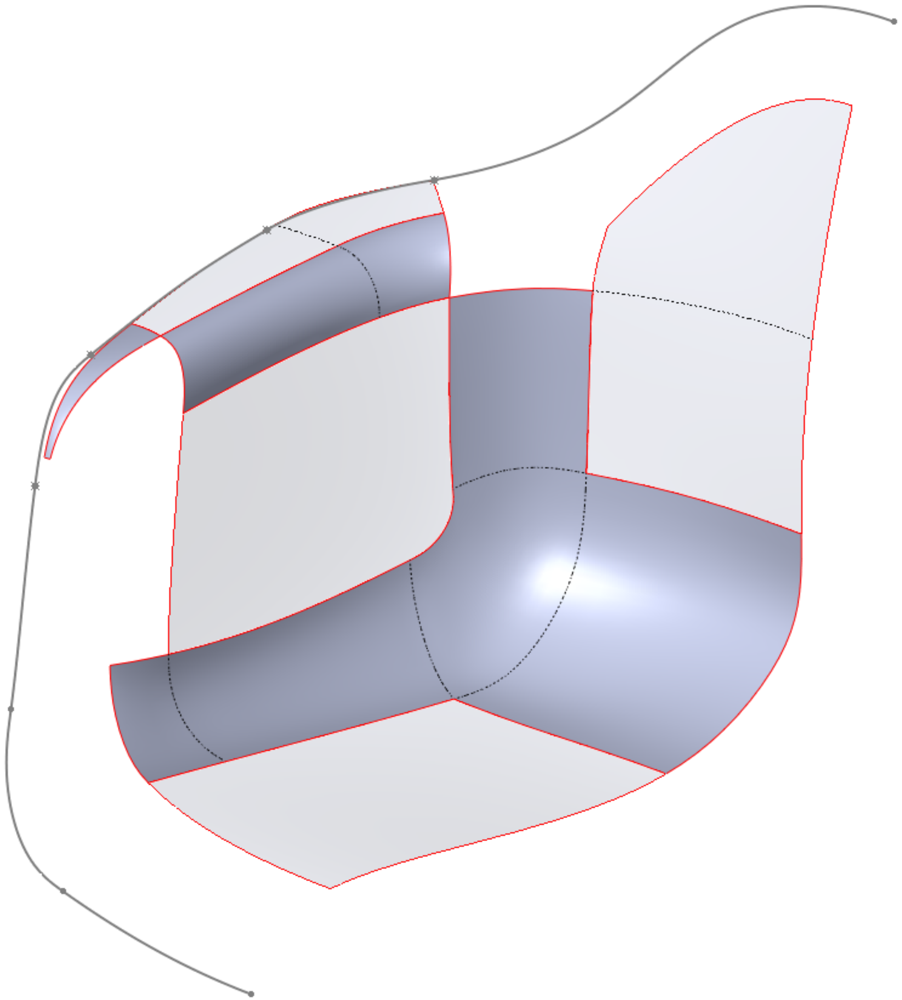


Blend Surfaces

Blend surfaces consist of 4 sided Boundary Surfaces constructed from existing model edges with 2D sketches or 3D sketches defining the blend between two Primary Surfaces.

Blend Surfaces differ from Fillets as the shape is precisely defined by the operator instead of the software.

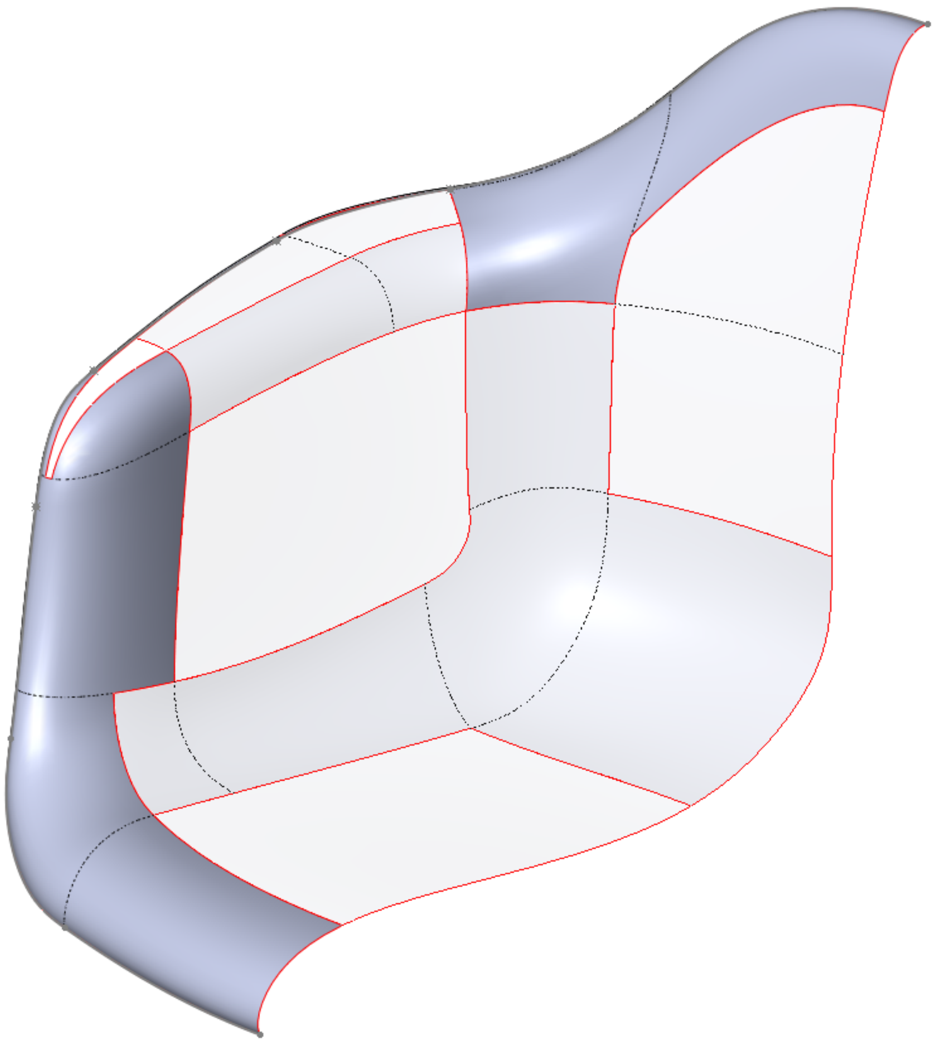
Hand sculpting each surface mimics the way the original form was sculpted by hand. It allows precise matching of the scan data.



Transition Surfaces

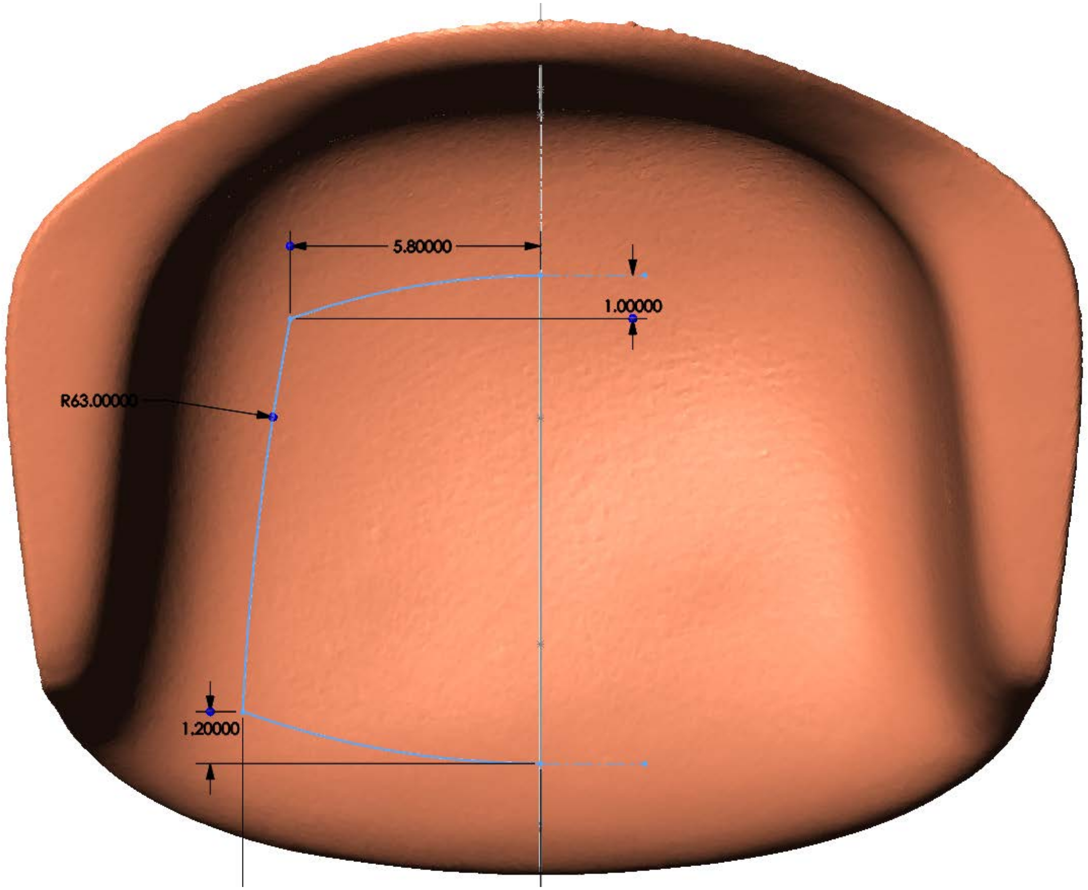
Transition Surfaces are 4 sided Boundary Surfaces or 3, 5 or more sided Surface Fills. They are constructed from 2D sketches, Project Curves, 3D sketches and existing model edges.

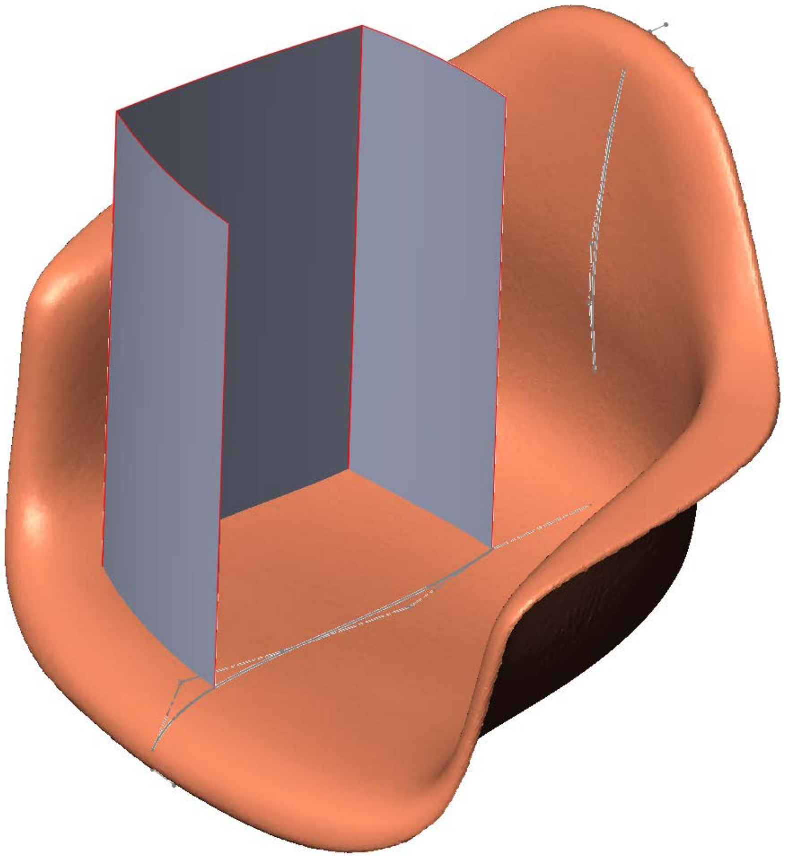
Transition surfaces connect the different regions of the chair together. They are the last step in surface modeling the chair.



Section Surfaces

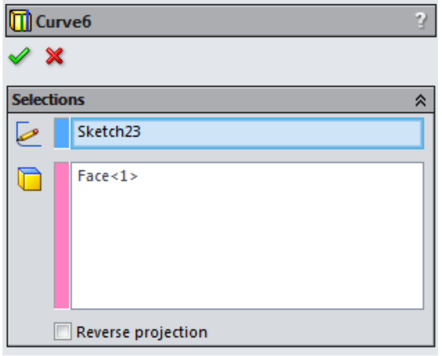
Sections surfaces are created from sketches on the default planes. The sketch approximates the start of the blend surfaces. Dimensions adjust the sketch after creation to match the scan.

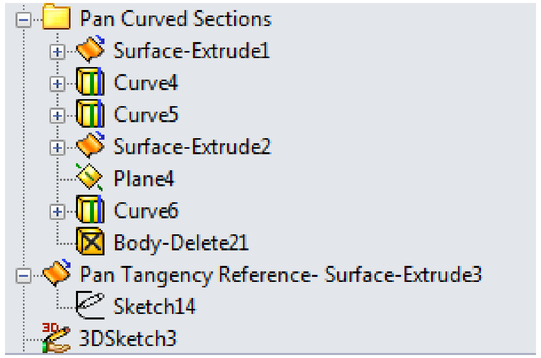


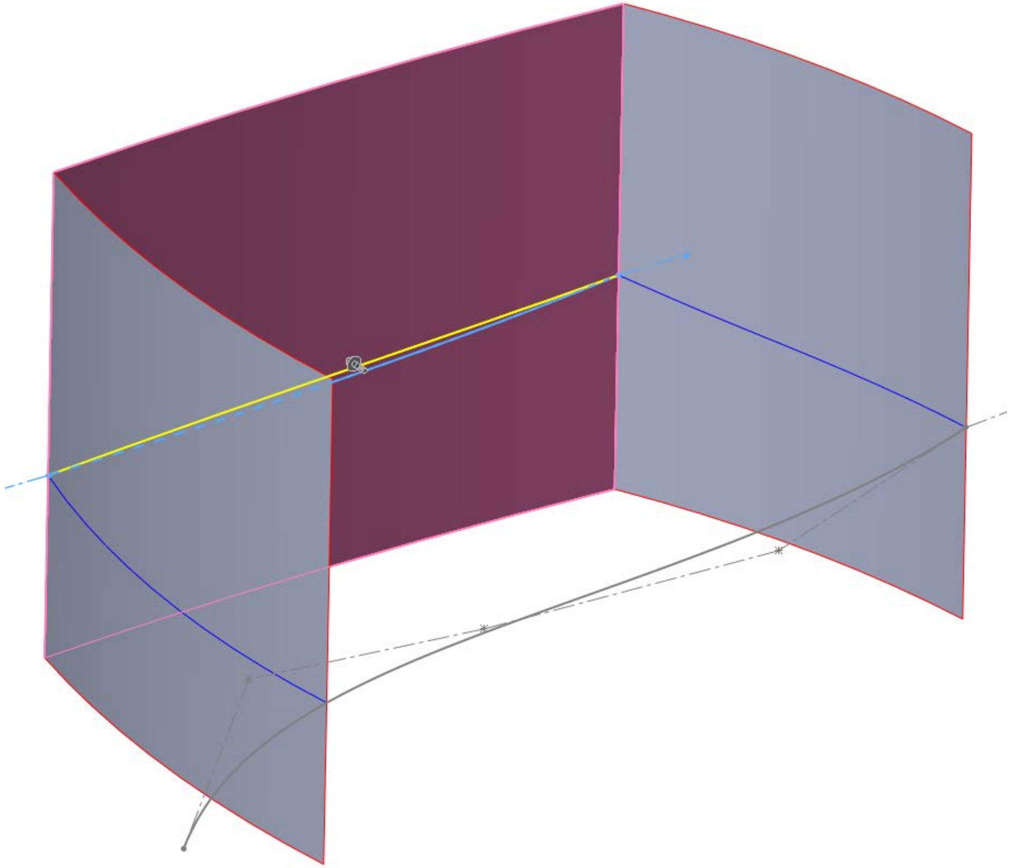


Project Curves

The sketches are projected onto section planes to create 3D curve sthat will form the profiles of the Boundary Surface creating the seat pan.





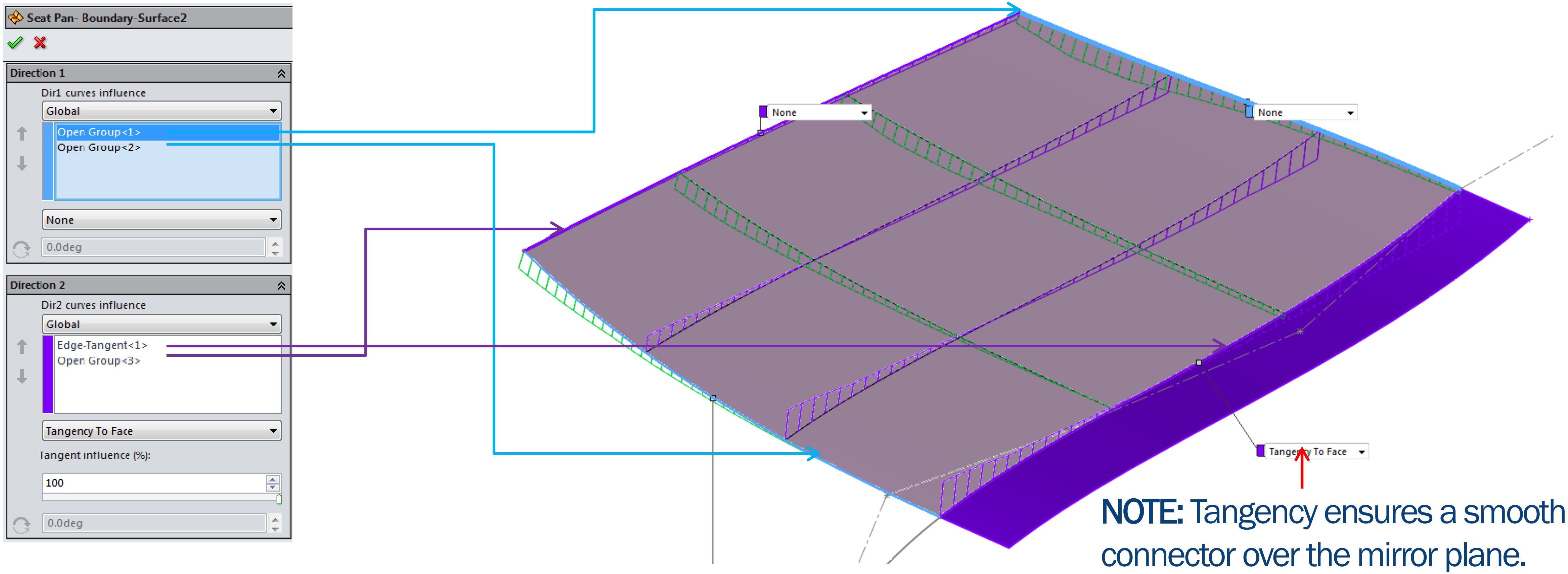


TIP: Until SW2016, absorbed curve features were not selectable in the graphics window and could not be used more than once. Work around this by converting the curves into a 3D sketch.

This has the added benefit of keeping a cleaner Feature Tree as Section Surfaces and Curves can be placed in a folder after creation. Remove un-needed Section Surfaces with a Body Delete feature.

Seat Pan Boundary Surface

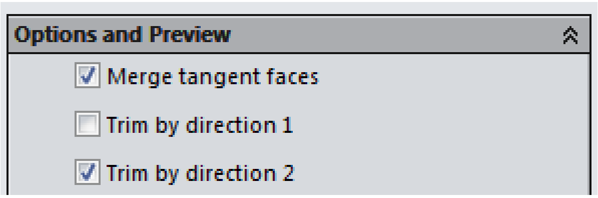
Boundary Surface creates the seat through Project Curves. A surface extrude is created from a profile on the right plane; the boundary is made tangent for correct mirroring.

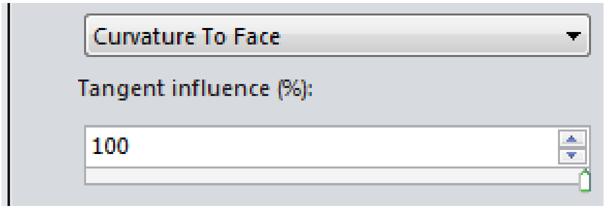


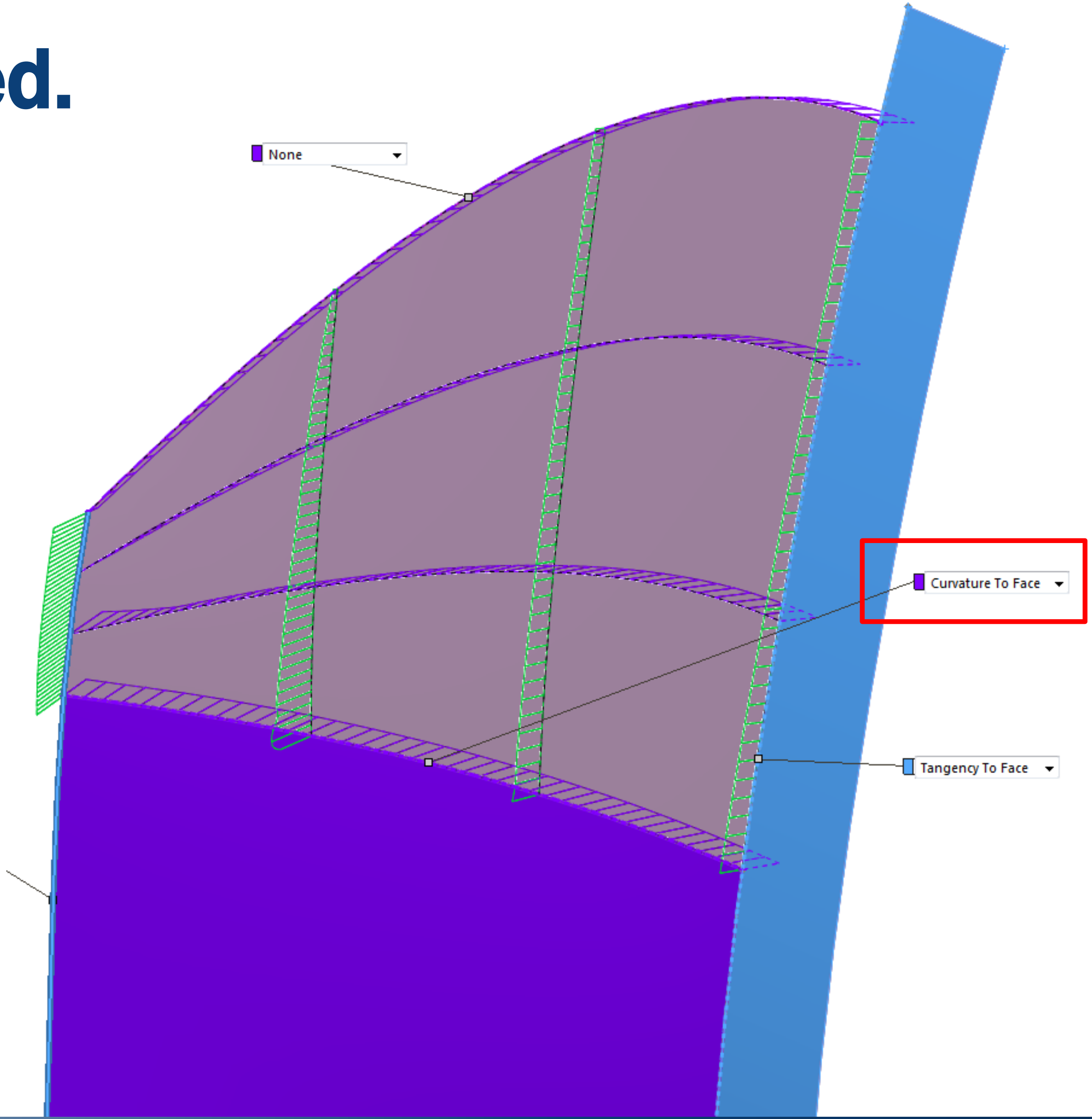
NOTE: Tangency ensures a smooth connector over the mirror plane.

Break Up Surfaces As Required.

It is better to break up an area into multiple boundary surfaces each with only 4 profiles instead of adding additional profiles to try and define a shape. Connect the surfaces with the Curvature option.





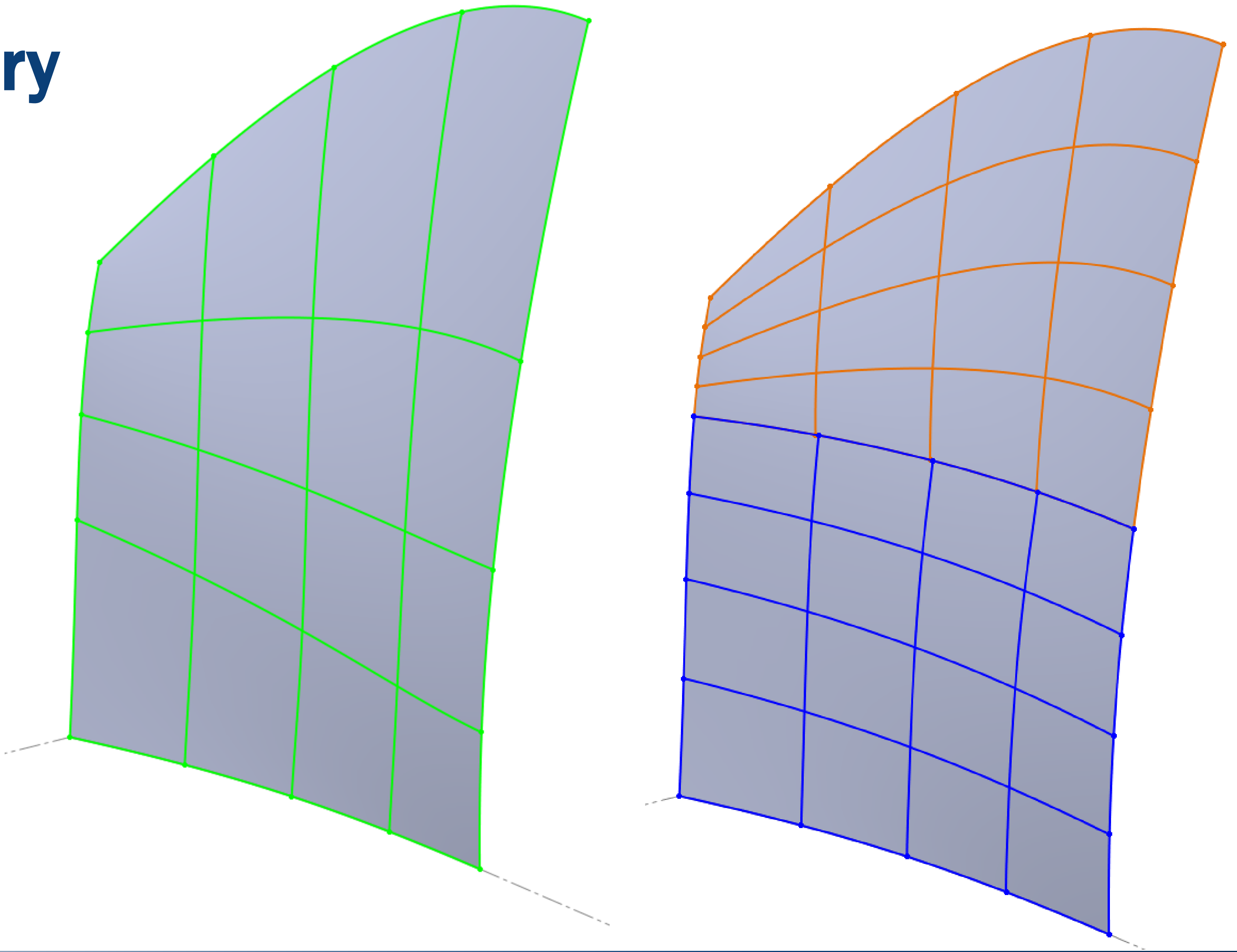


TIP: Enable the Trim by Direction option to build the curve only through the profiles in Direction 2, and not continuing the full length of Direction 1.

TIP: Increase the tangent influence slider to give more preference to the shape of set of profiles. It can be used to tame errant curvature combs.

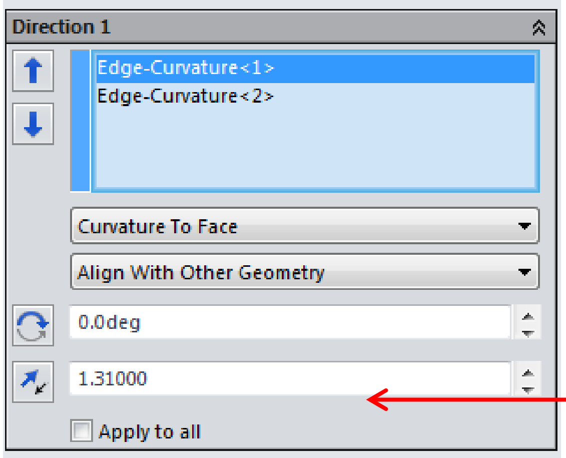
Surface Layout Theory

By splitting the surface up, the UV curves (the underlying math of the surface) can better be controlled. Ideally, the UV curves should match the natural flow of the surface.



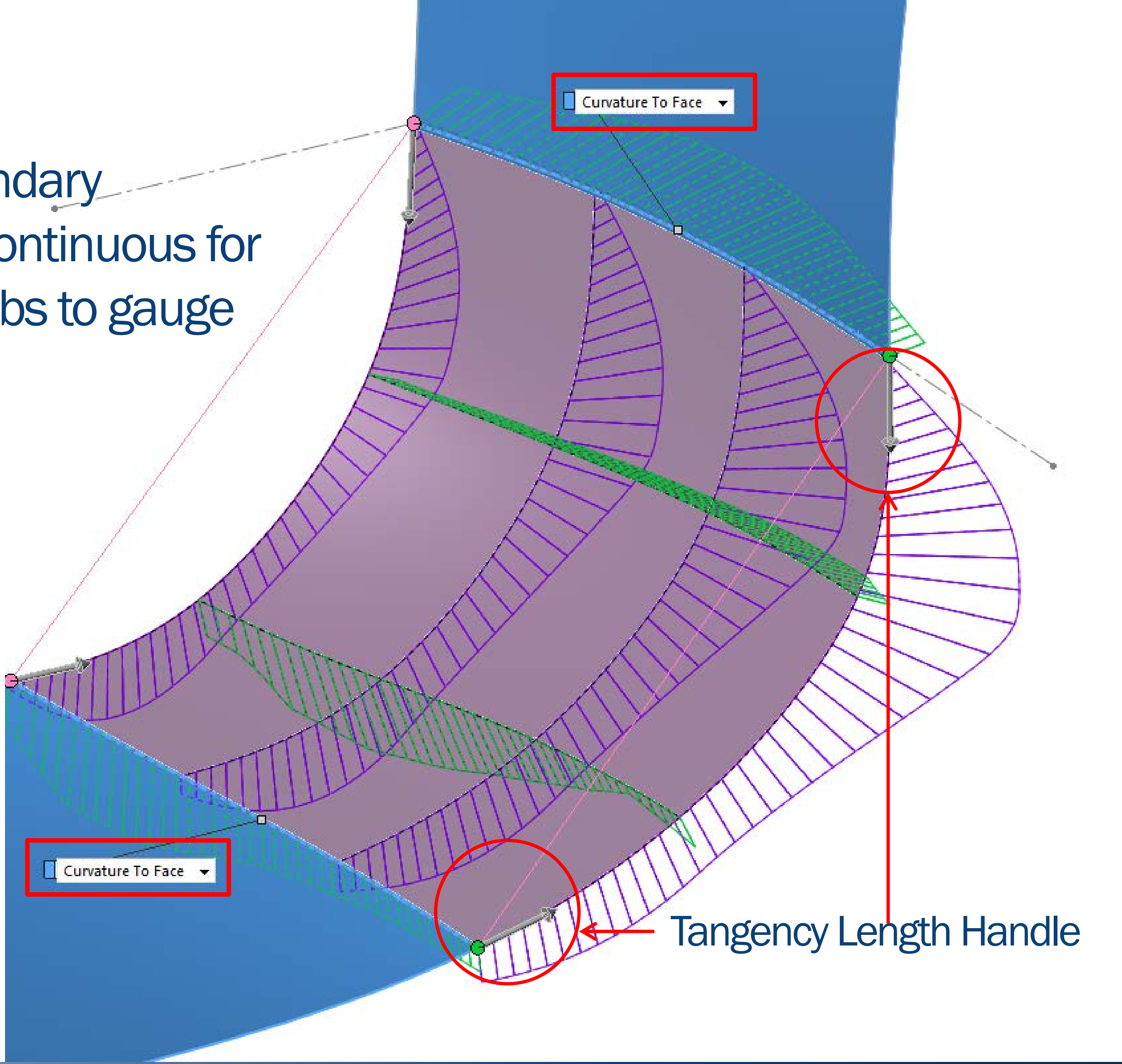
Blend Surfaces

Connect Primary Surfaces together with Boundary Surfaces. Connections are made curvature continuous for a smooth connection. Use the curvature combs to gauge the quality of the blend.



Tangency Length

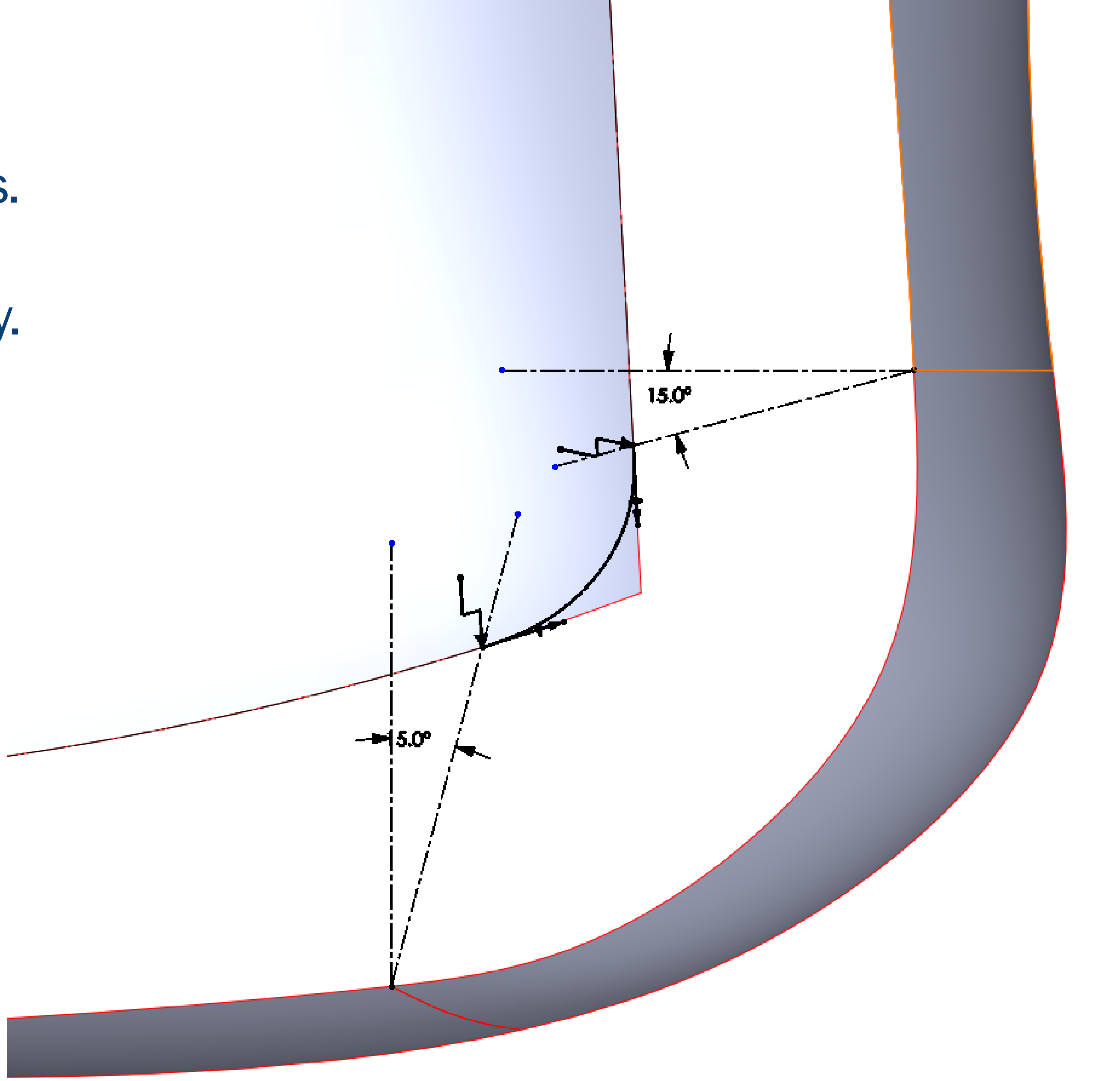
TIP: Shape the blend surface by manipulating the tangency length. The handles can also be directly manipulated in the graphics window.



Tangency Length Handle

Trim as Required

Boundary Surfaces should always have 4 sides. To create the corner blend surface, trim the sharp of the edge of the seat side surface away. Add construction lines to connect the trim spline to the existing model edges.



TIP: The trim spline should be smaller than the edge it is being blended with. Angles can quickly alter the size of the spline to dial in the exact trim shape.

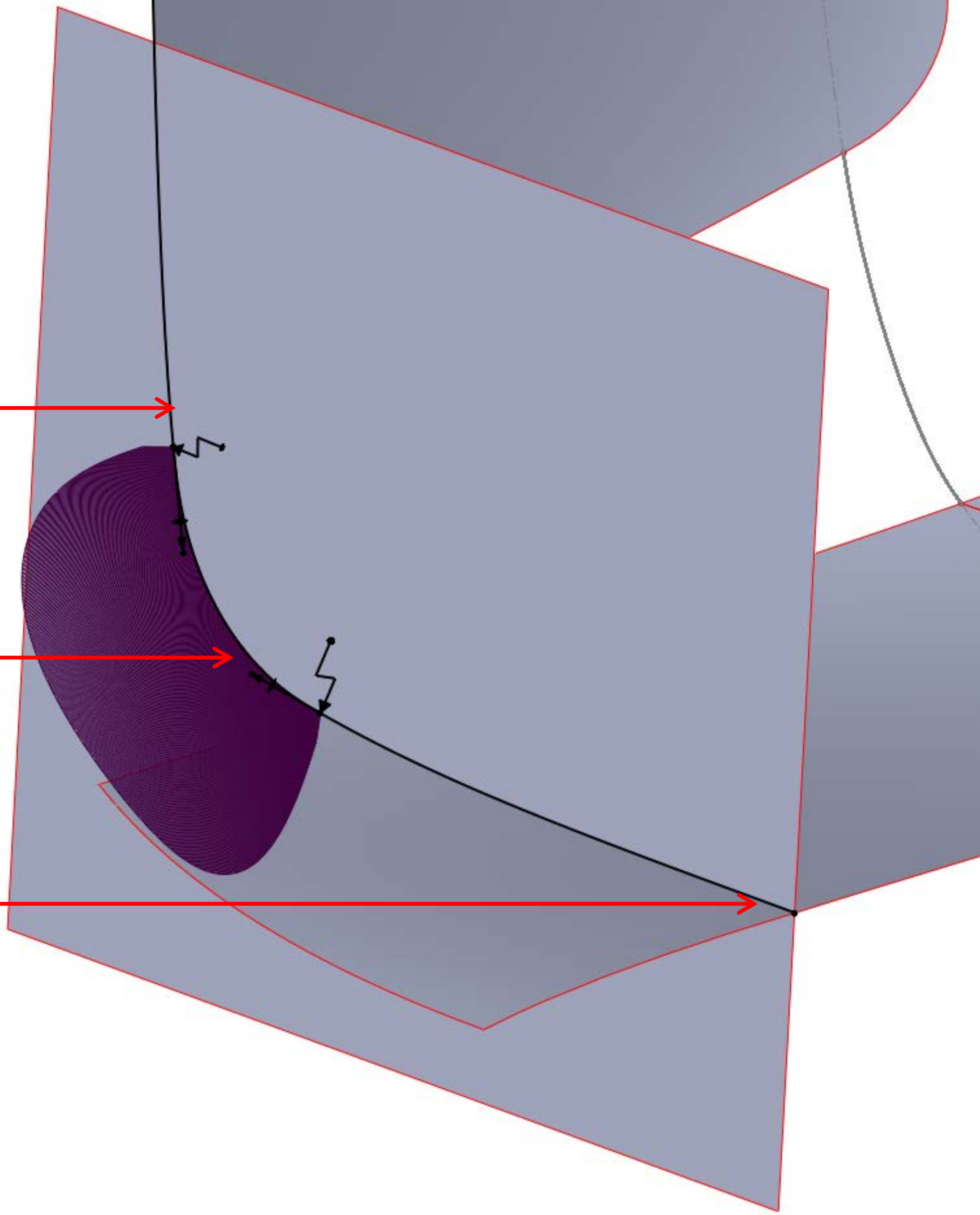
Create Blend Profiles

For more exact control of Blend Surfaces, create additional profiles on sketch planes.

TIP: Do not connect splines to model edges. Convert the edge into the sketch and then connect with the equal curvature relation.

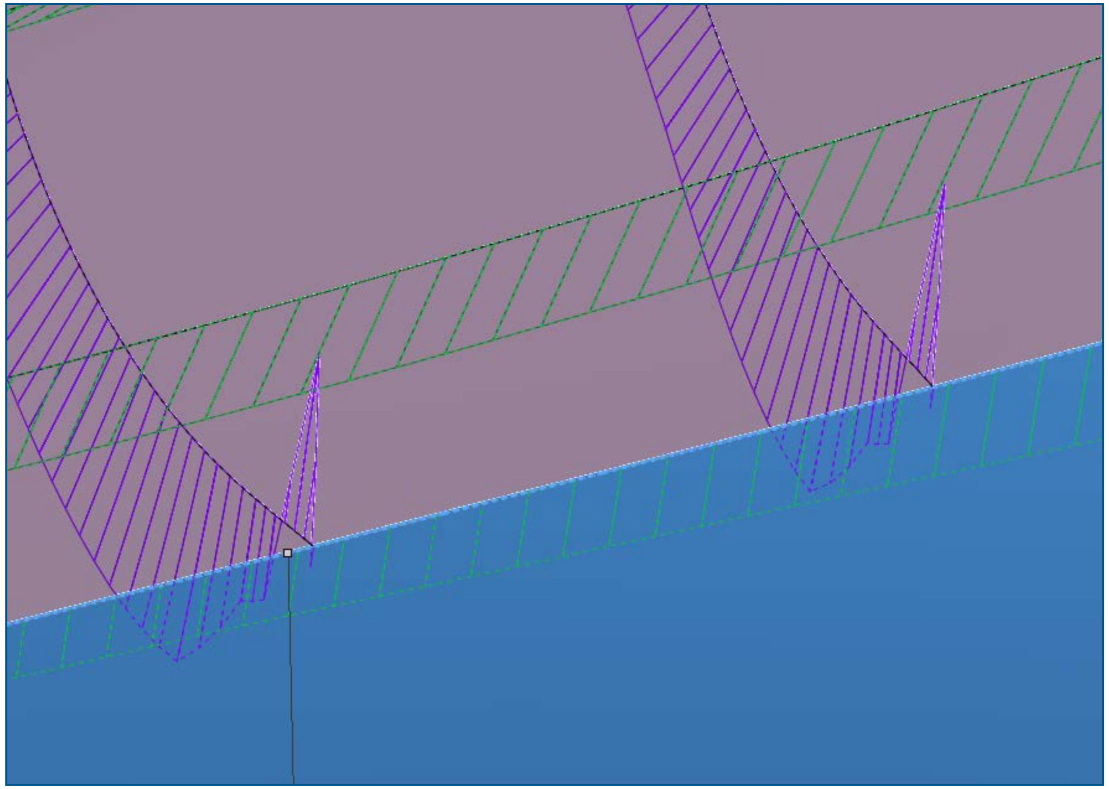
TIP: Adjust spline handles and evaluate the changes with the curvature combs. Try for the smoothest possible shape that matches the scan as closely as possible.

TIP: Add intersection curves to add the equal curvature relation where there is no model edge.

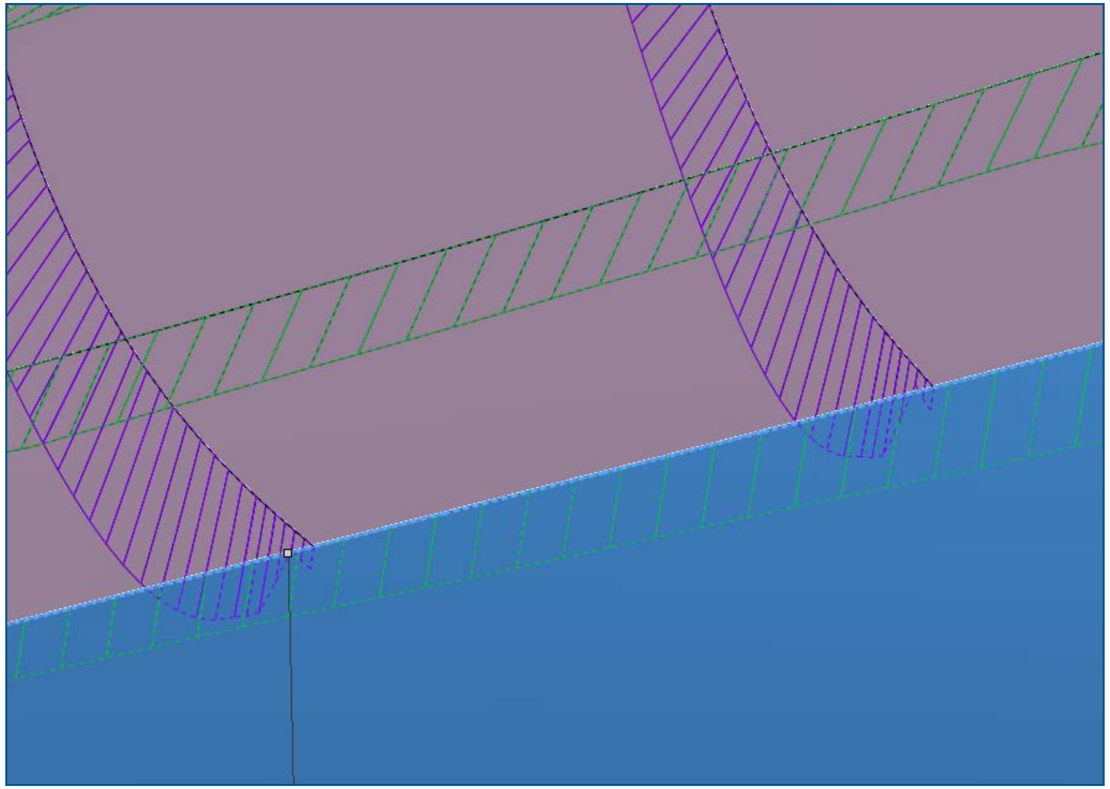


Tangent Influence

When there are profiles in both directions, use the tangent influence slider to give more preference to the shape of the Primary Surfaces. This can correct curvature spikes.



0% Tangent Influence

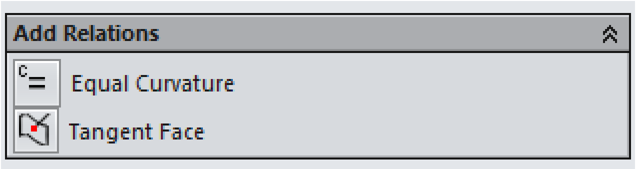


100% Tangent Influence

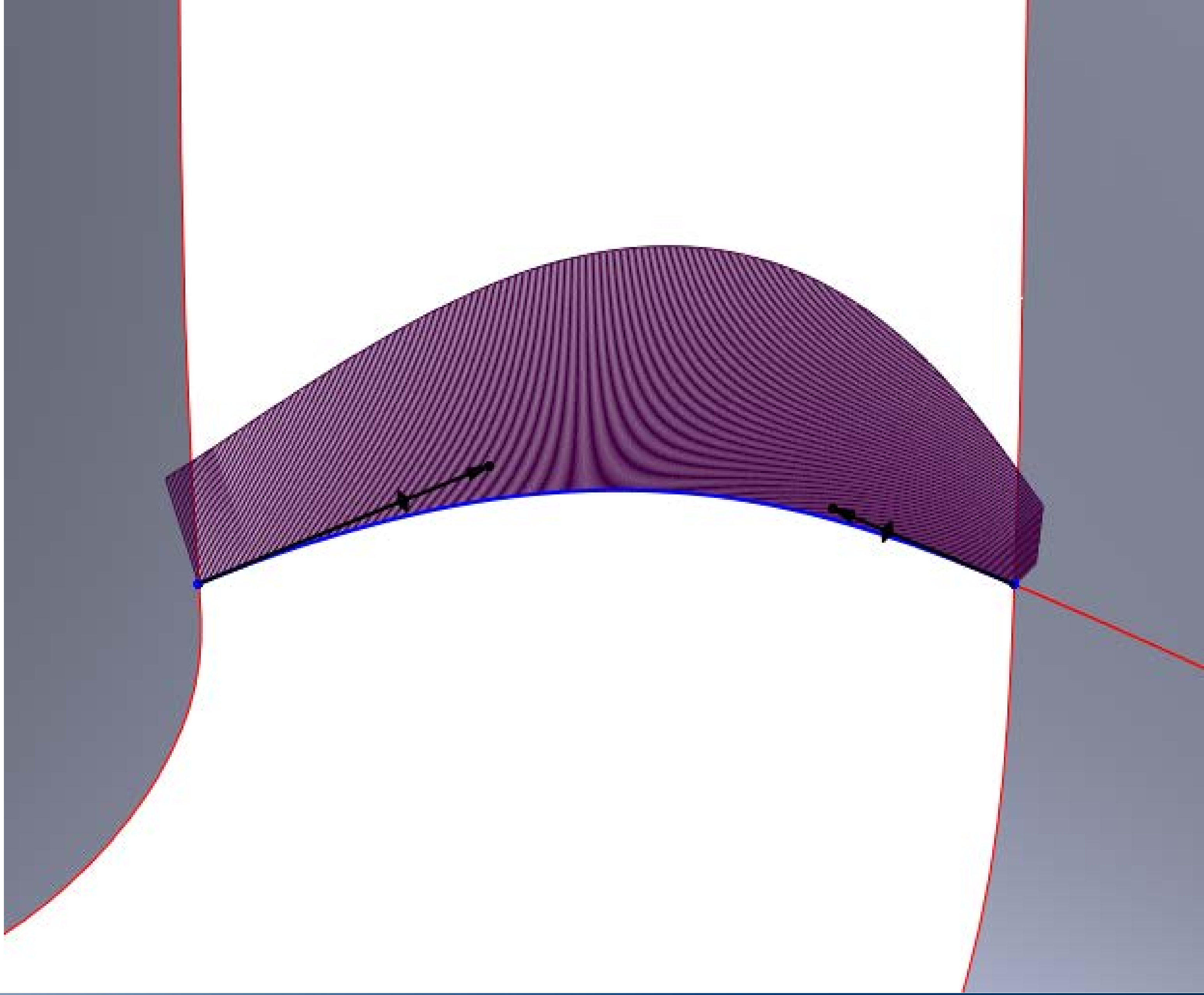
3D Sketches

Blend profiles can also be created with 3D sketches.

TIP: Add an equal curvature relation to a 3D sketch by using the Equal Curvature Face relation.

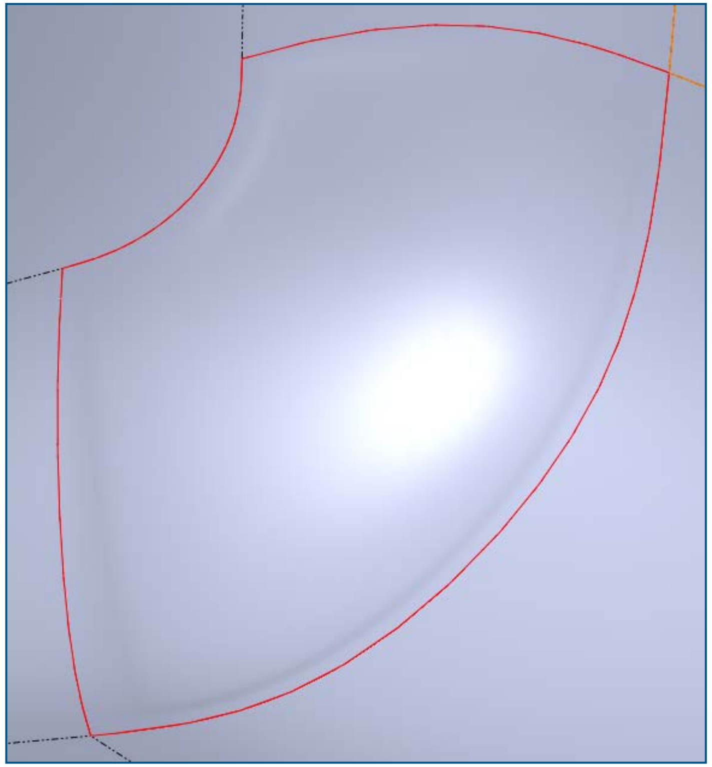


Select the sketch entity, model edge and face.

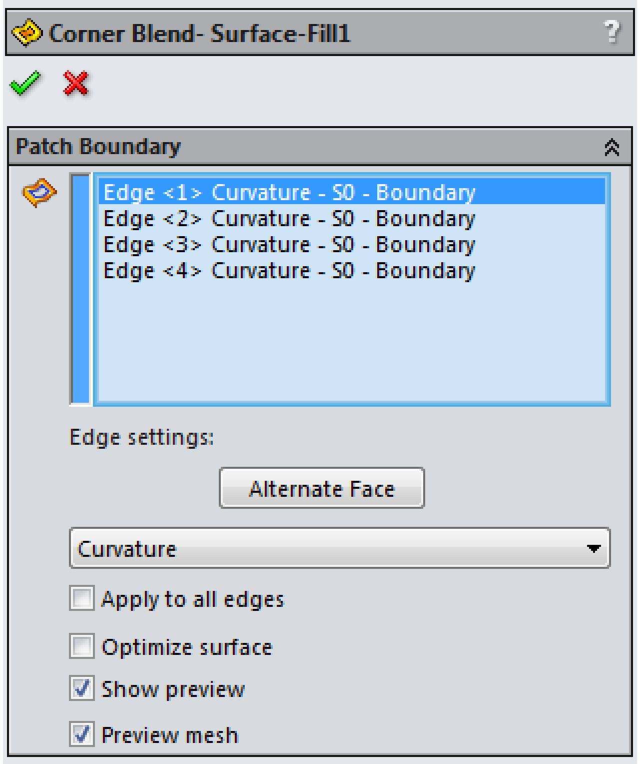


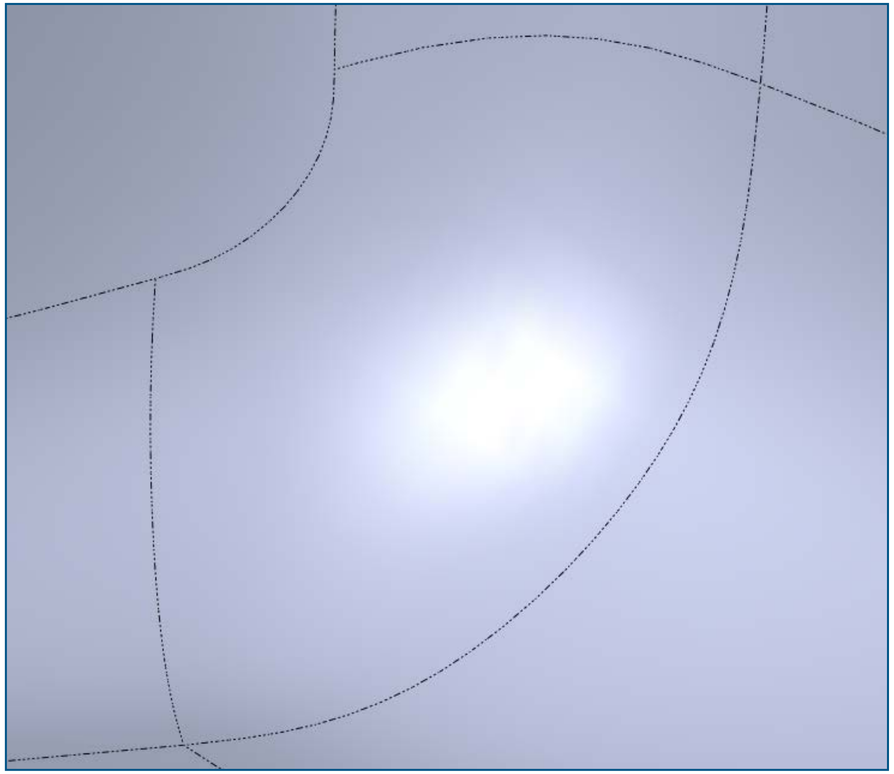
Complete Corner Blends

Occasionally, Boundary Surface produces a surface with ripples, creases or kinks that cannot be ironed out (or made worse) by using the tangency influence slider. Try Surface Fill Instead.



Boundary Surface



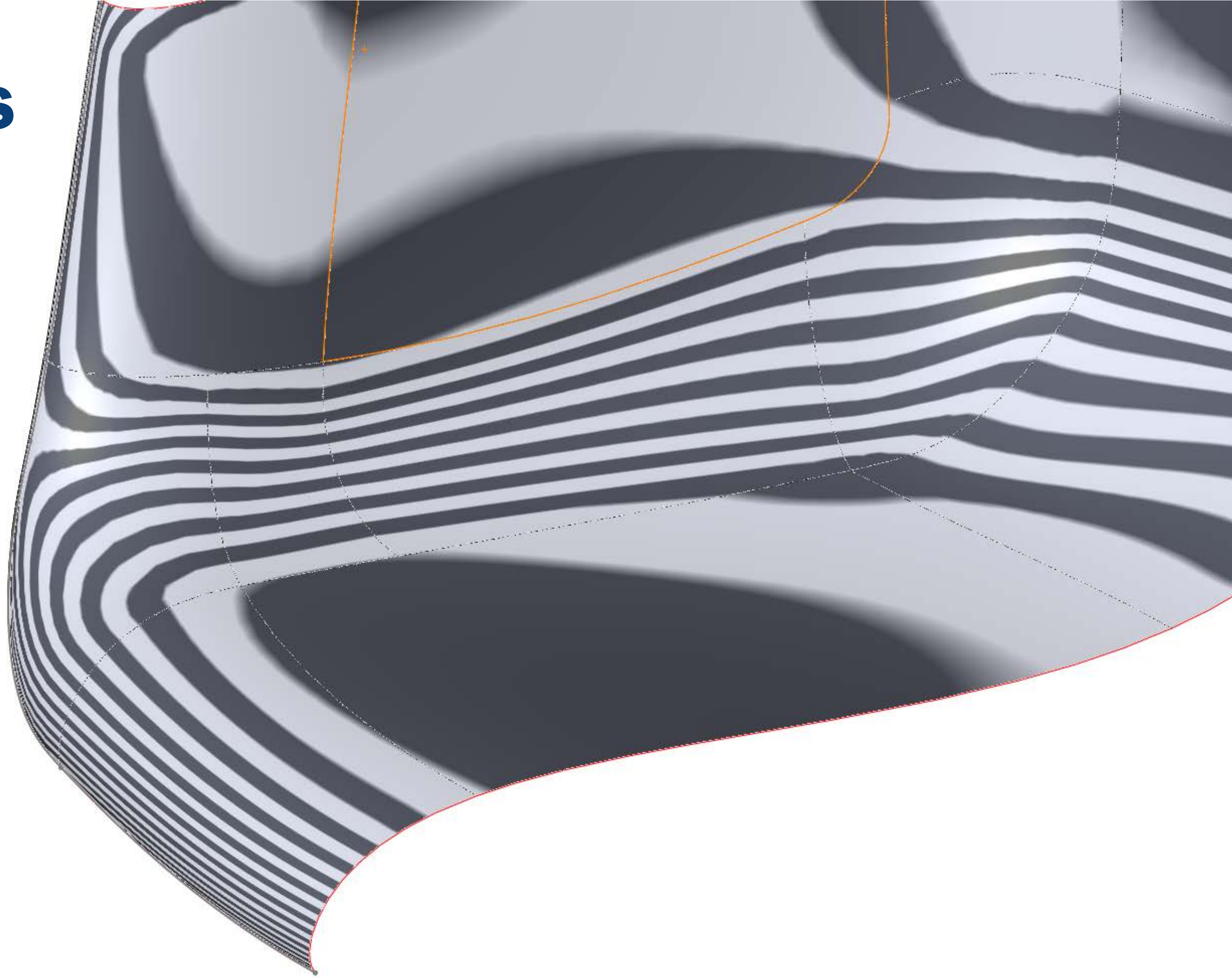


Surface Fill

Evaluating Connections Zebra Stripes

Evaluate the flow of light over the various surfaces with Zebra Stripes.

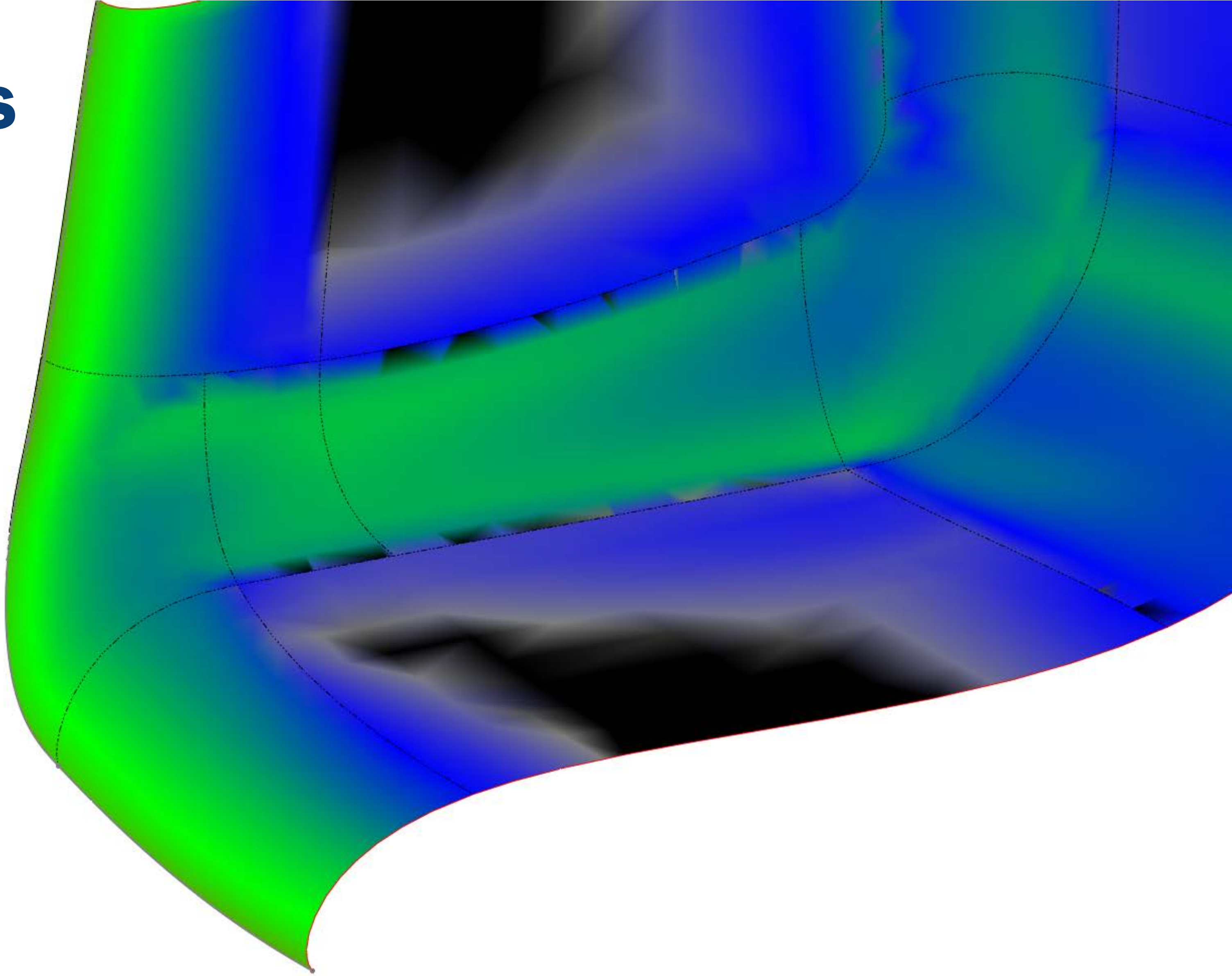
There should be no break in the zebra stripe over a surface edge. The connection should be perfectly smooth. A hard edge indicates dissimilar radii at the junction.



Evaluating Connections Curvature Display

Evaluate the flow change of curvature with curvature display.

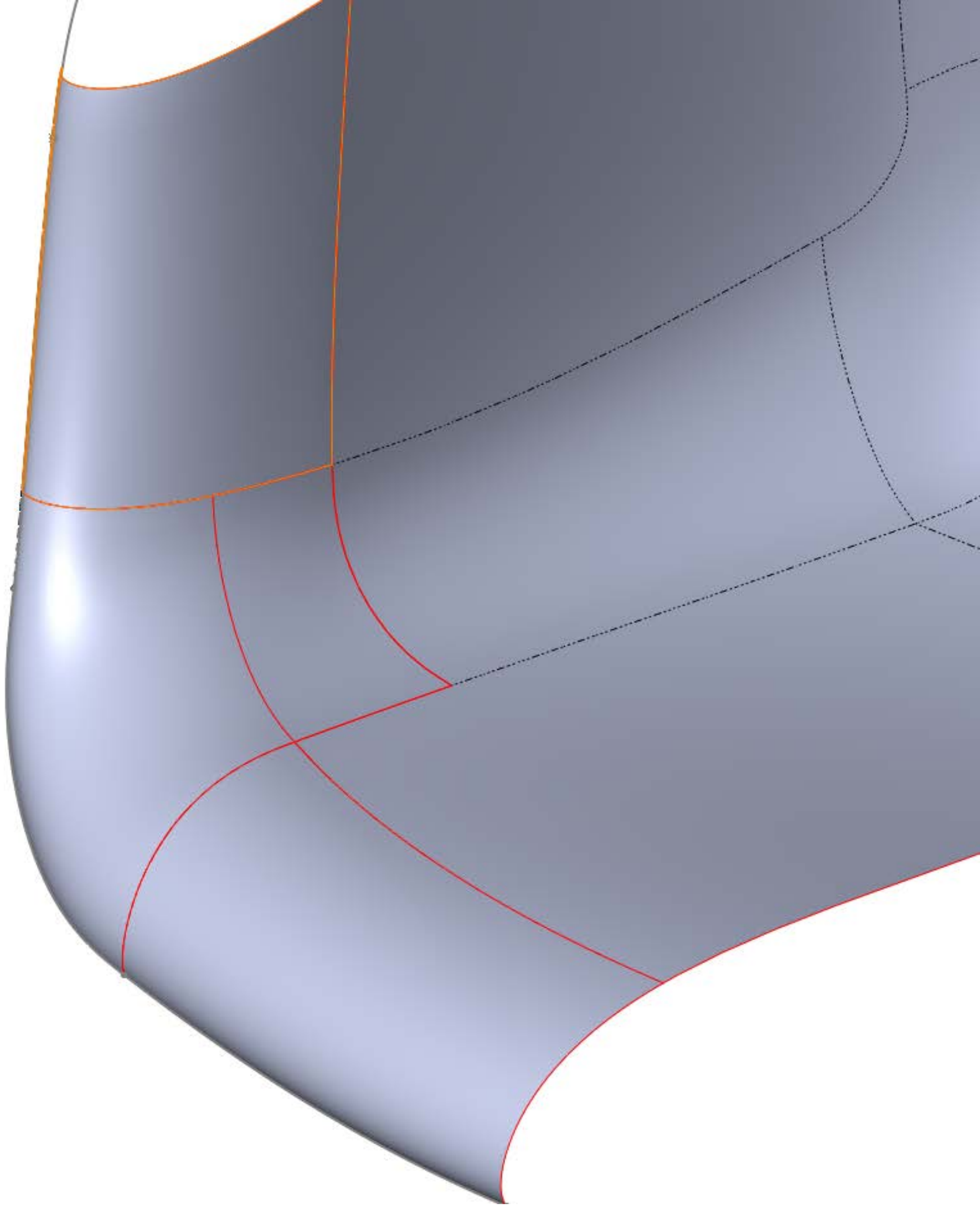
A gradual gradient indicates smooth change in curvature. A sharp color break between two surfaces indicates two different radii at the junction.



Build Transition Surfaces

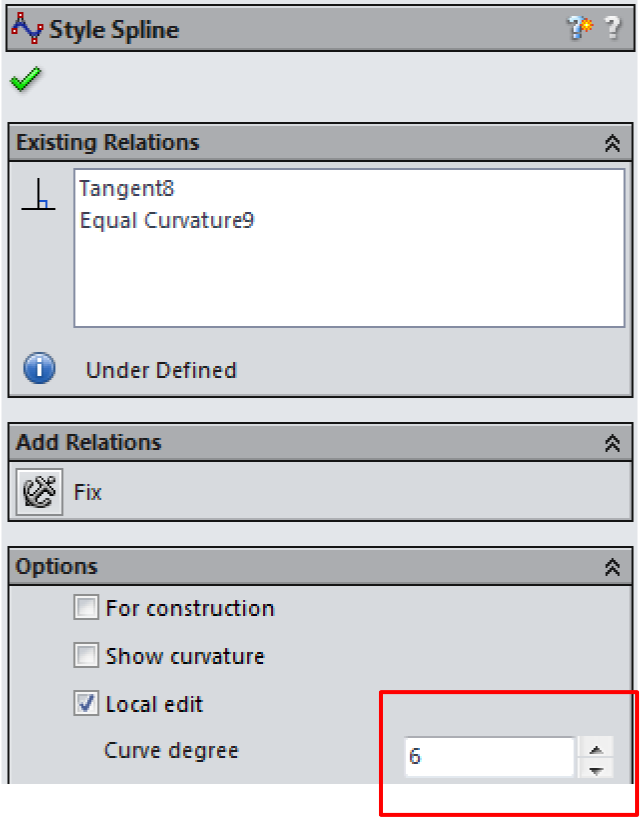
Continue to define the shape by creating section surfaces and sketching profiles on them. Create Boundary Surfaces between the existing model edges and the perimeter 3D sketch.

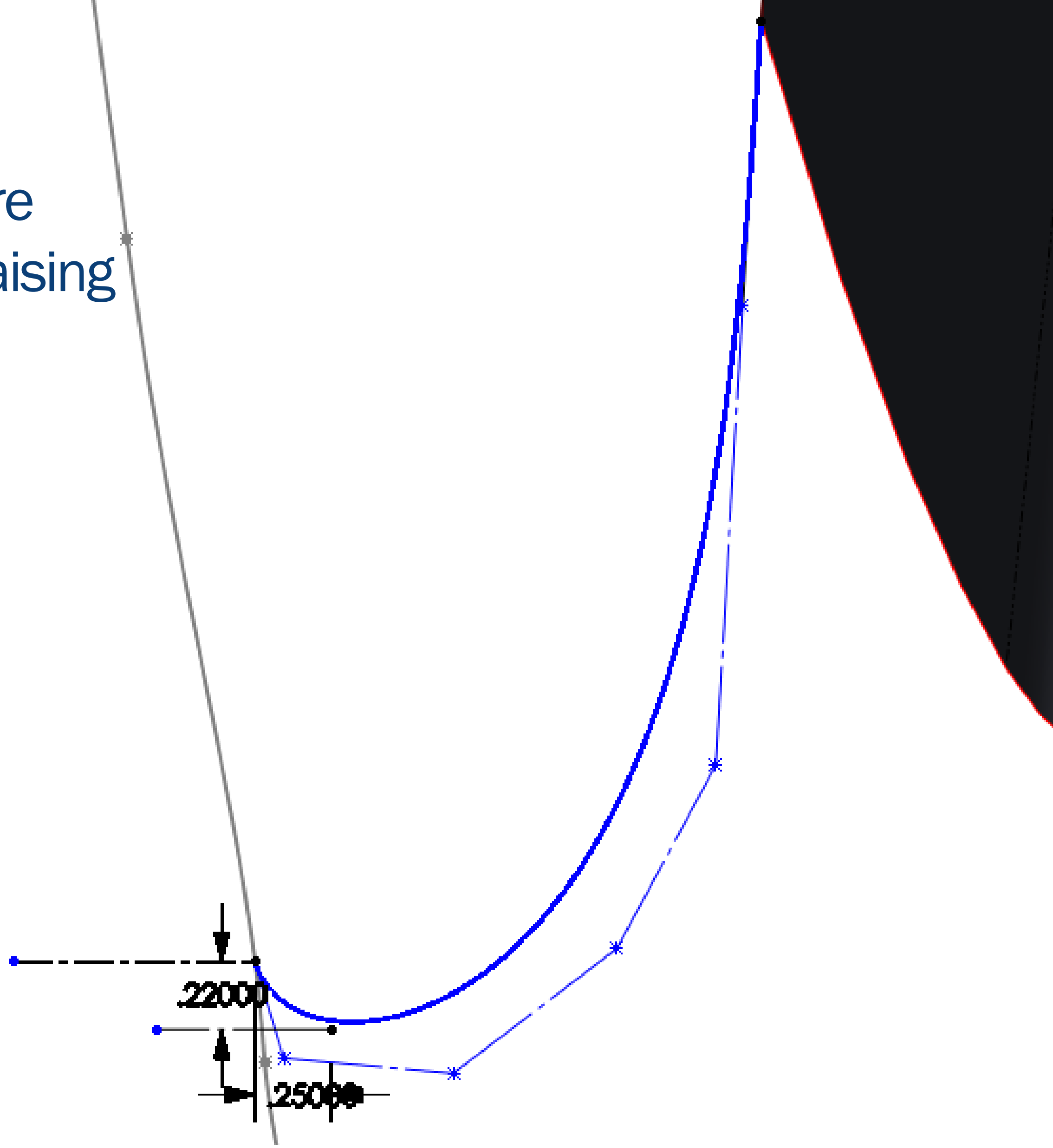
TIP: Convert segments of the perimeter 3D sketch. This allows the perimeter 3D sketch to stay at the top of the Feature Tree instead of being absorbed into a feature.



Style Splines

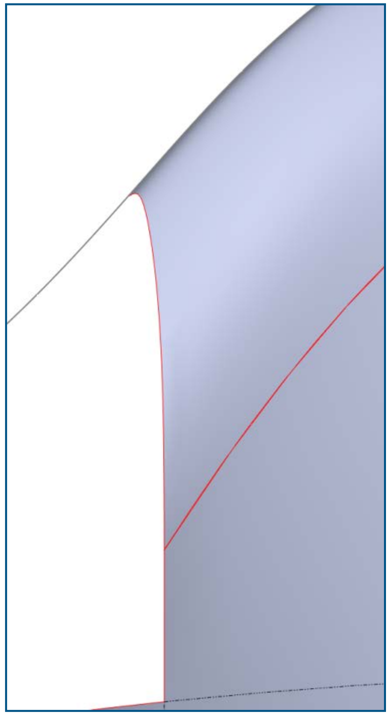
Use Style Splines when the spline changes shape more than once. Gain additional control over the spline by raising the degree of the spline.

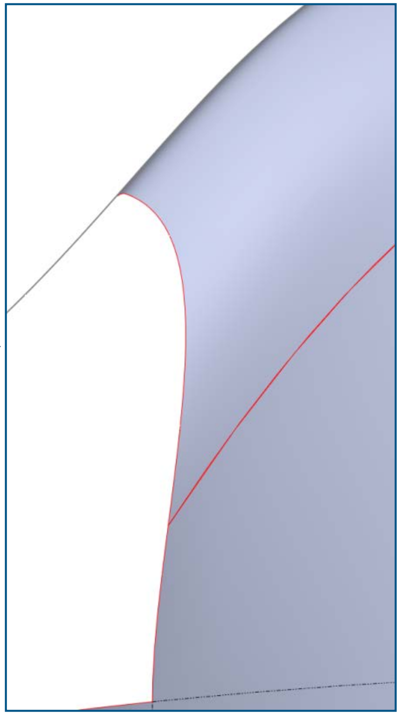


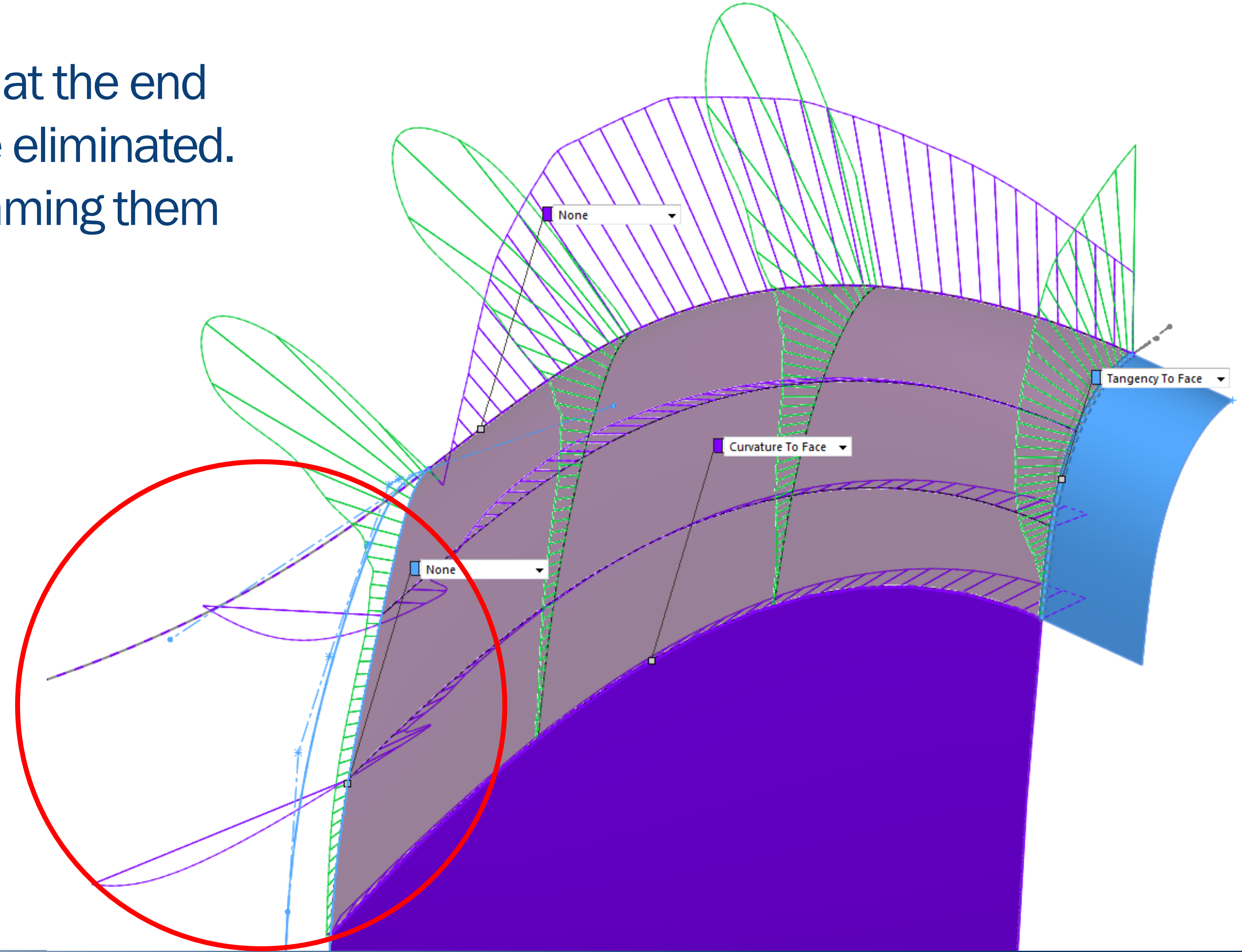


Curvature Spikes

Sometimes curvature spikes appear at the end of Boundary Surfaces and cannot be eliminated. Remove these problem areas by trimming them from the model.

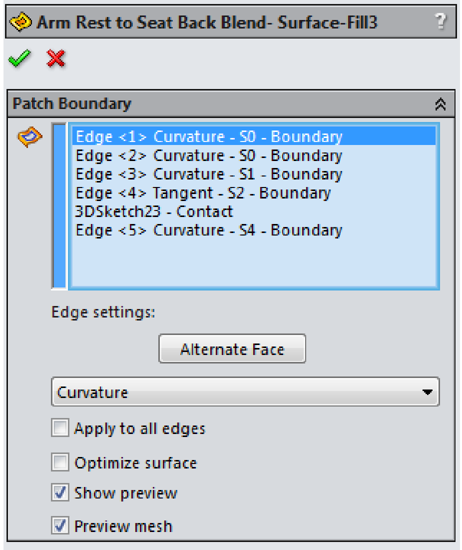


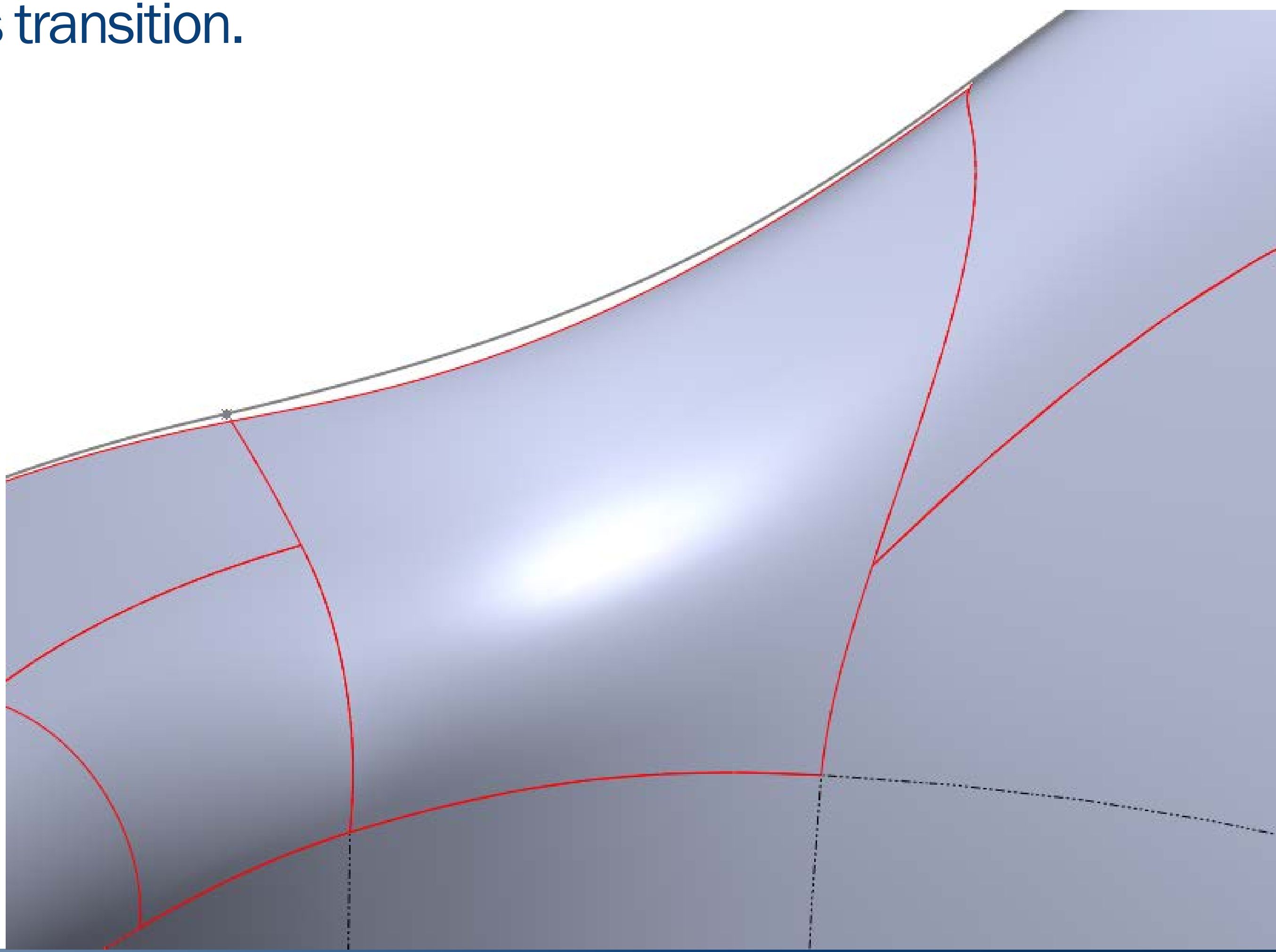




Challenging Transitions

The connection from the armrest to the seat back has differing shapes smoothly flowing into each other. Surface Fill is best at tackling this transition.

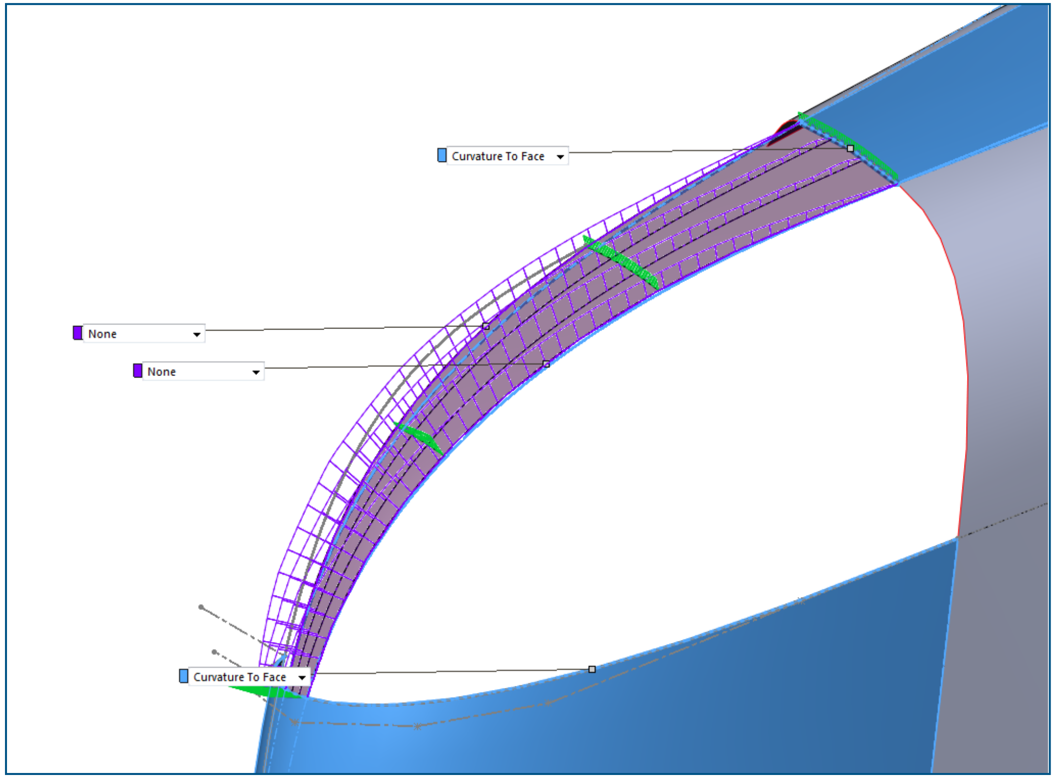


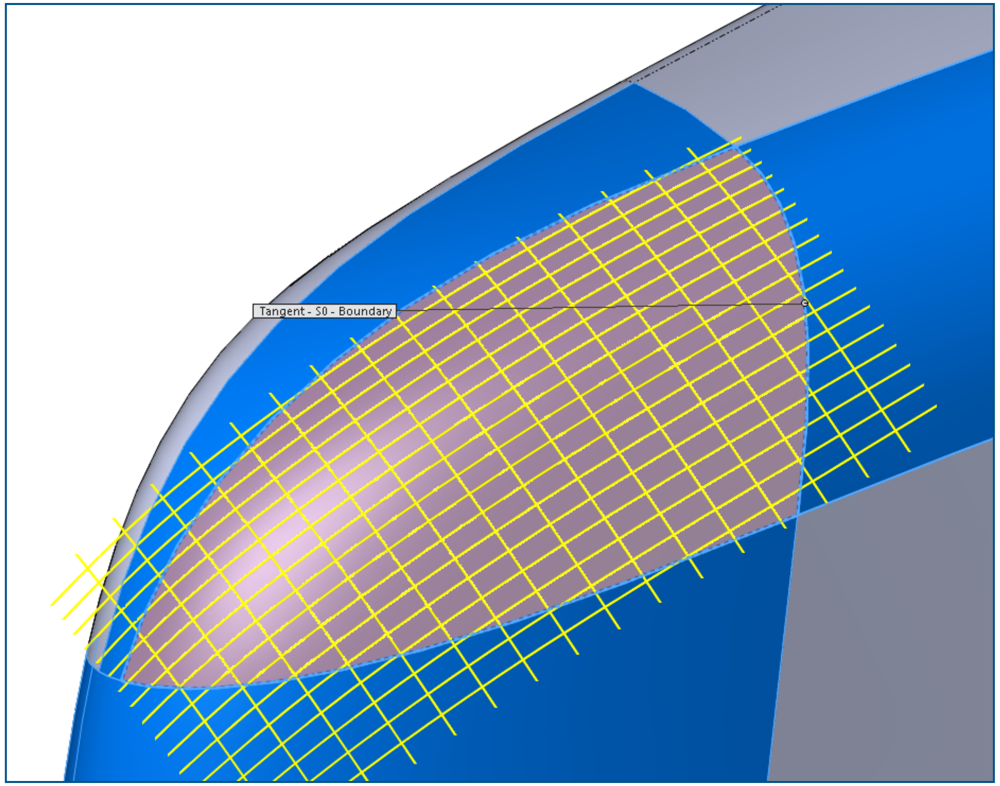


TIP: Do not default to curvature on all edges. Start with all edges on tangent and evaluate with zebra stripes and curvature display. Add curvature as required.

Guide With Boundary Surface

Instead of trying to use Surface Fill on the entire challenging front corner, guide the shape with a Boundary Surface. This will give direction to the Surface Fill that will complete the transition.

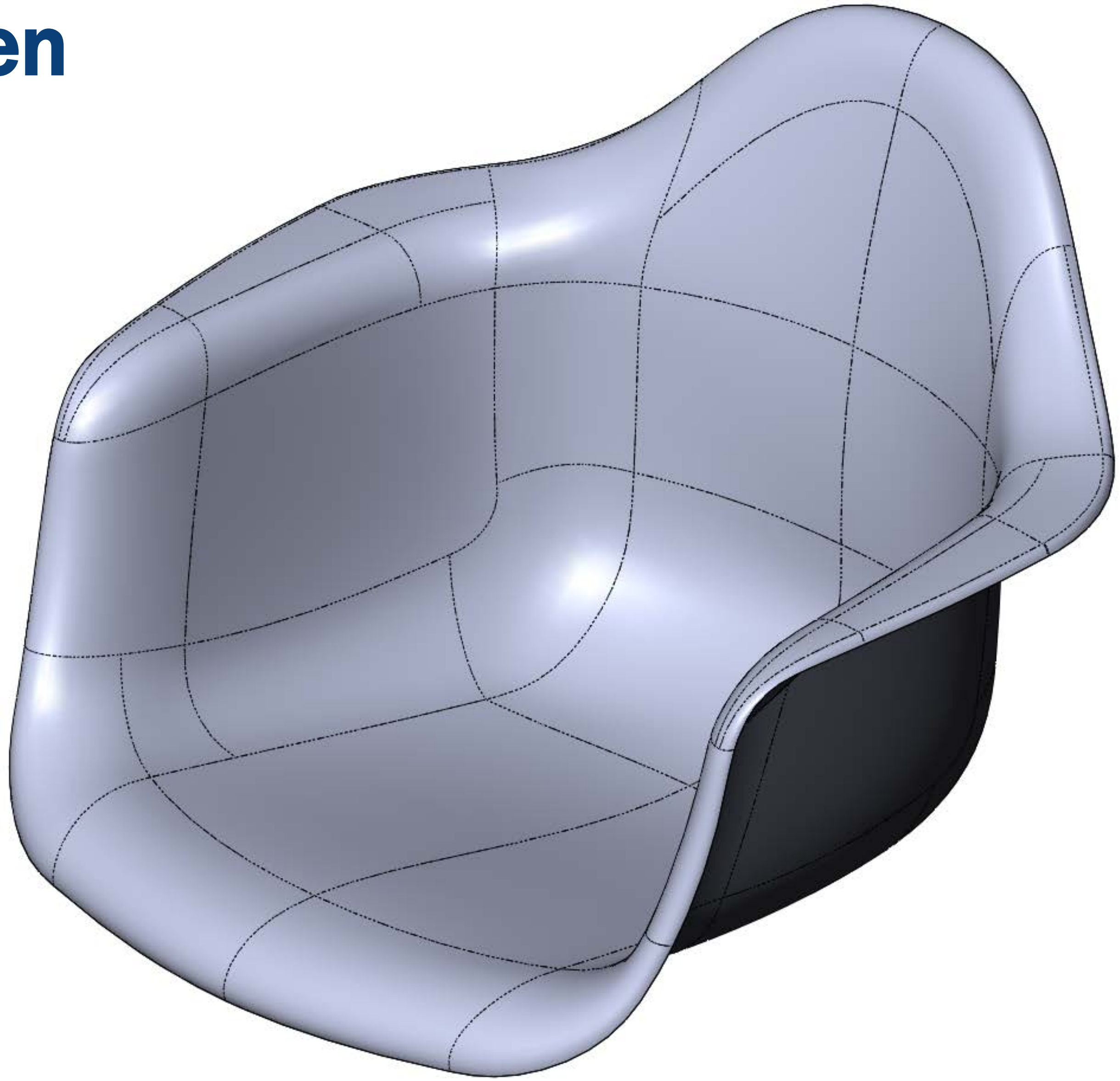




TIP: Surface Fill is excellent at patching 3 and 5 sides surfaces. It over builds a four side surface and trims back to fit.

Convert to Solid With Thicken

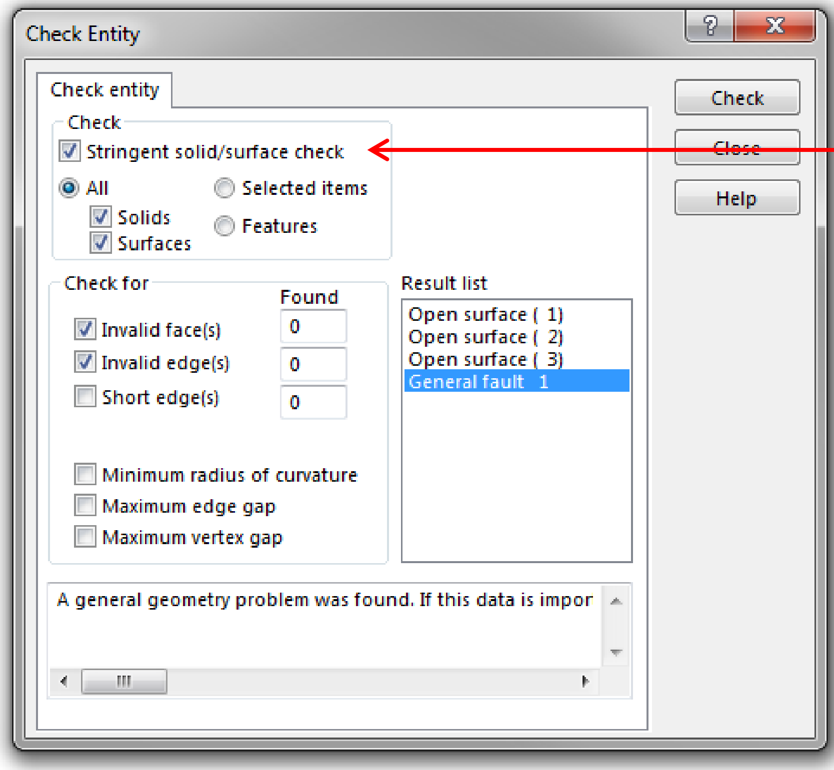
Once the chair surfaces are complete, mirror about the right plane. Use the Thicken feature to convert the surface body into a solid body.



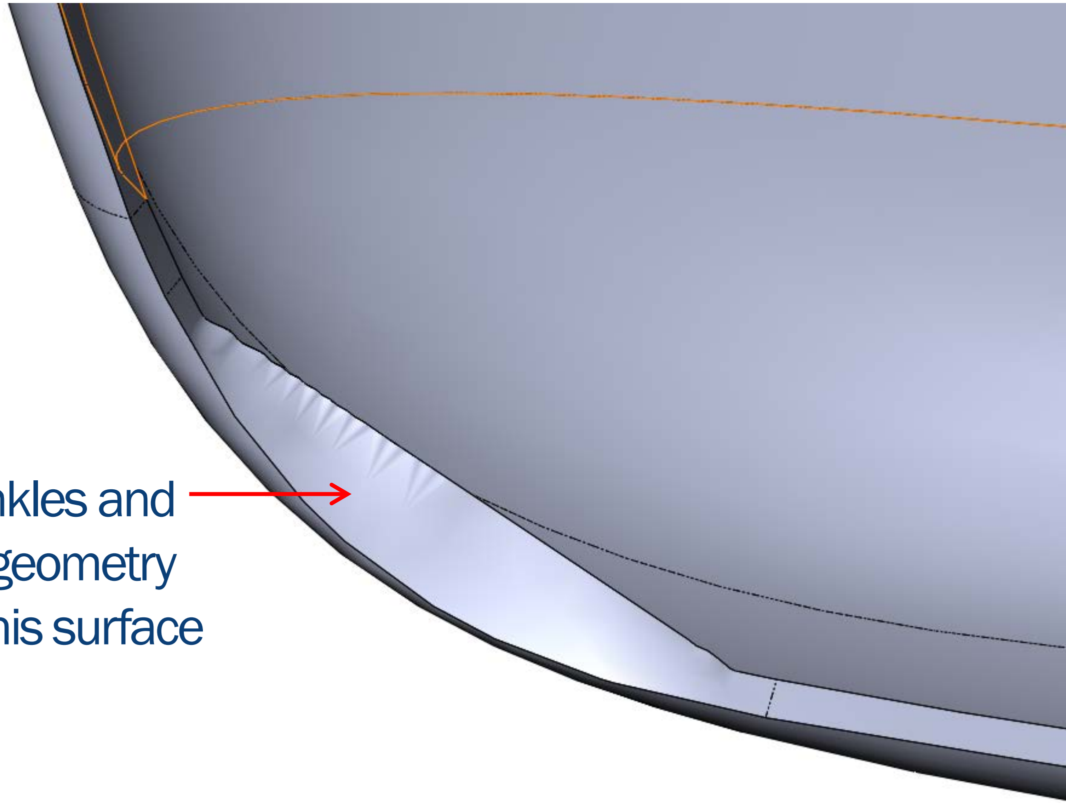
TIP: Thicken rarely creates a planar surface on the symmetry plane. Avoid this by mirroring first, thickening and then using Surface Cut with the Right Plane

Geometry Check

A best practice after using Thicken or Shell features is to perform a geometry check. These features can create invalid geometry that can cause down stream features to fail.



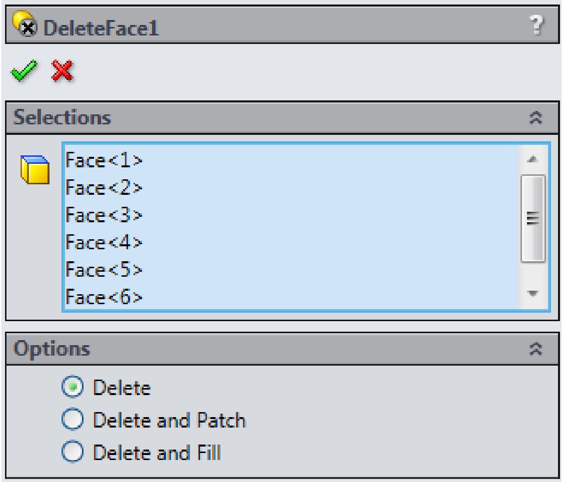
Stringent check avoids the re-use of previous check results.

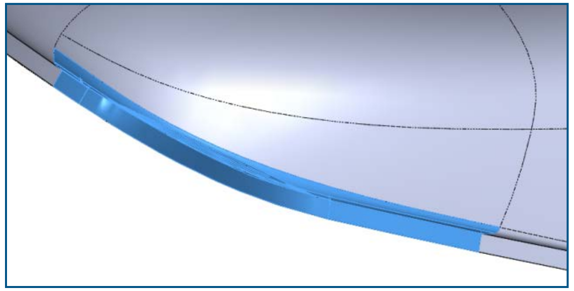


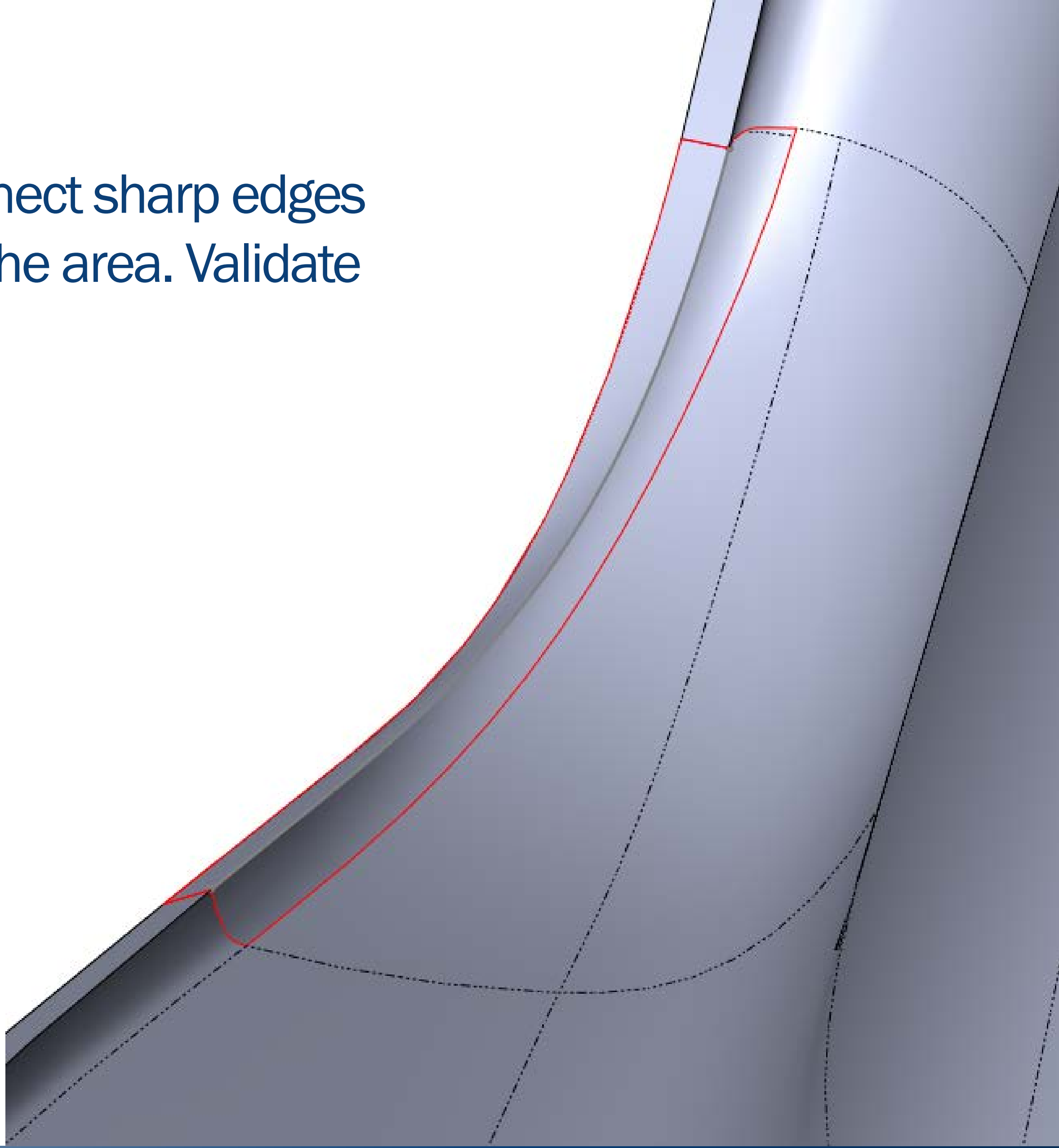
Faces with squiggles, wrinkles and odd curves may indicate geometry problems. The shape of this surface is also undesirable.

Geometry Repair

Delete the offending geometry from the model. Connect sharp edges with a 3D sketch spline. Use surface tools to repair the area. Validate geometry with Check.

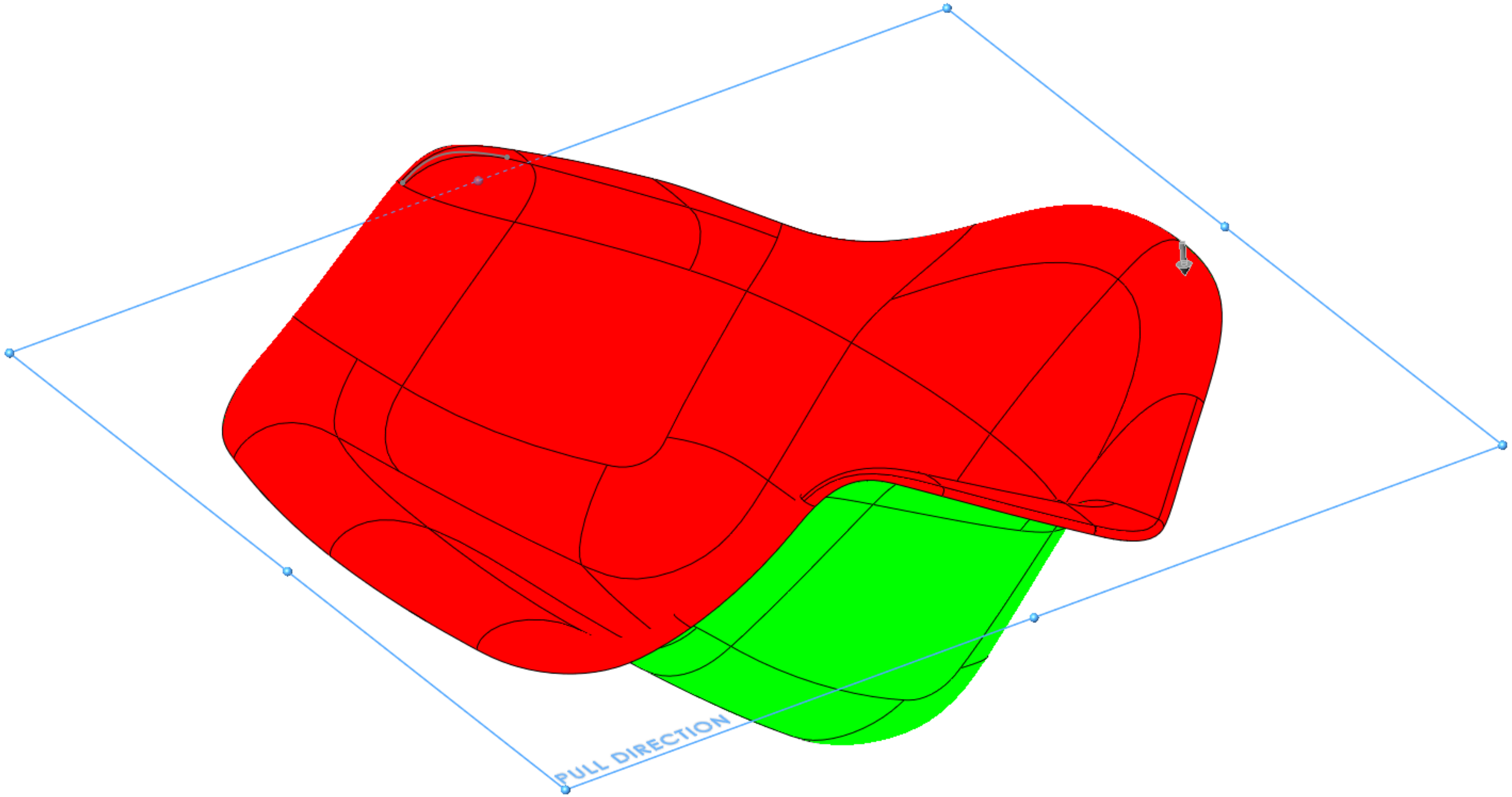


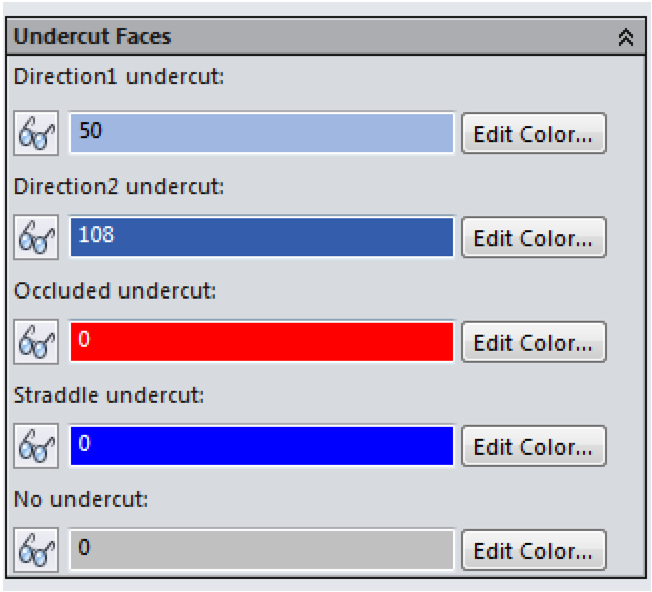




Evaluate Manufacturing

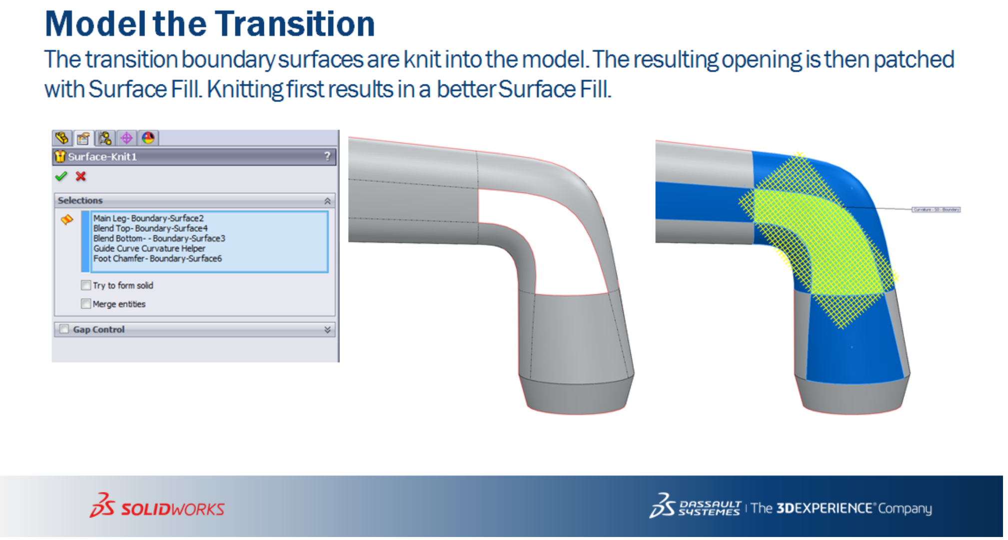
Evaluate the completed model for correct draft and undercuts using the draft and undercut analysis tools.

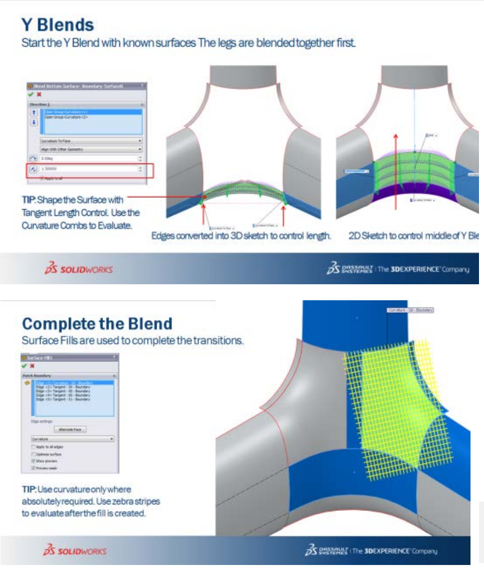


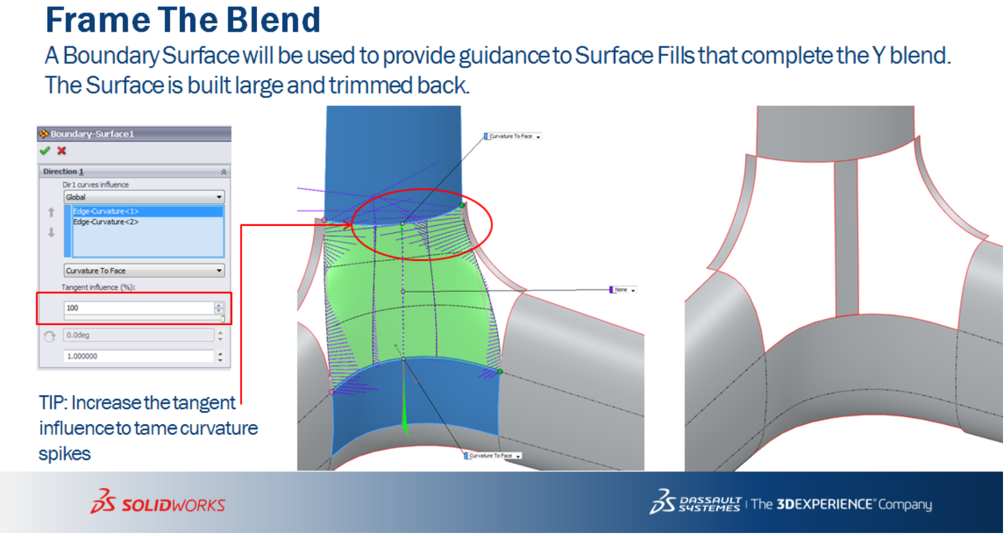


Model The Base

Check out "SWW 2014 Will It Blend" , available on YouTube and the DiMonte Group website, for strategies on how to blend shapes together as in the base of the Eames Aluminum Group series.

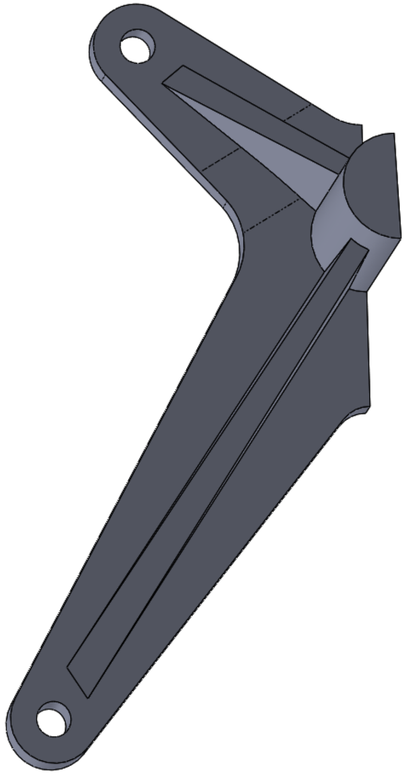




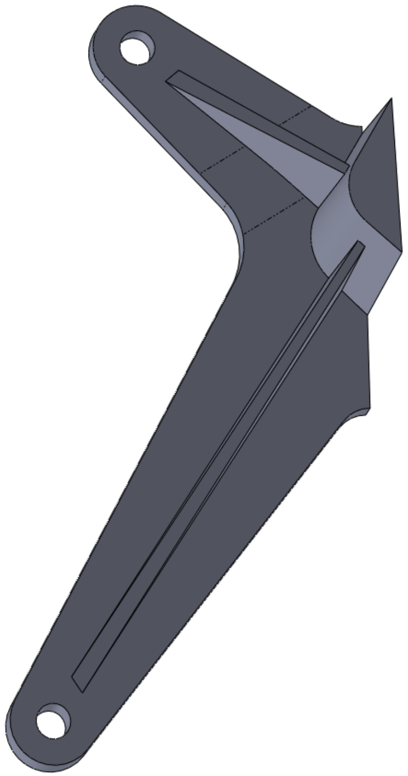


Draft Considerations

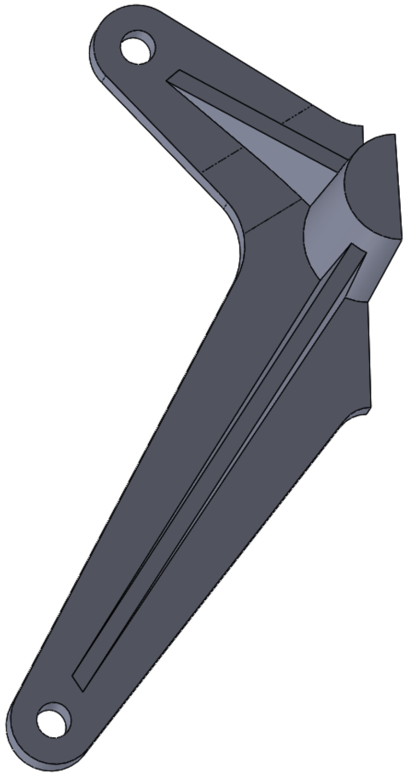
The draft tool can produce wildly different results depending on the options selected. A best practice is use the parting line draft tool on visual edges whenever possible.



Neutral Plane from Top Plane, ribs get fat



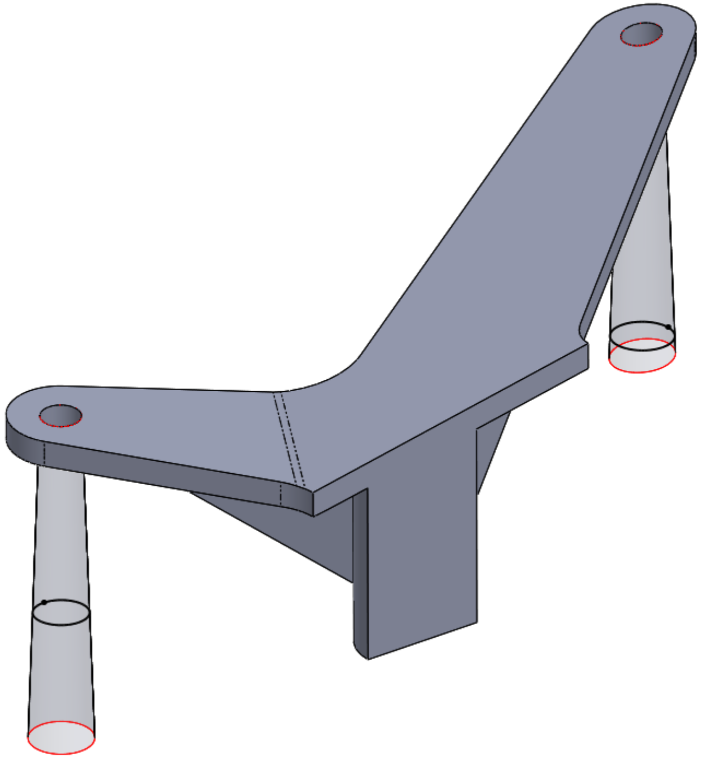
Parting Line from root, rib appears to taper



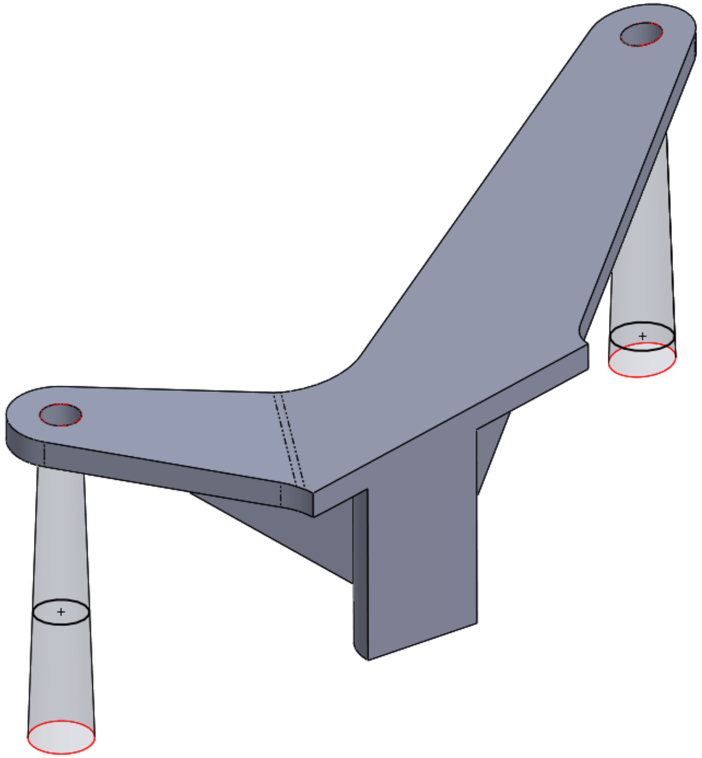
Parting Line from top face, rib appears straight.

Design for Core Pins

Holes in molded/ cast parts are often made by off-the-shelf core pins. Design holes accordingly based on the pull direction of the part.



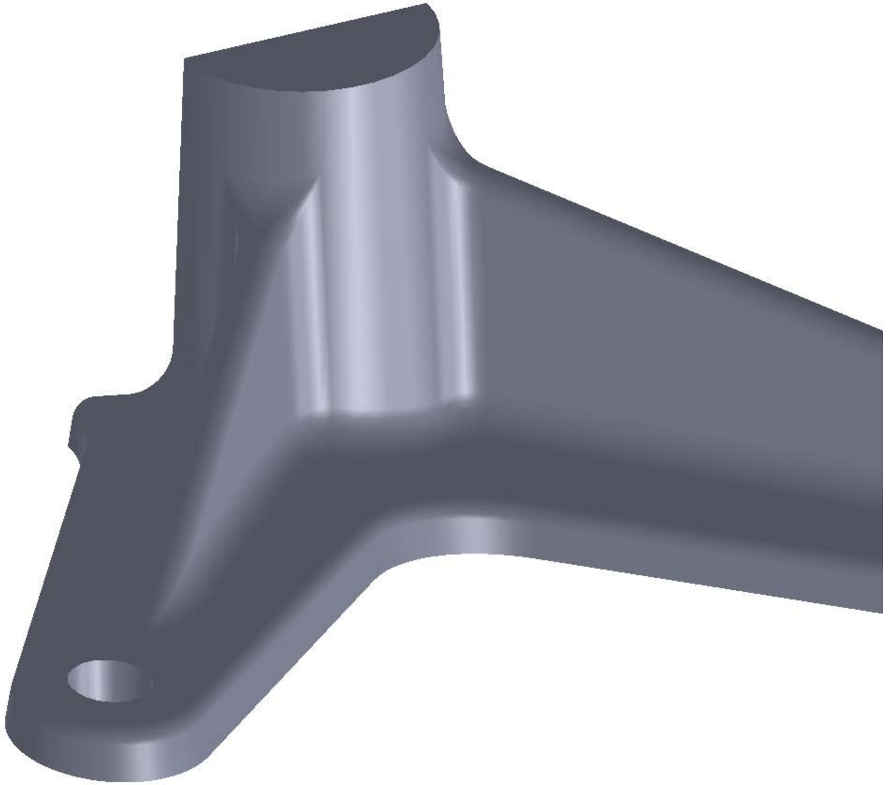
INCORRECT. Core pins are obround.



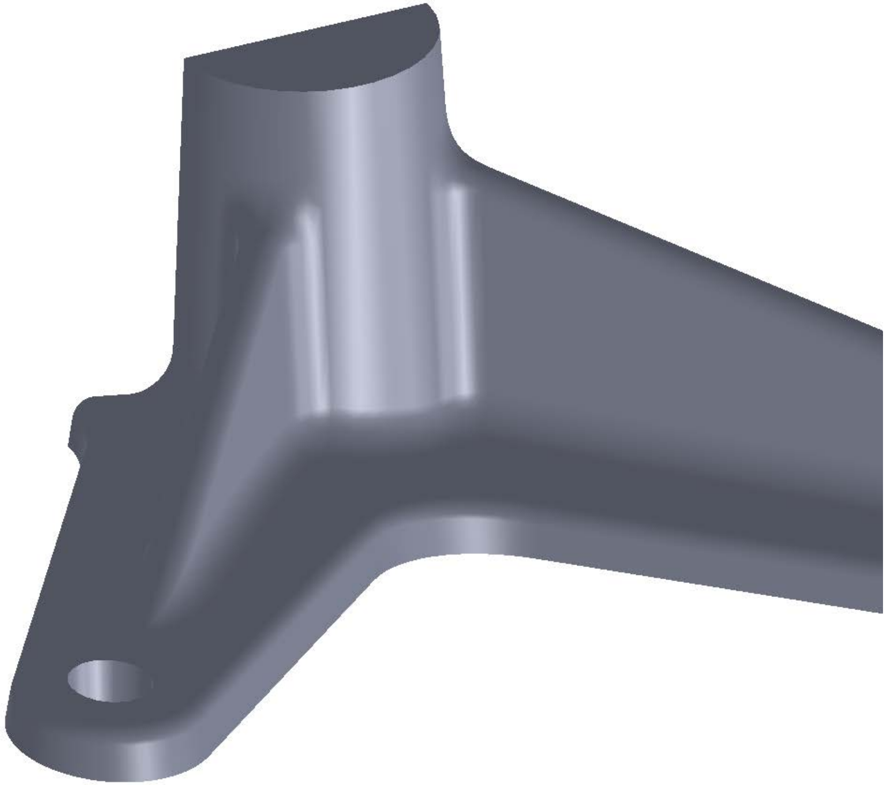
CORRECT. Core pins are cylindrical.

The Details Are Not The Details

Consider the result the fillet tool and SOLIDWORKS gives you. Does it match what the part should be? Consider manually tweaking fillet intersections, the details make the design.



Normal Fillet Intersection, fillets clearly visible.

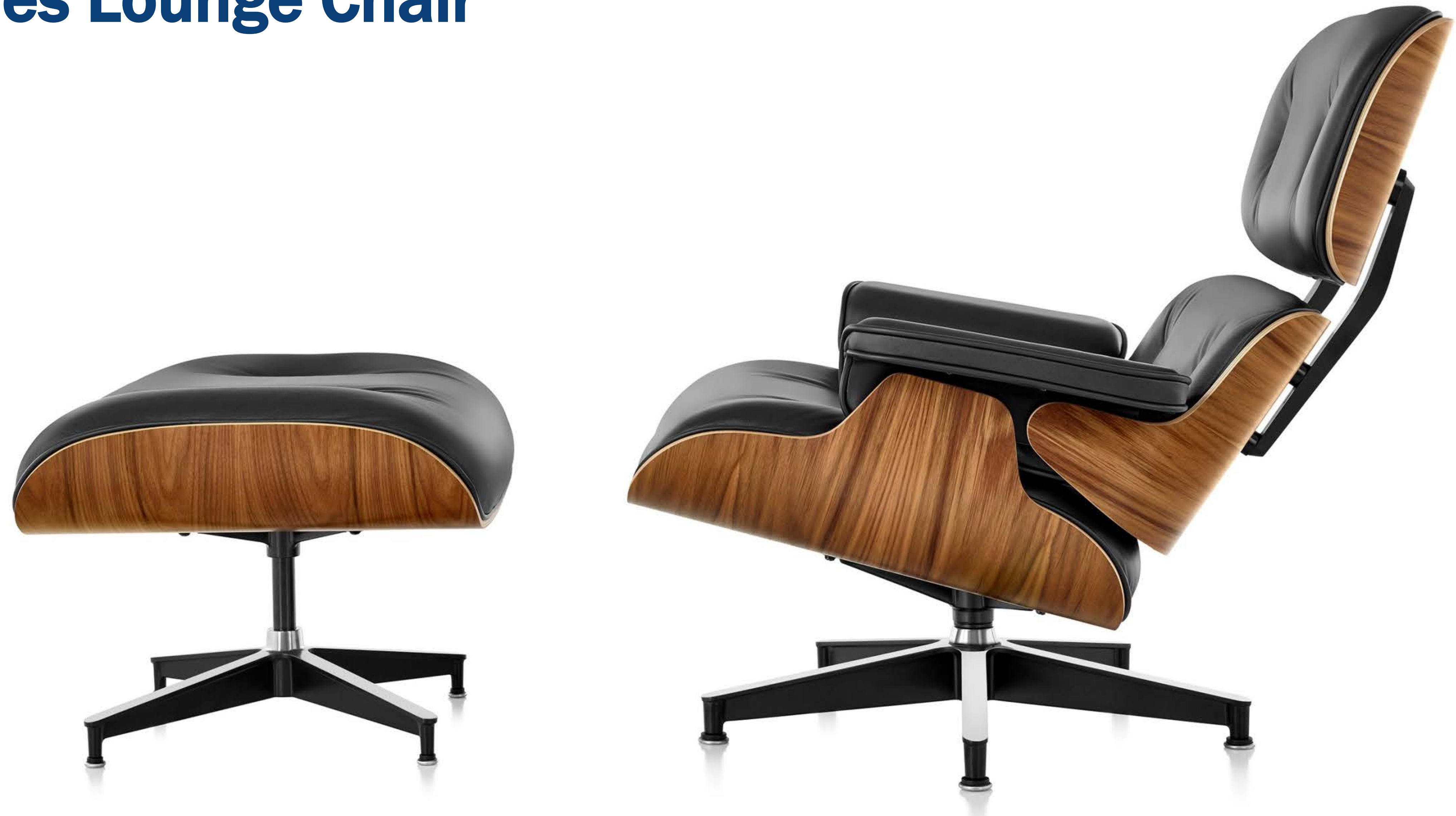


Split line and delete face

“The warm, receptive look of a well-used first baseman's mitt.”

-Charles Eames

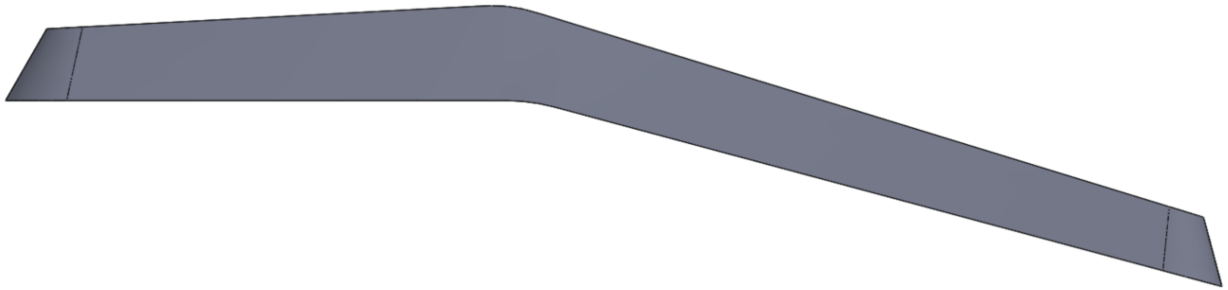
Eames Lounge Chair

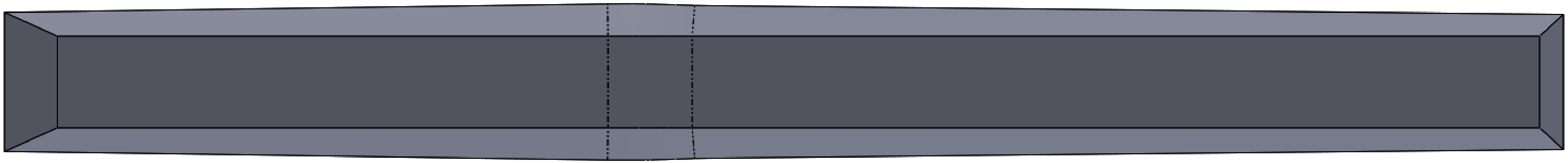


Eames Lounge Chair

Parting Line Draft

When two sets of edges need to appear straight, use loft to create drafted faces for exact control over edges.



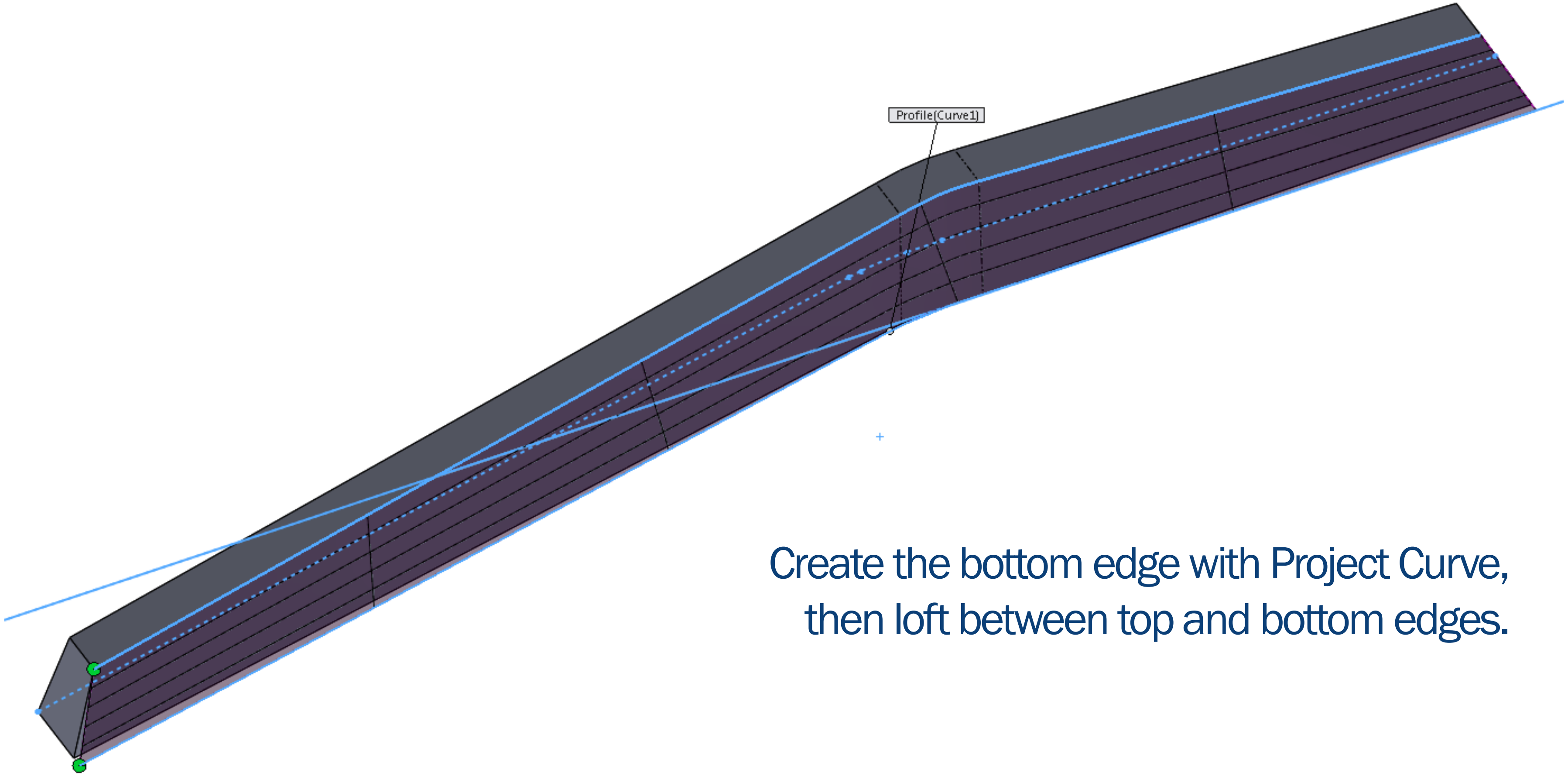


Due to part geometry, parting line draft creates distorted edges.

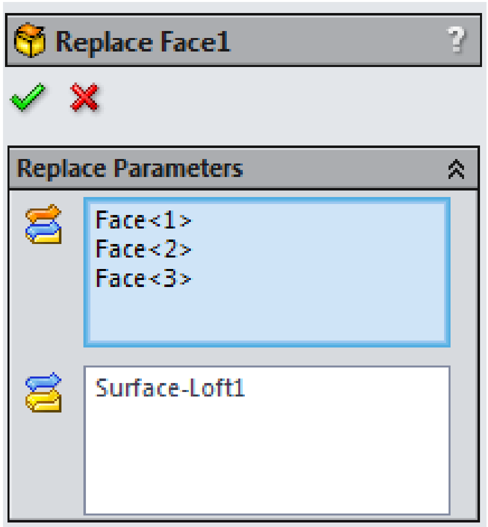
Manually creating the bottom edge and lofting the draft face created correct geometry.

Parting Line Draft Workaround

When two sets of edges need to appear straight, use loft to create drafted faces for exact control over edges.



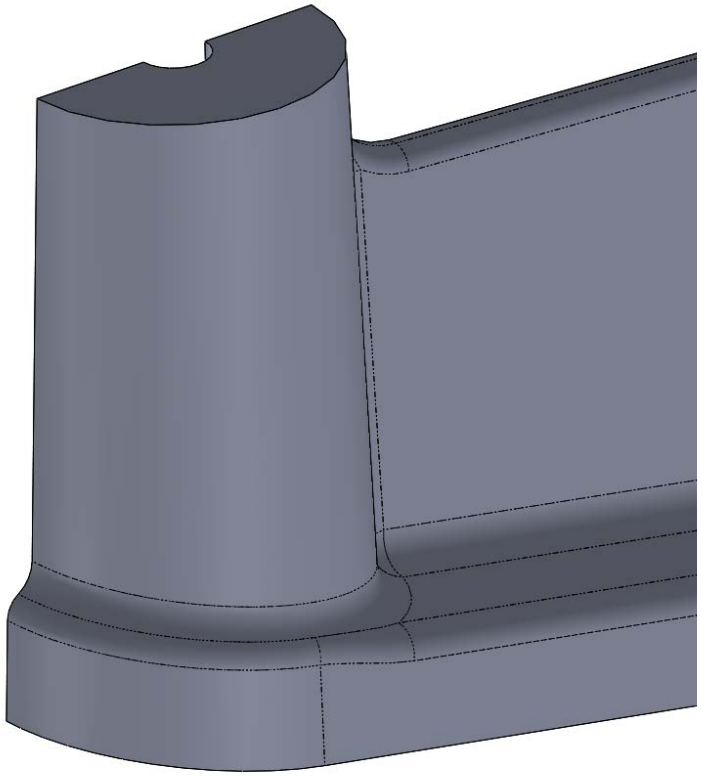
Create the bottom edge with Project Curve, then loft between top and bottom edges.



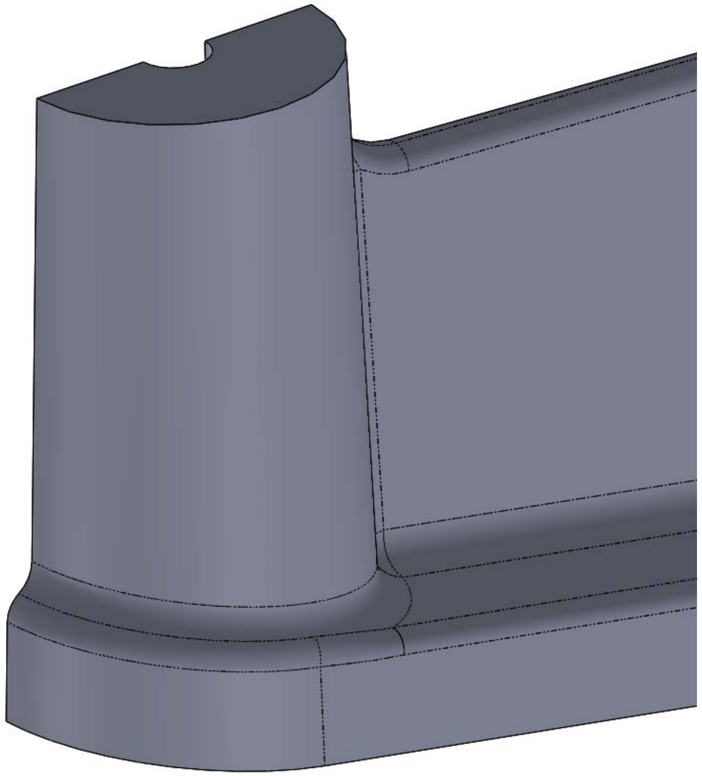
Merge the new face into the model with Replace Face

The Details Are Not The Details.

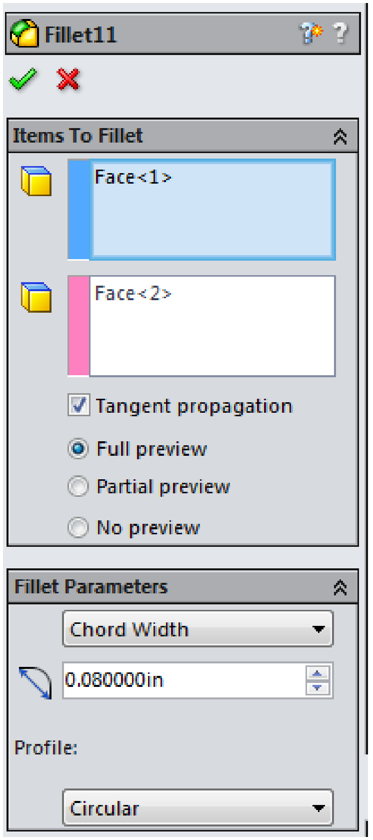
Consider the result the fillet tool and SOLIDWORKS gives you. Does it match what the part should be? Consider the constant width fillet, the details make the design.



Constant Radius Fillet

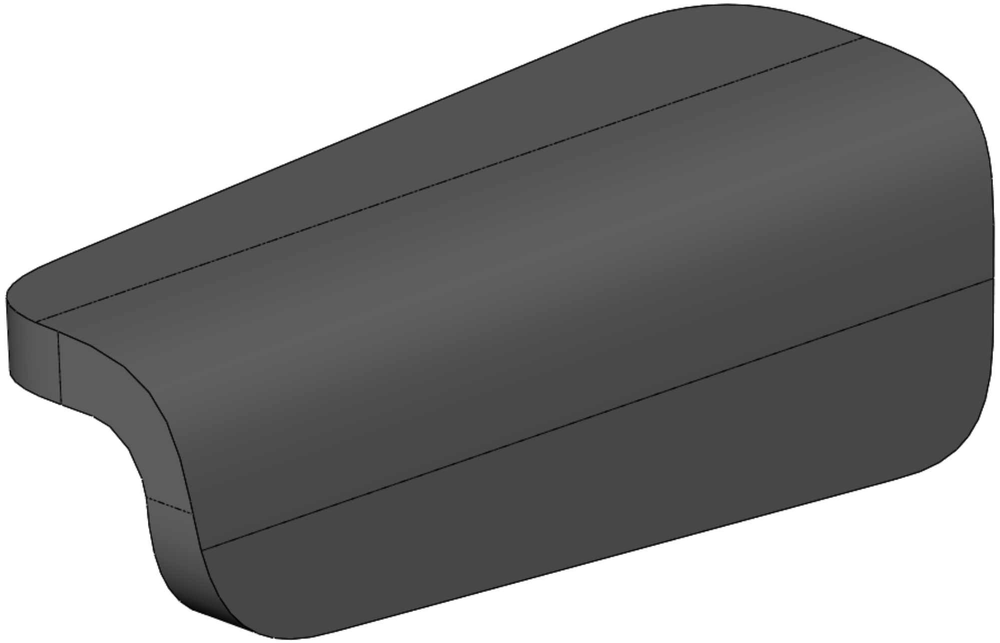


Constant Width Fillet

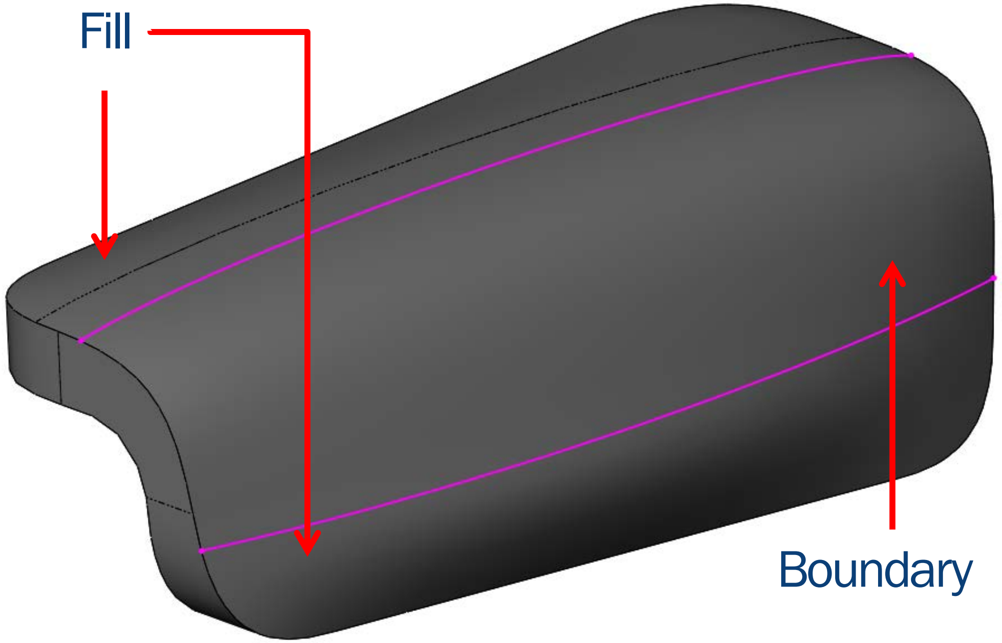


Natural Looking Upholstery

Upholstery never lays flat. Replace planar surfaces with pillowed surfaces to give a more realistic look to cushions.



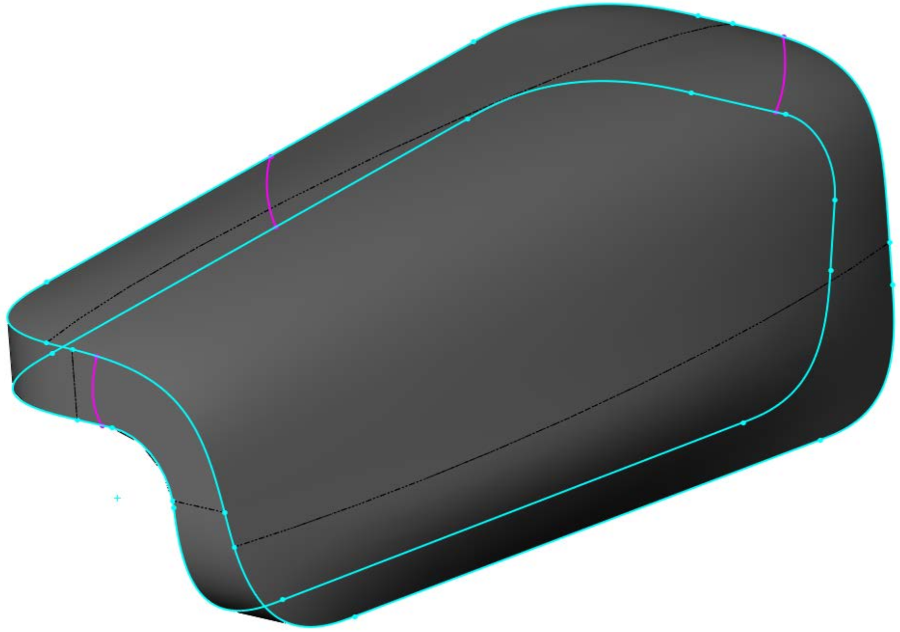
Armrest is blocked out with solid features.

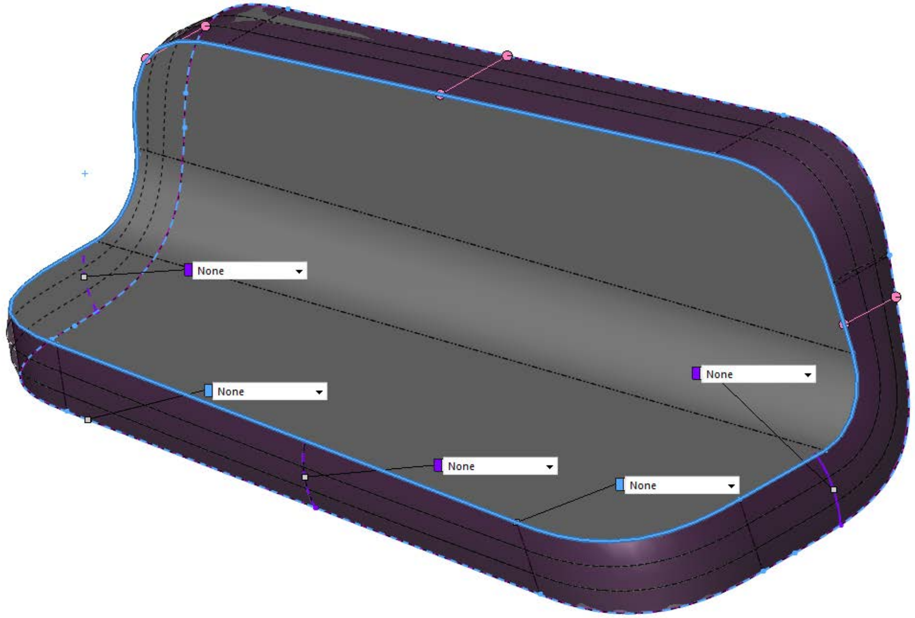


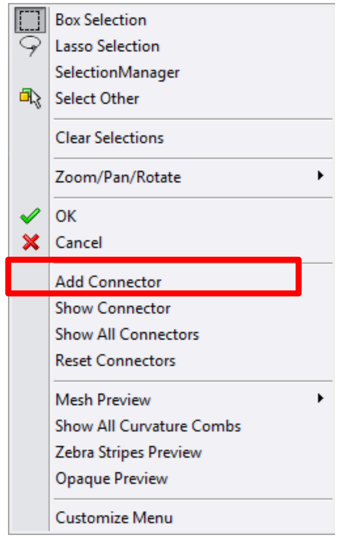
Surface features are used to give pillowed shape. Minor irregularities in the surface increase realism.

Puff Up Flat Faces

Use additional surface features to puff up flat faces for increased realism. Replace Face can be used to merge the new surface into the model.





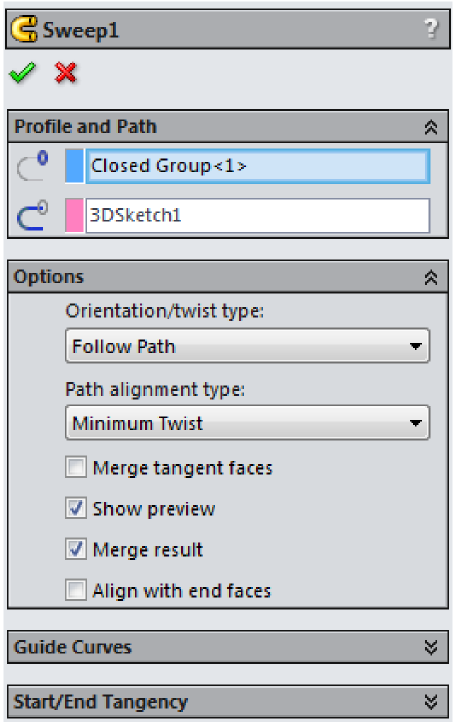


3D Sketches are used to convert the outer closed profiles, splines are sketched on 2D planes

Additional connectors may need to be added to the surface to prevent self intersection.

Add Piping

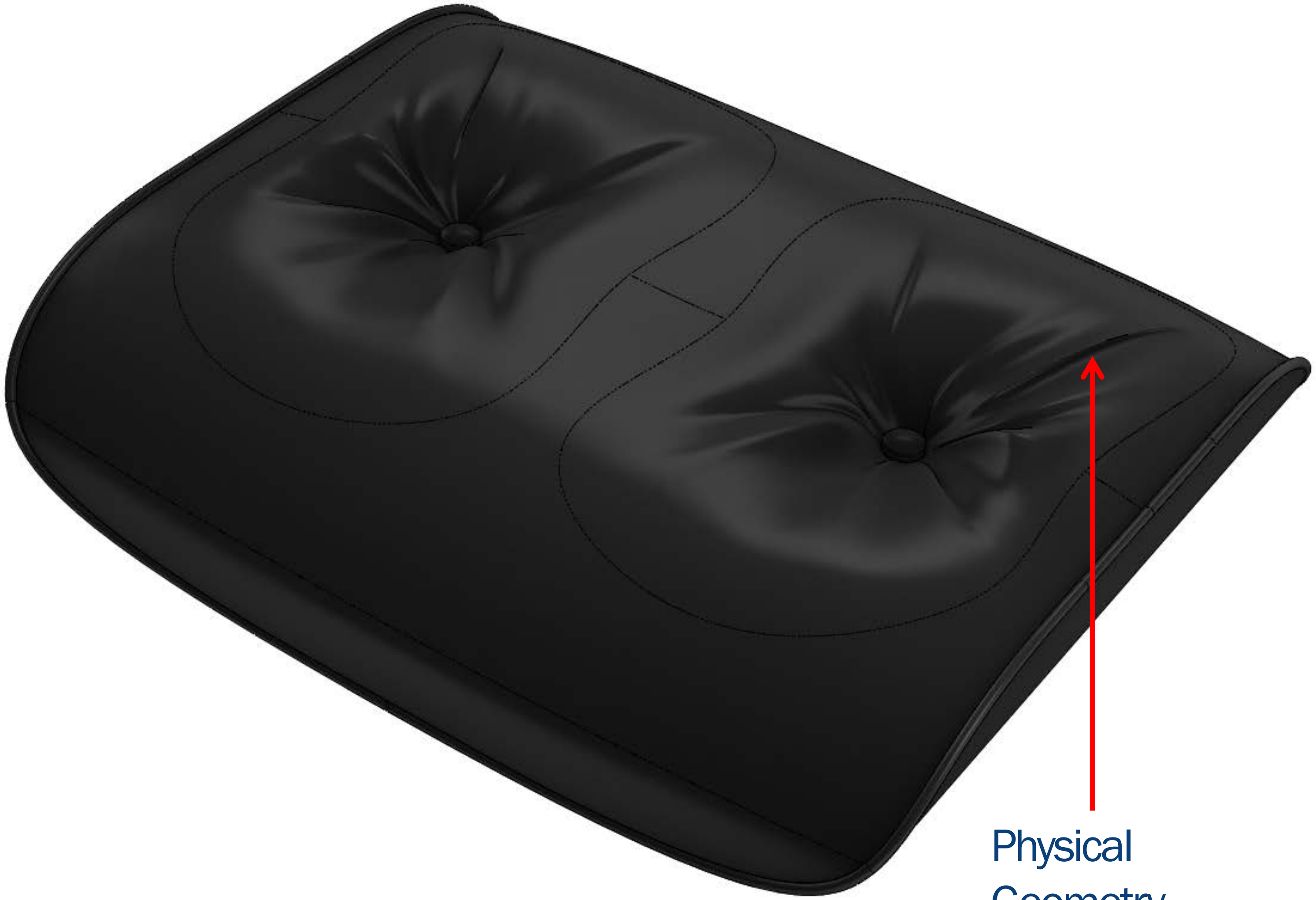
Piping can easily be added to the edge of the arm rest with a solid sweep.



TIP: Enable minimum twist to prevent the sweep twisting on itself.

Tufted Buttons

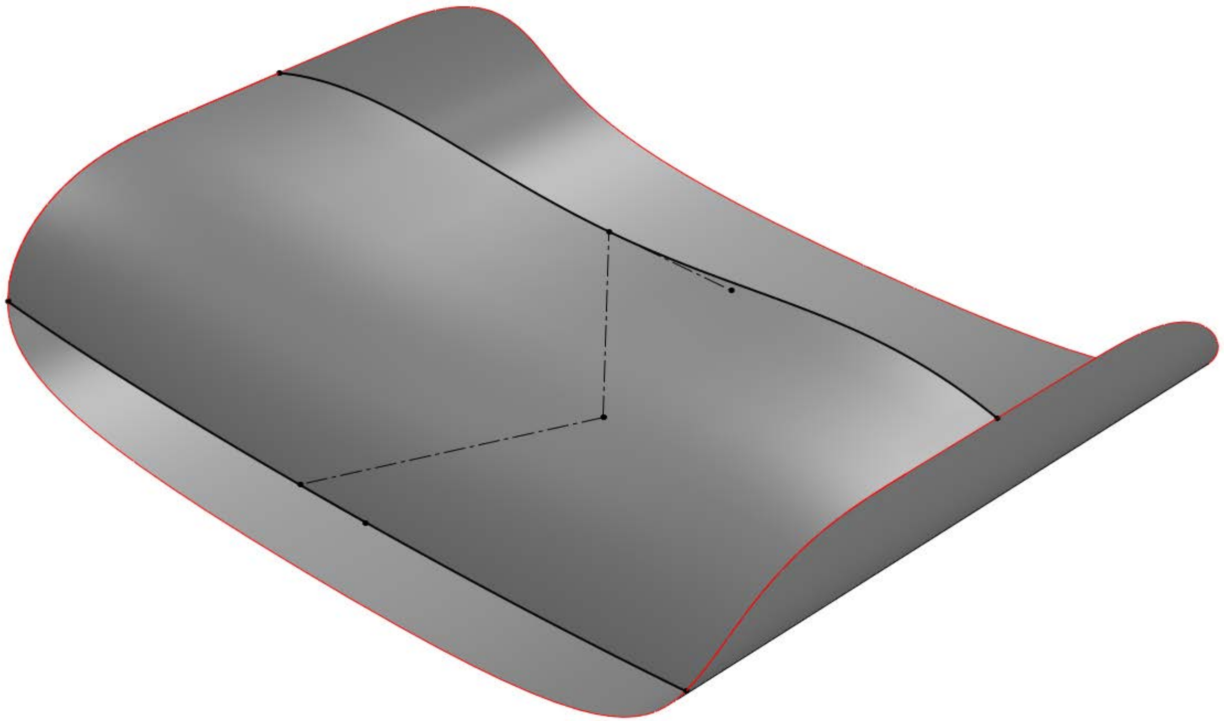
Modeling tufted buttons instead of relying on a rendering texture or bump map produces superior results.

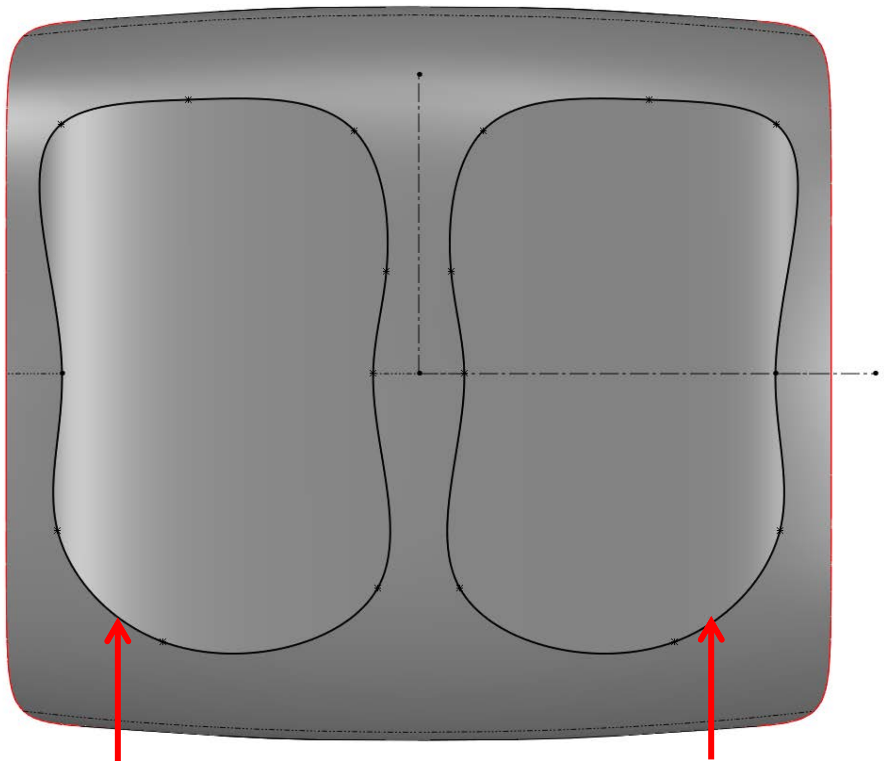


Physical Geometry

Create Cushion Surfaces

Use Boundary Surface and Surface Fill to create the main surfaces of the cushion. Next, trim away a large area for the tuft surface.

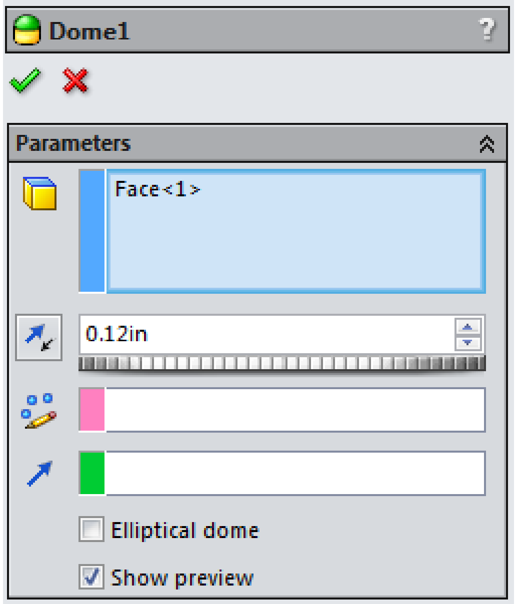




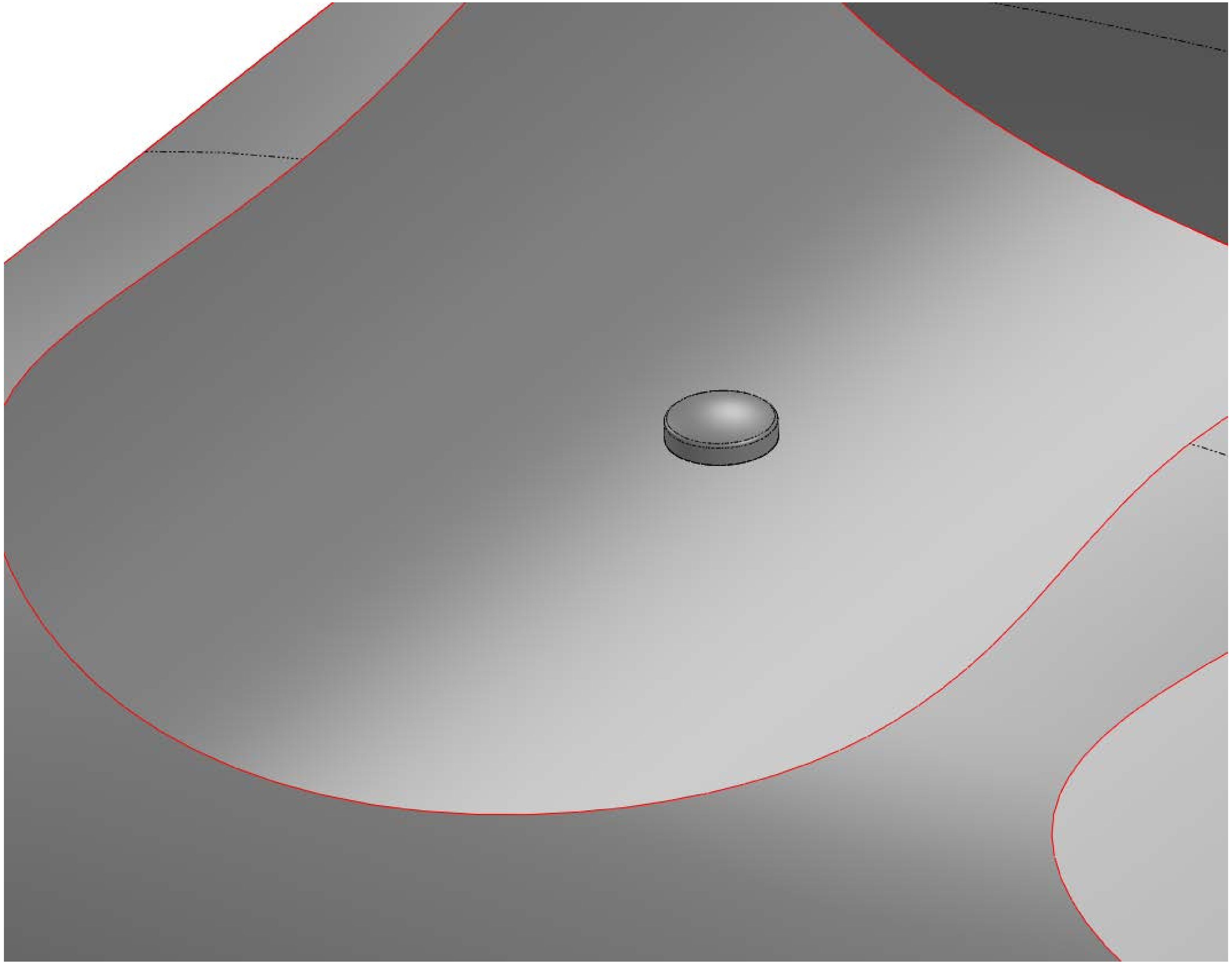
Multi- point closed spline, curvature quality is irrelevant

Create The Button

In the real world, the tuft is created by the button pulling the leather down, causing it to bunch up.

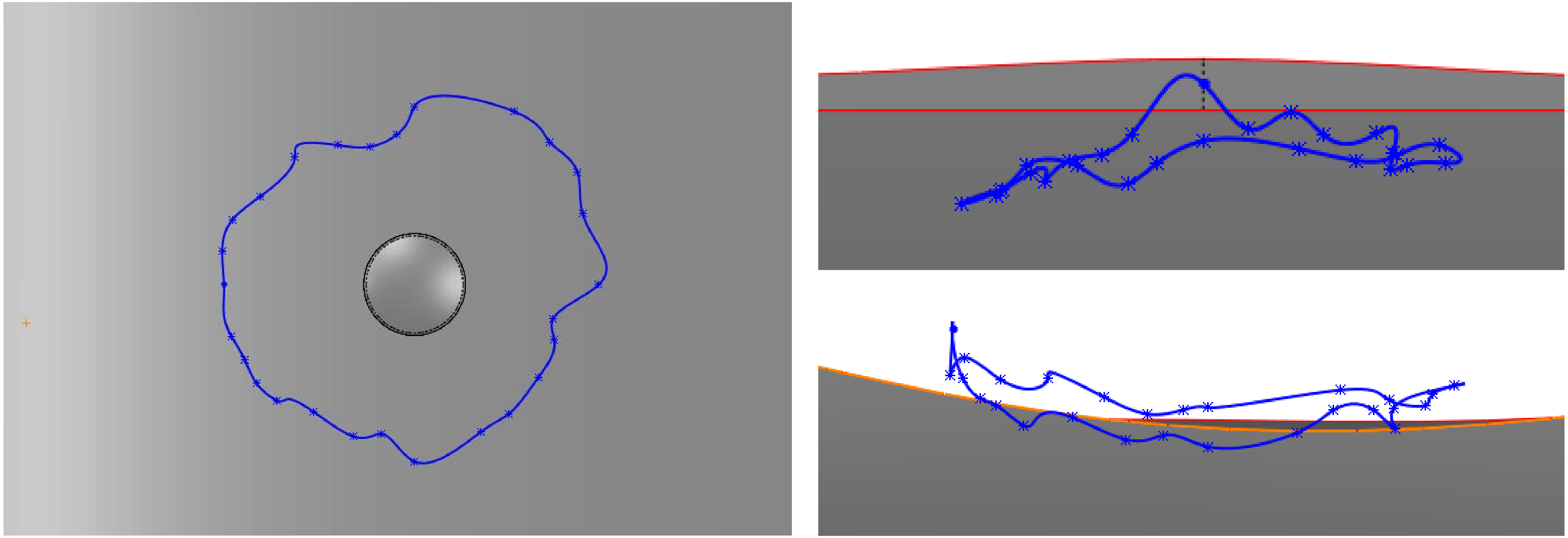


TIP: Use dome to quickly add spherical faces to models.



Create The Tuft Sketch

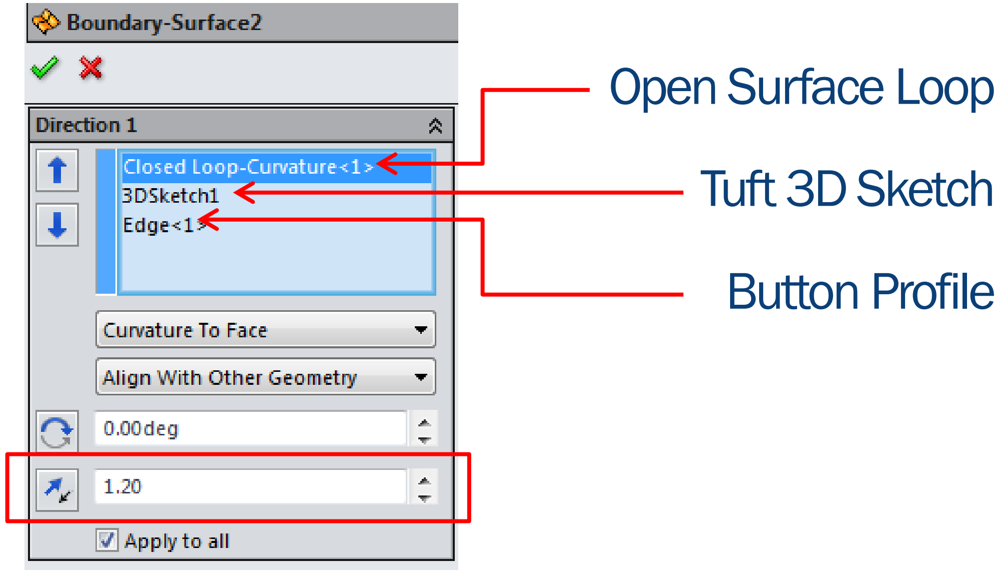
The tuft is model by forcing a Boundary Surface through an undulating spline with a high number of points in a 3D sketch. This will introduce all sorts of ripples and wrinkles to the surface.

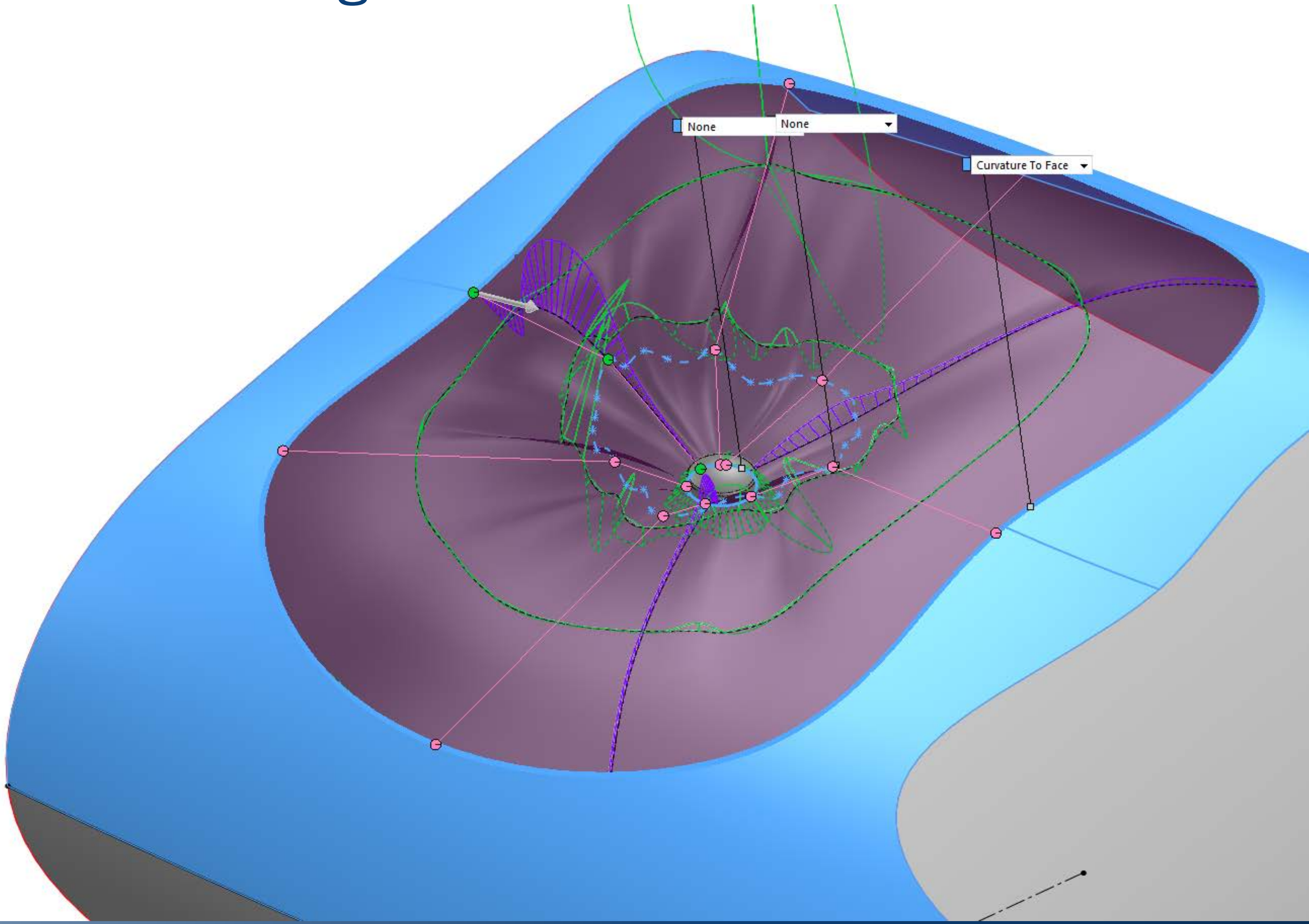


TIP: Sketch the 3D spline from the top plane first. Then move to the front and right planes and move alternating control points up and down.

Create The Tuft

Create the Boundary Surface Tuft passing through the open surface edge, the tuft 3D sketch and the button profile. Additional connectors will be needed to fight self intersection.





NOTE: The connectors may have to be tweaked multiple times before the surface finds a solution without self intersecting.

Eames Lounge Chair

If you liked this session, please take a minute to give your thoughts via the SWW2016 App.

Session surveys are available through the SOLIDWORKS World **mobile app.**

Thank you in advance for completing the session survey. Your feedback helps to shape future SOLIDWORKS World Events!

SOLIDWORKS WORLD 2016

QUESTIONS?

PRESENTATION AND SAMPLE FILES WILL BE AVAILABLE ON OUR WEBSITE SOON.

Andrew Lowe
Industrial Designer
DiMonte Group Inc

DIMONTE GROUP

www.dimontegroup.com