RhinoCAM does PolyFab!

This is a full scale model of the aft end of a German WWII torpedo. The brass object is the gyroscope.
It is presented at The Mechanical Engineering dept at Columbia Univ.

PolyFab is a Wilmington, MA based company that sells custom fabrication to clients world-wide. Anything that starts with a Clear Industrial Plastic sheet or a tube, PolyFab can machine it or form it. The company, originally founded in 1968, was purchased in 2003 by Preston Fiske, a Mechanical Engineer from Santa Barbara, California.

Preston received an MS degree from Stanford, served in the Army, graduated from UC Davis with a degree in Agricultural Engineering and worked for John Deere at their Moline, Il facility. After 5 years with John Deere Preston went to business school prior to purchasing PolyFab.

We recently sat down with Preston to discuss his use of RhinoCAM software from MecSoft Corporation.

What *is Clear Industrial Plastic?*

When you pick any plastic for a project, you chose between chemical resistance, temperature range, strength, transparency, formability and cost. For transparent products the typical choices are acrylic, clear PVC or polycarbonate. Acrylic has the hardest surface, is completely clear and is well suited to drape forming. It is also the least expensive of the three. Clear PVC is the most resistant to acids and is easily formed, but the sheets are 1/2 inch or thinner. Polycarbonate is by far the strongest because it stretches under load, but it is very difficult to form and is very expensive for sheets 1/2" and thicker. It is also the softest and scratches easily.

The RhinoCAM Difference

When Preston purchased the company in 2003, they were laying out sheets of plastic on the floor, using tape measures and string! Seriously. Preston quickly realized that he had to take it up a few levels. When looking for a CAD program, he consulted with a few of his equipment manufacturers. *"The consensus was that those that started with Rhino seemed to have the least amount of trouble!"*

When Preston purchased his first CNC router he also purchased VisualMill. Three years later he bought a custom 4 axis machine and it was time to step up to Rhino and Rhinocam. Three years ago he bought his third CNC router, a Laguna Smartshop III and there was almost no transition to the Laguna because everyone was familiar with Rhinocam!

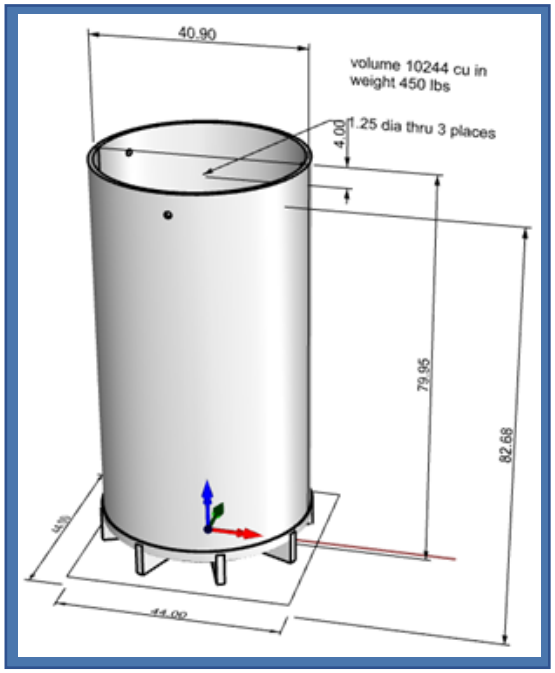
“I liked RhinoCAM immediately because I could make changes quickly. Changing the drawing did not mean that I had to start the whole CAM process over again. The G-Code adapted automatically. I started learning VisualMILL first and the transition to RhinoCAM was very easy.”

Preston Fiske
Owner/Operator, PolyFab Corporation, Wilmington, MA

Want to see how RhinoCAM can help you? Click Here to download a demo!

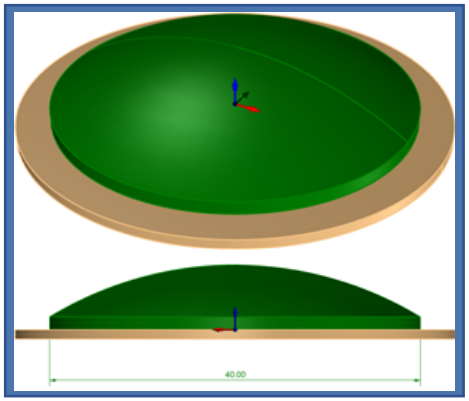
The Slurry Tank Project

This project illustrates the use of a thermoform mold to form a 1” thick acrylic blank for the base of the slurry tank shown below. The tank, manufactured for a local university, is used to study coal slurry and is still in use today. The images below show the assembly design in Rhino on the left and the actual completed tank on the right. The thermoform mold is required to form the inverted domed base indicated at the white arrow in the left side image shown below.

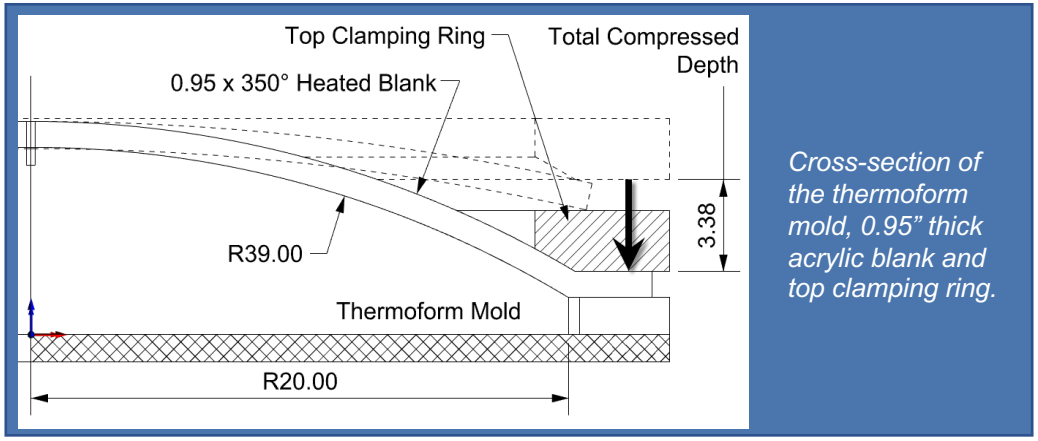


The Thermoform Mold

To form the 1” thick acrylic blank Preston had to first design and machine the thermoform mold shown here. The mold is 40” in diameter at its base with a 29” spherical radius that extends approximately 5½”.



The cross-section drawing below shows the thermoform mold, the 0.95” thick acrylic blank (heated thru to 350 degrees) and the top clamping ring compressed to a total depth of 3.38”. There is also a ¼” diameter center hole at the apex of the dome that is used for positioning while the blank is placed on the mold. A clamping mechanism (not shown) is used to gradually compress the Top Clamping Ring down to form the heated acrylic blank and contain it while it cools.

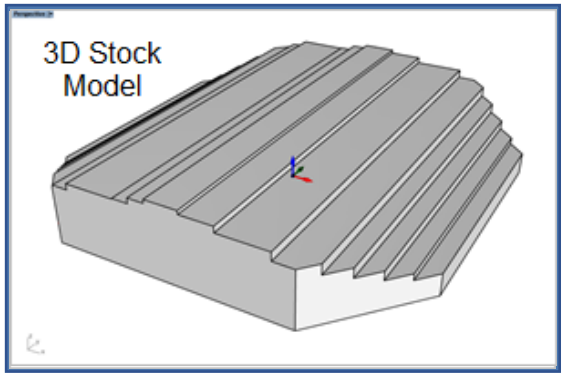


Cross-section of the thermoform mold, 0.95” thick acrylic blank and top clamping ring.

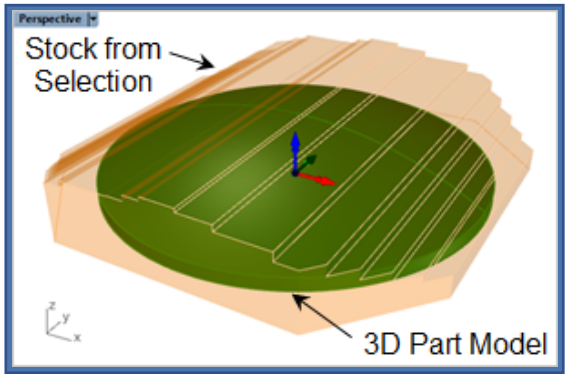
The Stock Definition

To conserve material and minimize machining time, the 42” x 44” x 7.875” stock was made up of pre cut and glued maple sections as shown in the image on the right. The stock was then cut with a bandsaw to remove the excess corners. This irregular 3D stock definition was then modeled in Rhino and is shown in image (A) below.

The solid stock model is selected in Rhino and then is defined as a Stock From Selection in RhinoCAM. Once the stock is defined in RhinoCAM, it’s 3D model representation is no longer needed and can hidden in Rhino. The 3D RhinoCAM stock and the 3D thermoform mold model is shown in image (B) below. The Machine Coordinate System (MCS) origin is located at the center of the part in XY and at the bottom of the part in Z.



(A)

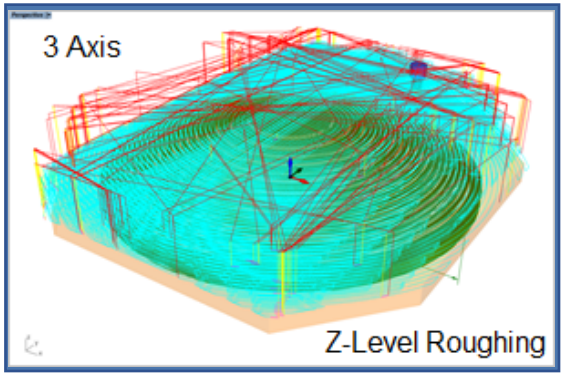


(B)

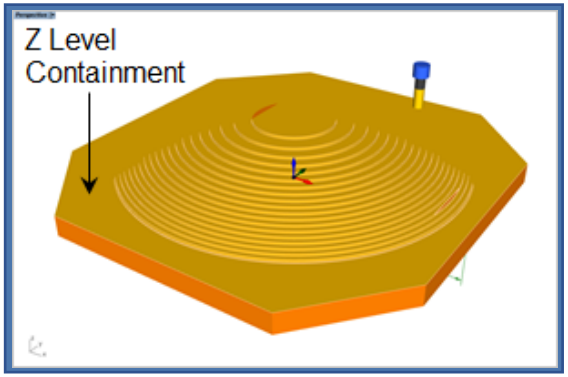
3 Axis Roughing

To rough out the stock Preston uses a 3 Axis Horizontal Roughing toolpath strategy that removes material in consecutive Z levels using a 1.5” diameter flat end mill. No containment geometry is selected for this cut. RhinoCAM calculates based on the stock definition and the part geometry. General cut parameters include a global tolerance of 0.02 and a stock allowance of 0.2. Cavity/Pocket parameters include an Offset cut pattern, Mixed cut direction, an Inside start point and a stepover of 40% of the tool diameter (0.6).

Core/Facing parameters include an Island Offset cut pattern, Mixed cut direction and a 40% stepover. For Cut Level control the stepdown between levels is set to 0.25 with a Bottom limit set to 2.25. The engage/retract is set to a 10 degree path at a height of 0.25 and linear extensions of 0.625. The resulting toolpath is shown in image (A) below with the resulting cut material simulation shown in image (B).



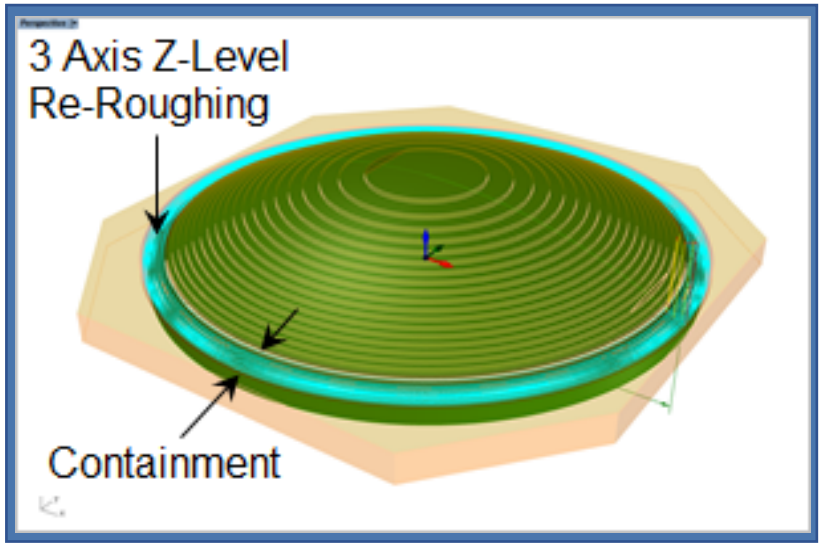
(A)



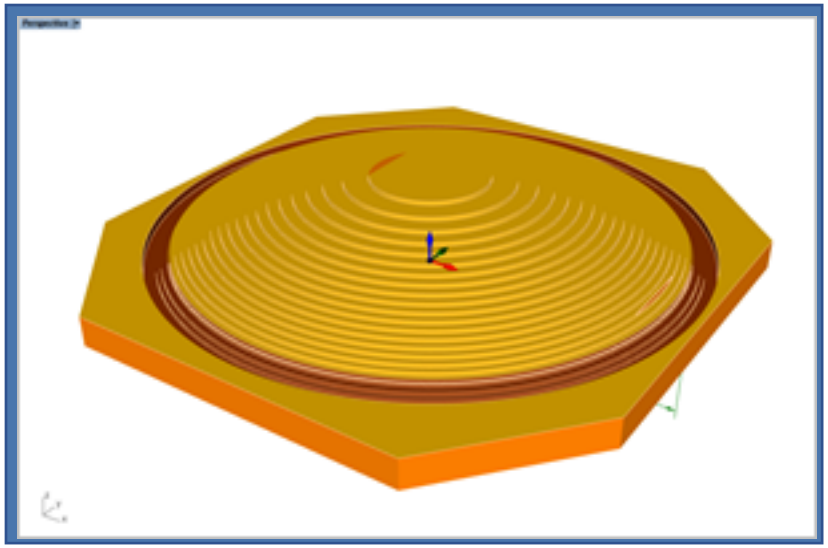
(B)

3 Axis Re-Roughing

To remove more stock near the outer diameter of the mold, Preston uses the 3 Axis Re-Roughing strategy that takes into account the previous 3 Axis Roughing toolpath and only removes material based on the inprocess stock. This cut uses two circular curves as containment and a 0.5” diameter flat end mill with a 0.025 stock allowance. No Z level limit is set meaning that all material that the tool can access is removed between the two containment curves.



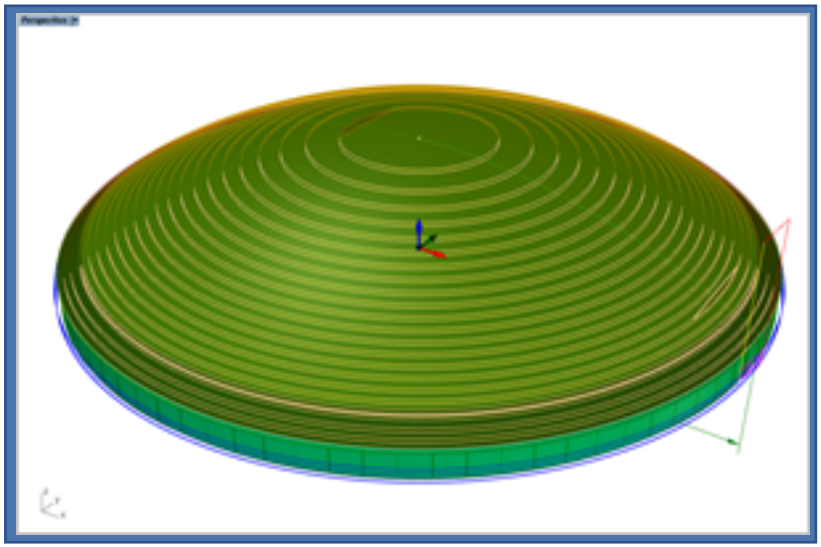
(A)



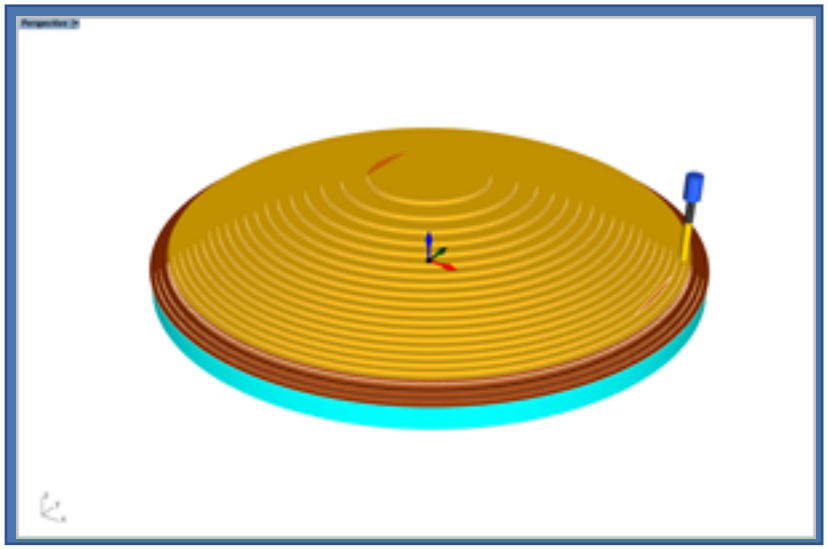
(B)

2 Axis Outer Perimeter Cut

In this next operation Preston cuts the outer perimeter using a 2 Axis Profiling toolpath and the same 0.5” diameter end mill, a 0.001 toleranace and a stock allowance of zero. This is the finished perimeter cut and allows him to remove the excess outer stock before continuing. At a total cut depth of 0.957, the cut is divided into a 0.917 rough depth and a 0.07 finish depth. The rough depth is divided into 0.25 cut levels while the finish depth remains at one cut level 0.07. The entry motion is set to ramp Along Path at an angle of 10 degrees and a height of 0.5. This entry motion is repeated at each cut level. No exit motion is used. The toolpath and cut material simulation are shown below.



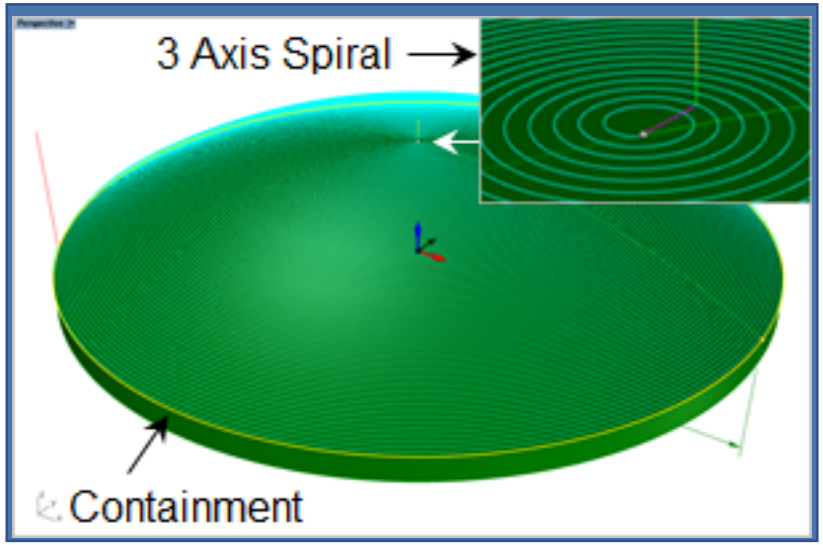
(A)



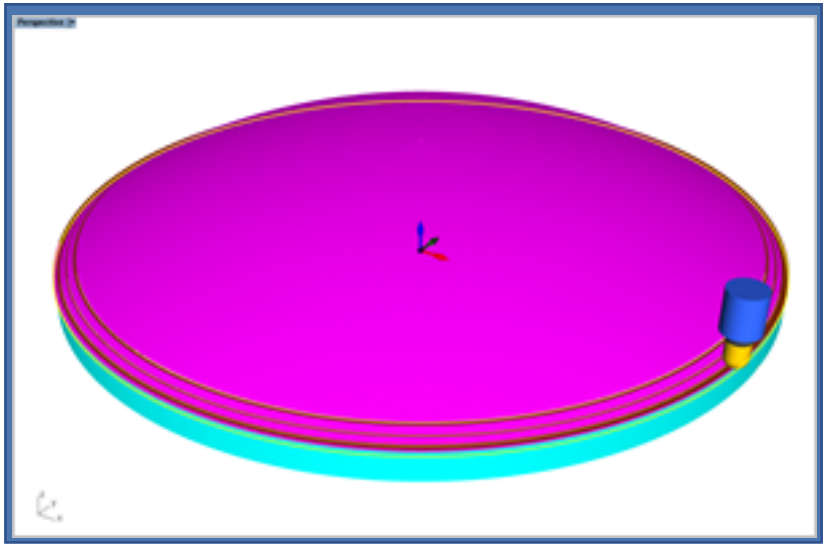
(B)

3 Axis Pre-Finishing

As a pre-finishing operation, the 3 Axis Spiral Machining strategy is used with the top outer perimeter curve selected as containment using a 1.250” diameter ball mill. In this toolpath the tool spirals about a center point following the part surface until it meets the perimeter curve. The tolerance is set to 0.002 with a stock allowance of 0.1. The path uses a conventional upcut pattern, starts at the top center and steps over a distance of 0.188 between each spiral. The entry motion is set to a linear extension of 0.5 and at an angle of 30 degrees and vertical approach distance of 0.25. The toolpath and cut material simulation is shown in the images below.



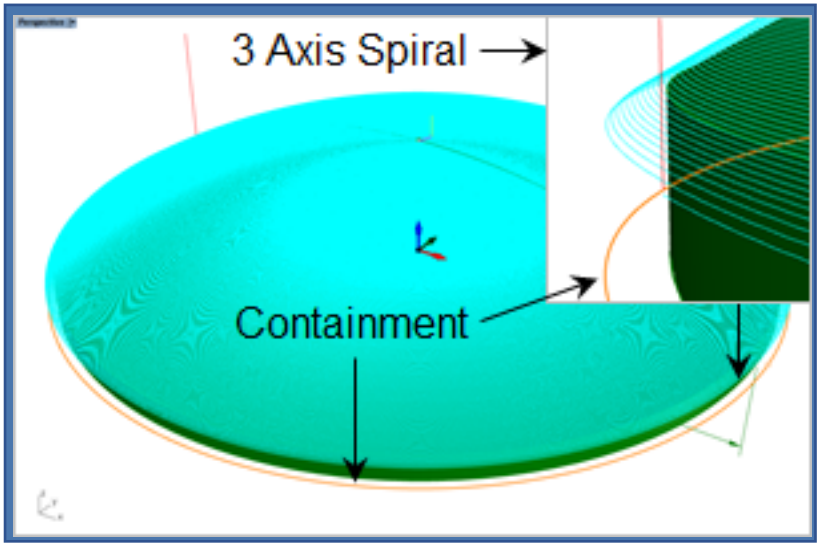
(A)



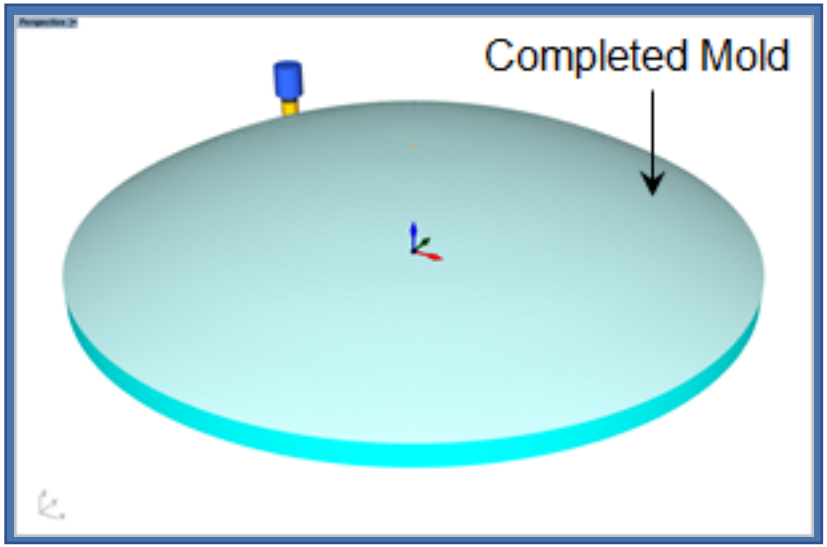
(B)

3 Axis Finishing

For the finishing operation, another 3 Axis Spiral Machining strategy is used. This time the containment is a circular curve that is offset outward from the bottom outer perimeter. This is shown clearly in the inset image (A) below. The offset amount is calculated to contain the ball mill to stop when tangent to the top outer perimeter, using the same 1.250" diameter ball mill. The tolerance is set to 0.002 with a stock allowance of zero. The path again uses a conventional upcut pattern, starts at the top center and steps over a distance of 0.04 between each spiral. The entry motion is set to a linear extension of 0.75 and at an angle of 20 degrees and a vertical approach distance of 0.025. The toolpath and cut material simulation is shown in the images below.



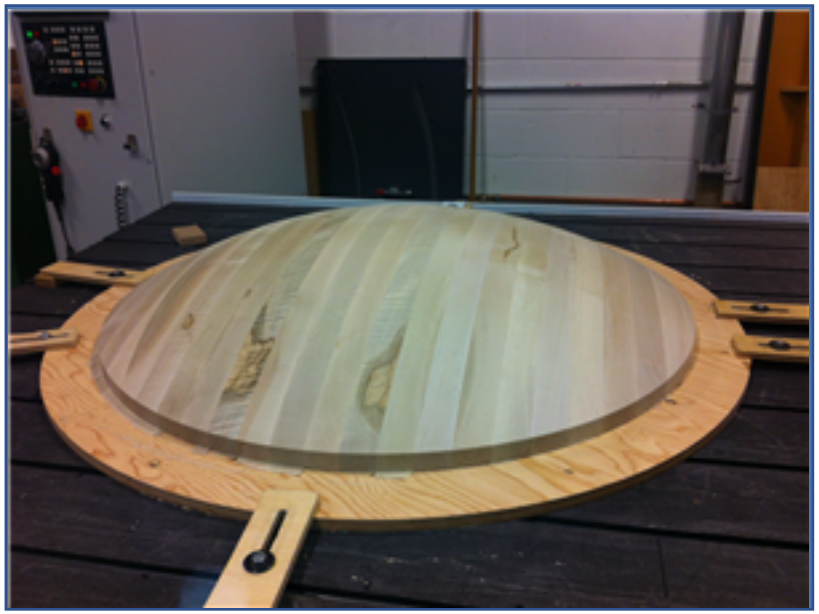
(A)



(B)

The Completed Thermoform Mold

Here is the completed thermoform mold still on the 3 Axis router at PolyFab.



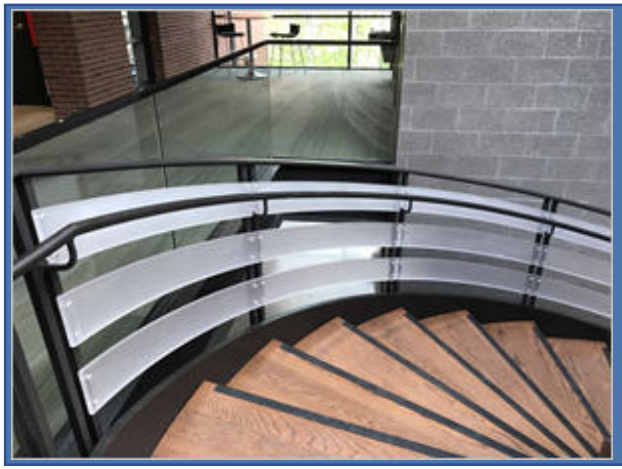
"Just one of the many things I like about Rhino and RhinoCAM is that my customers want to send me all kinds of different files and in different units, 2D, 3D, DXF, STEP, IGES, SOLIDWORKS, etc. and I say YES, no problem! I can post G-Code for any file that opens in Rhino!"

Preston Fiske
Owner/Operator, PolyFab Corporation, Wilmington, MA

More about PolyFab

PolyFab is a Wilmington,l MA based company that sells custom fabrication to clients world-wide. Their motto "You design it. We'll build it." is true to its word with projects that span a wide application spectrum including Architectural, Laboratory, Water Treatment, Marine, Air Handling and Government Contracting all manufactured with the help of RhinoCAM. Here are just a few project images courtesy of PolyFab. See PolyFab's complete photo gallery here.

Architectural: 8 ft diameter acrylic diffuser National Signs, Houston, TX Example of Drape Forming Acrylic



Architectural: Circular Staircase Rails for Eaglebrook School, Deerfield, Massachusetts. Staircase by Charles Wiemeyer.

Architectural: Polypro Chairs, produced for Eric Howeler, www.hyarchitecture.com

Air Handling: PVC scrubber

Want to see how RhinoCAM can help you? Click Here to download a demo!

Marine:
Seaboard Locker

Marine:
Refrigerator Liner

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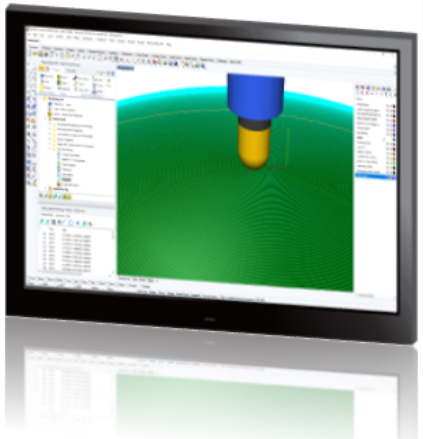
More about RhinoCAM

RhinoCAM - MILL is available in five different configurations (Express, Standard, Expert, Professional and Premium). The part shown here was programmed using the Professional configuration. Here are some additional details about each of the available configurations. For the complete features list, visit the RhinoCAM Product Page.



- **RhinoCAM MILL Express**: This is a general-purpose program tailored for hobbyists, makers and students. Ideal for getting started with CAM programming. Includes 2 & 3 axis machining methods. Includes ART & NEST modules as well!
- **RhinoCAM MILL Standard**: This configuration includes everything that is in the Express configuration and additional 2-1/2 Axis, 3 Axis & Drilling machining methods. Also now includes 2½ Axis Turning!
- **RhinoCAM MILL Expert**: Suitable for 4 Axis rotary machining. Includes the Standard configuration, plus 4 Axis machining strategies, advanced cut material simulation and tool holder collision detection.
- **RhinoCAM MILL Professional**: Ideal for complex 3D machining. Includes the Standard and Expert configuration, plus advanced 3 Axis machining strategies, 5 Axis indexed machining, machine tool simulation, graphical toolpath editing and a host of other features.
- **RhinoCAM MILL Premium**: Tailored for complex 3D machining with both 3 Axis and full 5 Axis methods. Includes the Standard, Expert and Professional configurations, plus 5 Axis simultaneous machining strategies.

Want to see how RhinoCAM can help you? Click Here to download a demo!

For the complete features list, we invite you to visit the
RhinoCAM Product Page:
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