Mold & Die at
# Conley Manufacturing

Conley Manufacturing located in Shelby Township, just north of Sterling Heights, MI, manufactures machined tool & die components for the automotive and aerospace production markets. Companies like Boeing, Cessna, Honda Jet, Ford, GM and Chrysler turn to Conley Manufacturing for specialized jigs, SPC (Statistical Process Control) checking fixtures and CMM (Coordinate Measuring Machine) holding fixtures. The company also machines inserts for plastic injection mold tooling.

Al Grifka, CNC Manager for Conley Manufacturing, has been machining tool & die components using RhinoCAM for the past 5 years. Al comes from a family of engineering expertise. His father is an engineer with Chrysler Corporation and three of his cousins are all tool & die machinists with the top three automakers. We recently sat down with Al to discuss his use of RhinoCAM CNC software from MecSoft Corporation.

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1
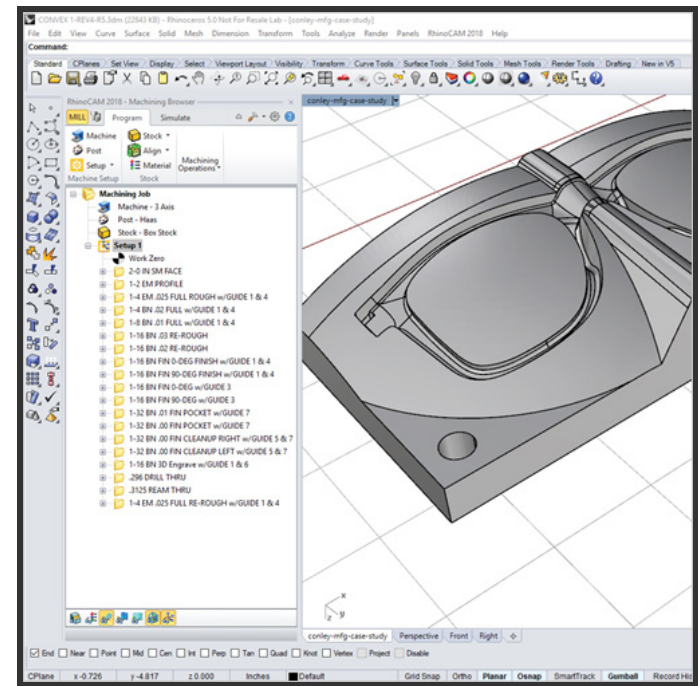
The RhinoCAM Difference

Al started his career operating 3 Axis CNC mills for a local machine shop. Demonstrating his skills in numerical control, Al was quickly promoted to a CNC programmer. Using RhinoCAM, Al demonstrated his skill set where it counts: cutting quality metal components alongside older and more experienced machinists, many of whom who were using Mastercam.
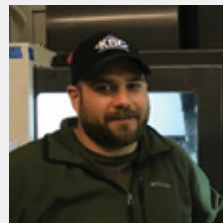
"When I help to opened this shop I knew that we were going to use Rhino and RhinoCAM! This combination together allows us to do both design and CNC programming. One of the many things I like about RhinoCAM is the High Speed Cut patterns. I can set our Haas VF2 to rough and remove a lot of material very quickly using RhinoCAM!"

*Al Grifka, CNC Manager, Conley Manufacturing, Shelby Township, MI*

Quality & Craftsmanship

When you consistently provide accuracy and quality while producing SPC and CMM tooling for the automotive and aerospace industries, you know and your customers know how good you really are! That's why we at MecSoft Corporation are proud that Al Grifka and Conley Manufacturing rely on our RhinoCAM CNC software!
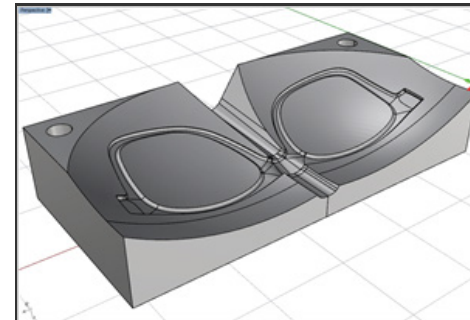
Machining Core & Cavity Inserts

Conley Manufacturing also machines core & cavity inserts for plastic injection mold tooling. While Al is restricted from showing us his production automotive and aerospace tooling, he has agreed to collaborate with us on another one of his projects for the purposes of this case study. The convex cavity side insert for the injection mold to produce these glass frames is an excellent opportunity to discuss some of the techniques you can use in Rhino and RhinoCAM to ensure machining accuracy and quality, especially relating to parting lines.
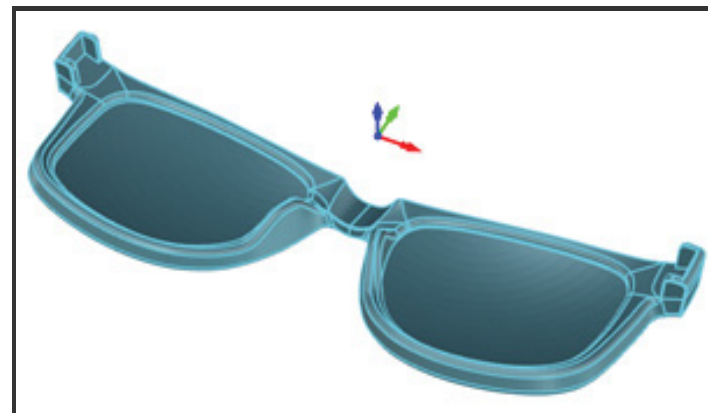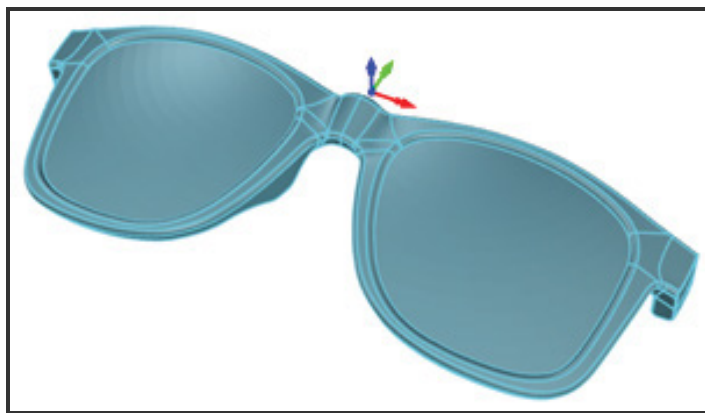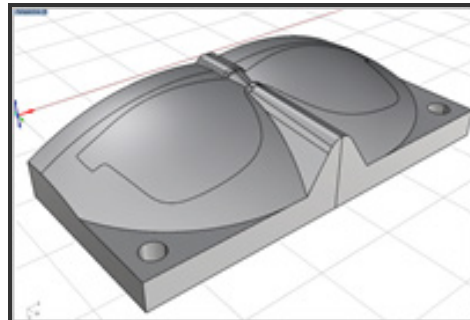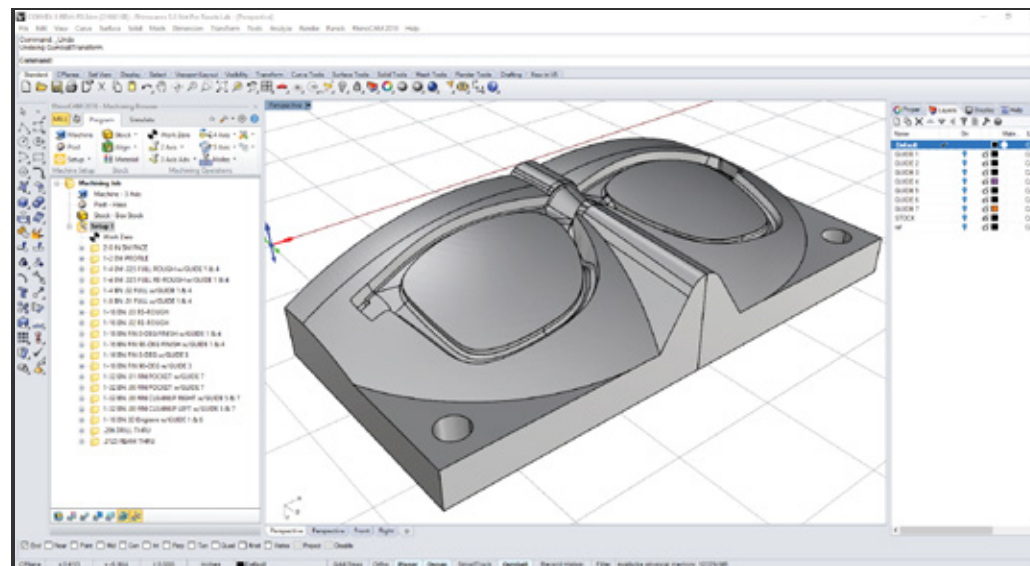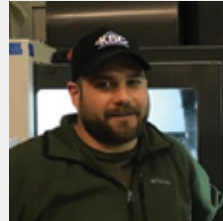
The Convex Cavity Insert

The Concave Cavity Insert

The Convex Mold Cavity part is open in Rhino with the RhinoCAM plug-in loaded and the toolpaths listed in the Machining Browser on the left and the Rhino Layer Manager shown on the right.

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"For our CNC programming, RhinoCAM was the better choice than Mastercam. RhinoCAM is both cost-effective and easy to use. Coming from a tool & die family, I have a cousin who has been in this business for many years and has used many different CAM programs. The fact he recommended RhinoCAM over Mastercam was refreshing and helped to reinforce my decision to go with RhinoCAM!"
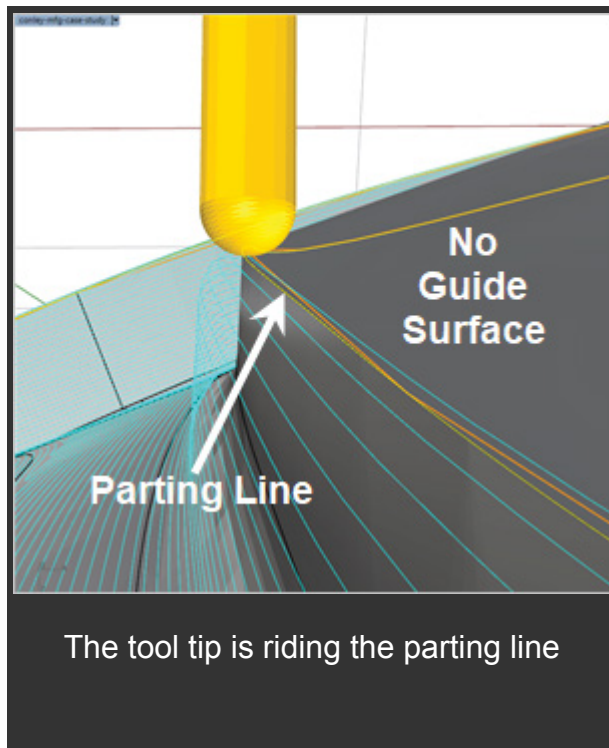
Al Grifka, CNC Manager, Conley Manufacturing, Shelby Township, MI
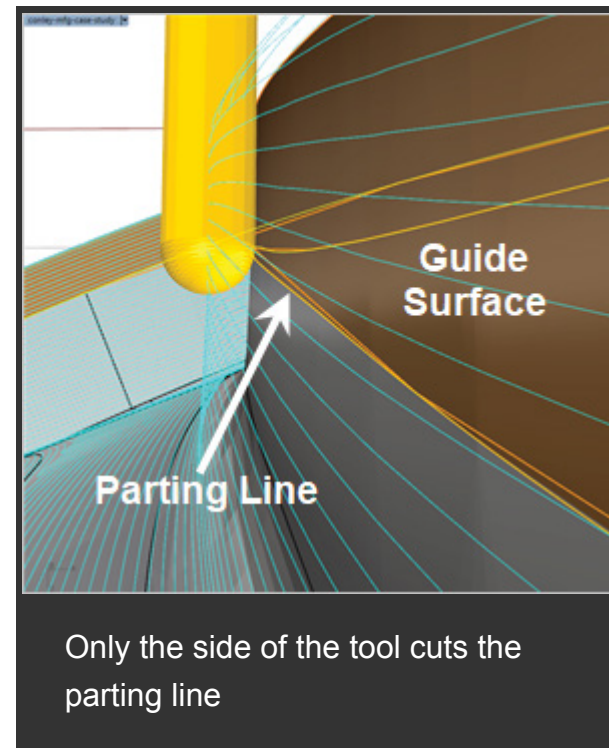
It's all about the Parting Line!

To maintain parting line accuracy and integrity during 3 Axis machining, the cutting tool SHOULD NOT ride on or along ANY parting line edge. With the use of guide surfaces (discussed in more detail below), the side of the tool always cuts along the parting line in the Z Axis, while the tip of the tool always cuts past the parting line in the X and Y Axis.
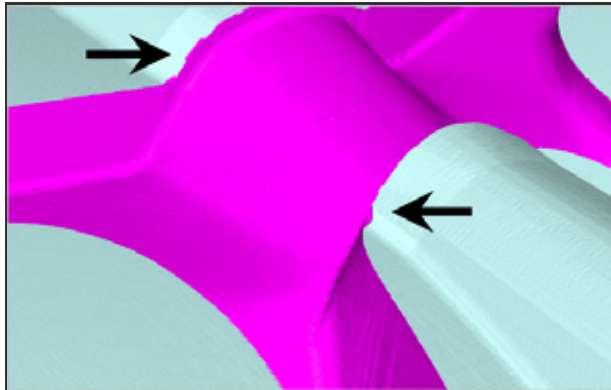
You can see the effect on the quality of the parting line even in the RhinoCAM cut material simulation! In the images below, allowing the tool to ride the parting line (shown on the left) will degarde the parting line and cause mismatch and flash in the injection molded part. With the use of guide surfaces (shown on the right), the integrity of the parting line is maintained. In the images below, the mold cavity is displayed as grey, the guide surfaces are brown and the cut material simulation of the cavity is shown as magenta.
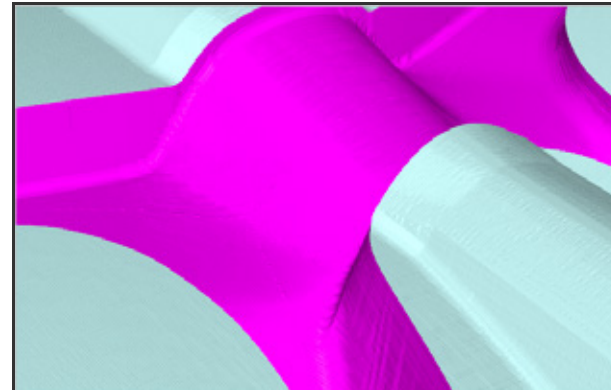
NOT RECOMMENDED!	RECOMMENDED!
The tool tip is riding the parting line	Only the side of the tool cuts the parting line

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Simulation results when tool tip rides the parting line
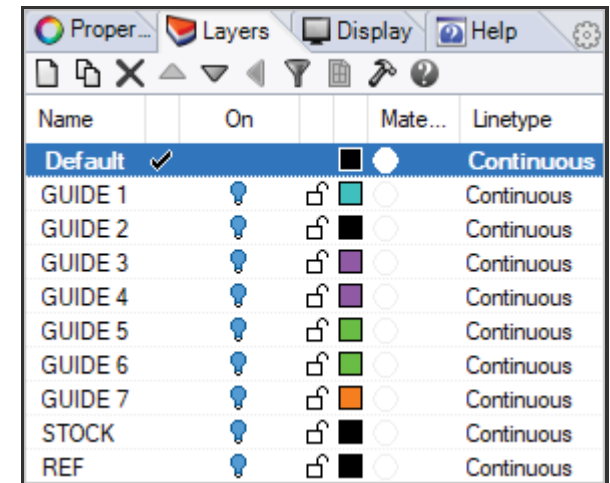
Results when the side of tool cuts the parting line

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Using Guide Surfaces in 3 Axis Machining

The key to accurately machining cavity inserts is all about tool control at and along parting lines or other key surface boundaries. This is effectively accomplished with the use of guide surfaces. Most of the toolpath strategies shown below have one or more additional geometry layers assigned to it. The Layers tab in Rhino is shown here. At the time the toolpath is generated, the assigned GUIDE surface layers are displayed along with the part geometry. The additional surfaces on these layers guide the tool over these key areas.

The guide surface geometry listed and shown below is used for the convex side of the cavity insert:
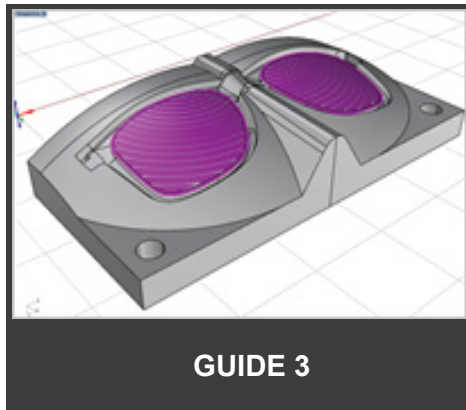
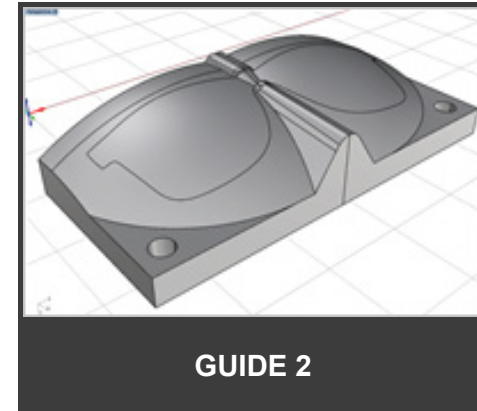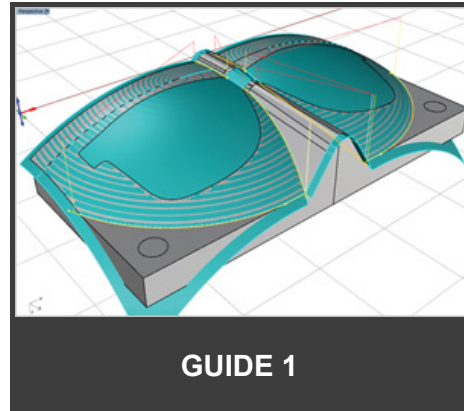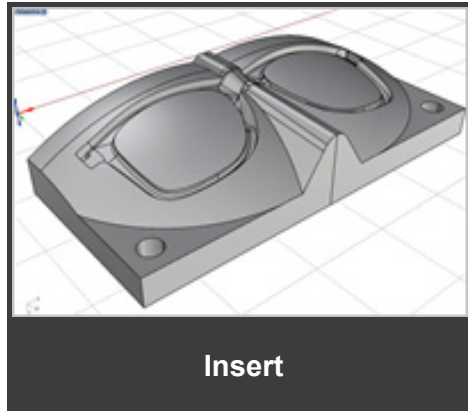**Insert:** The insert geometry

GUIDE 1: The entire cavity parting surface extending past the insert boundaries

GUIDE 2: The parting surface covering the cavity only.

GUIDE 3: The parting surface of the inner island core (each side) that extends past the cavity parting line.

GUIDE 4: The horizontal parting surface at the split plane extending past the insert boundaries.

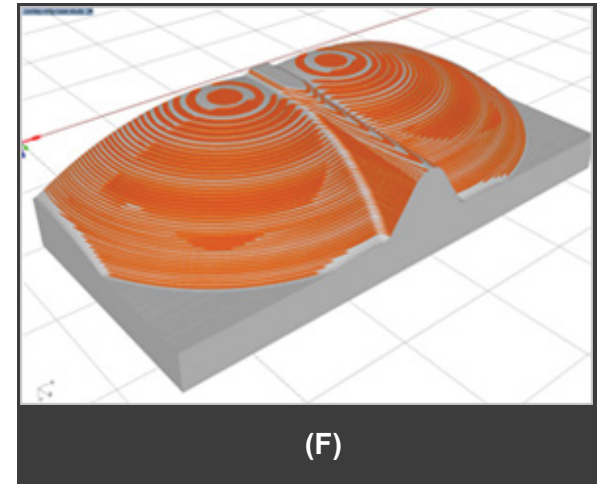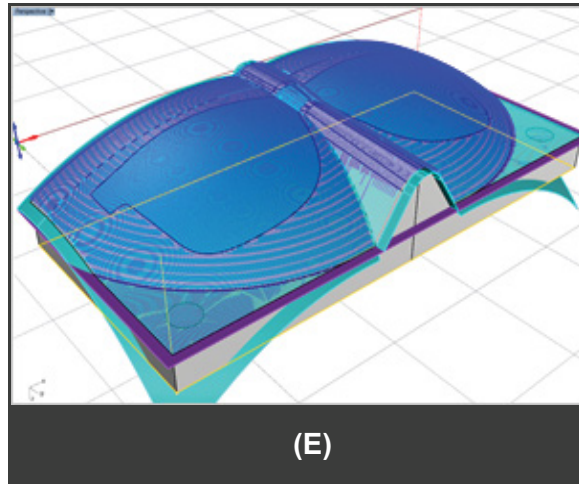**GUIDE 7:** The guide surfaces that extend upward from the parting line.

Insert

GUIDE 1

GUIDE 2

GUIDE 3

GUIDE 4

GUIDE 7

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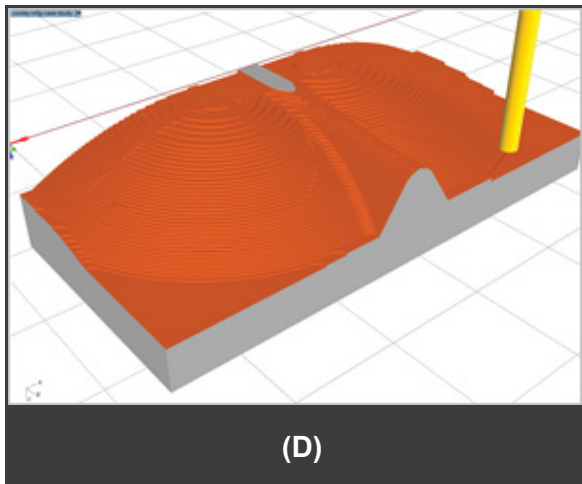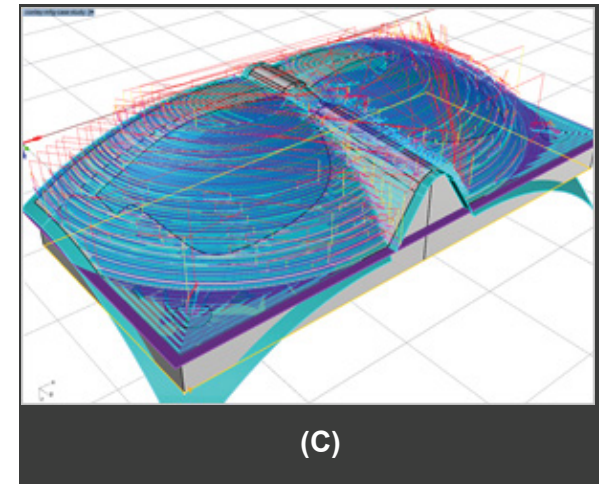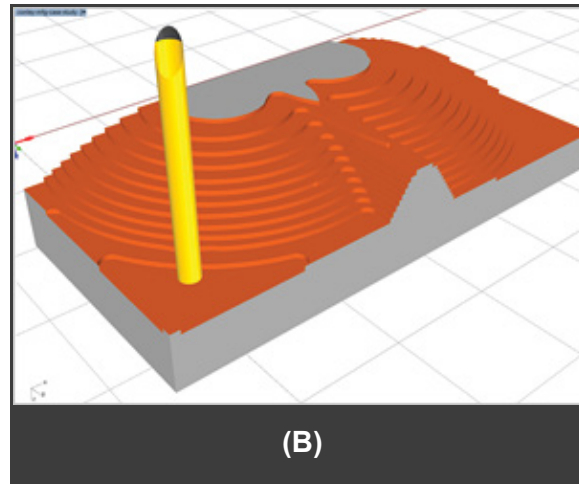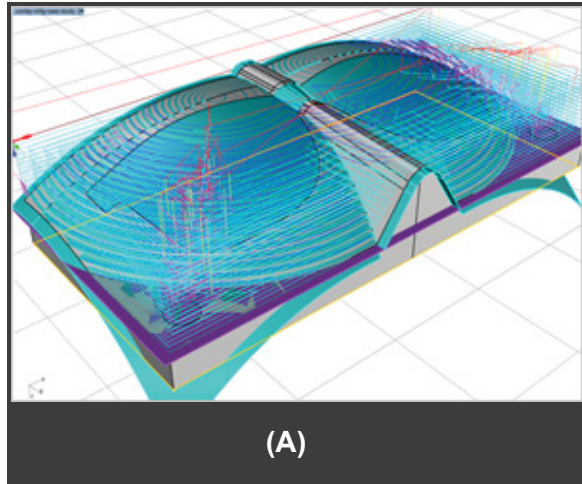
9
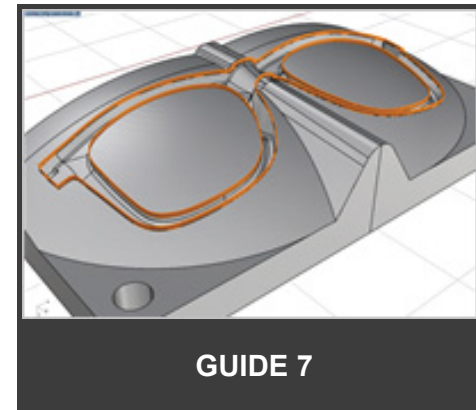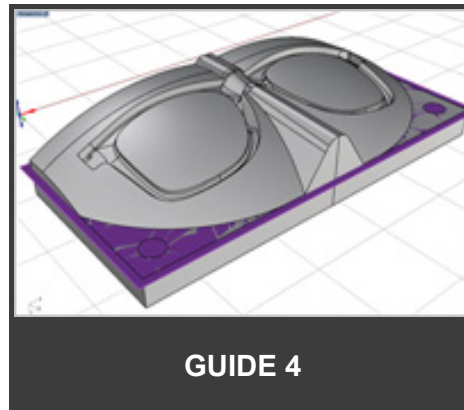
The Machining Job Tree

Let's take a closer look at Setup 1 in the Machining Job tree in the convex cavity insert part. The first two operations are 2½ Axis Facing & Profiling toolpaths used to square the stock. The next seven operations are the 3 Axis Roughing toolpath strategies. The next nine operations are comprised of 3 Axis Advanced Finishing toolpath strategies. The assigned guide surface layers are added to the operation names (i.e., w/GUIDE 1 & 4). The last two operations are Drilling and Reaming toolpaths.
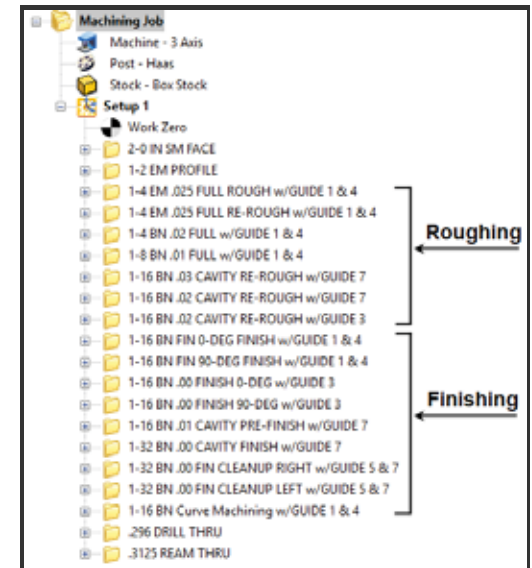
Roughing the Parting Surfaces

In this set of roughing toolpaths, the 3 Axis Advanced Horizontal Re-Roughing strategy... is used extensively to clear material away from the parting surfaces. You will notice that GUIDE 1 & 4 are displayed during the generation of the roughing paths to keep the cutting tool clear of the cavity. You will notice that GUIDE 3 & 7 are displayed while generating the roughing paths exclusively for the cavity. Let's have a closer look.

It begins with the initial 3 Axis Horizontal Roughing operation using a ¼" end mill leaving 0.025" of stock (images A & B). Then a re-roughing operation using the same ¼" end mill leaving 0.01" of stock (images C & D). At this point, two parallel finishing operations are used for additional roughing, the first with a ¼" ball mill, leaving 0.02" of stock (images E & F) and the second with a ⅛" ball mill leaving 0.01" of stock (not shown).

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(A)

(B)

(C)

(D)

(E)

(F)

Roughing the Cavity

To rough cut the cavity, three re-roughing operations are used while GUIDE 3 & 7 are displayed. While guide surfaces are not really needed for roughing operations because of the stock allowance values, we use them here to further illustrate their purpose. Again, only previously uncut material within these areas are calculated for these toolpaths.

It begins with two 3 Axis Advanced Horizontal Re-Roughing operations using a 1/16" ball mill for the cavity while GUIDE 7 is displayed. The first leaves 0.03" of stock while the second leaves 0.02" of stock. The second operation is shown in images A & B below. The third re-roughing operation is contained to the perimeter of the inner islands using the same 1/16" ball mill and leaving 0.02" of stock (images C & D below).
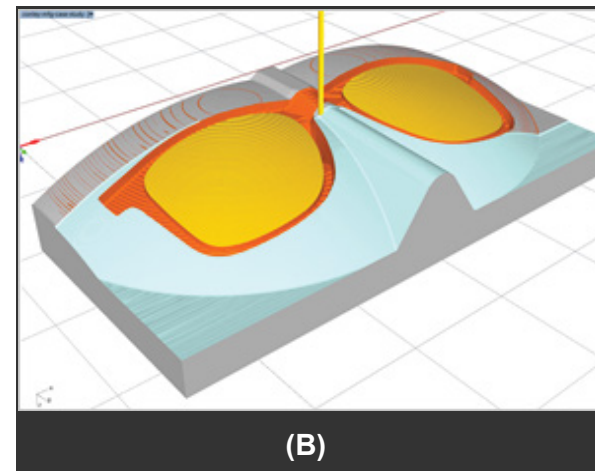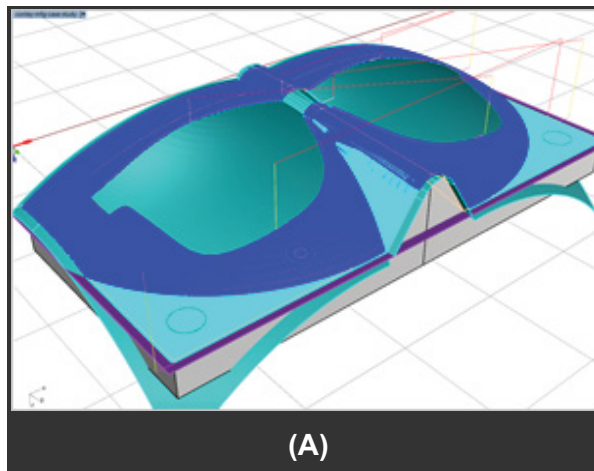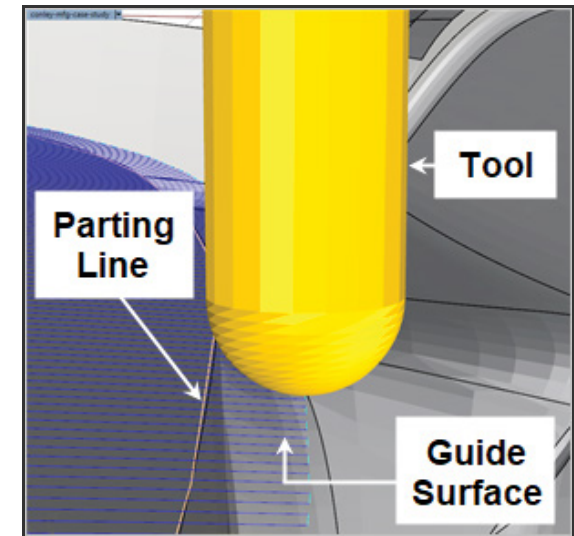

(A)

(B)
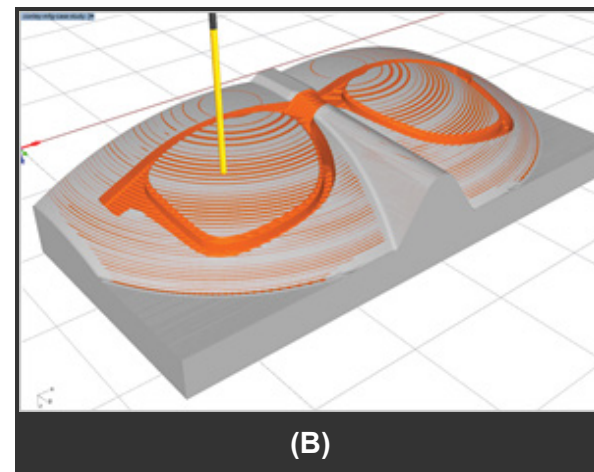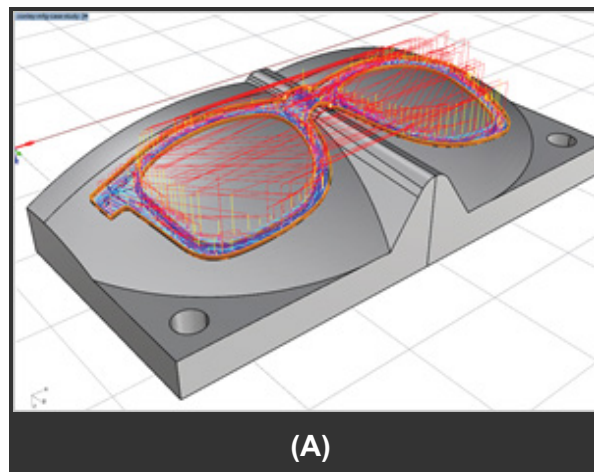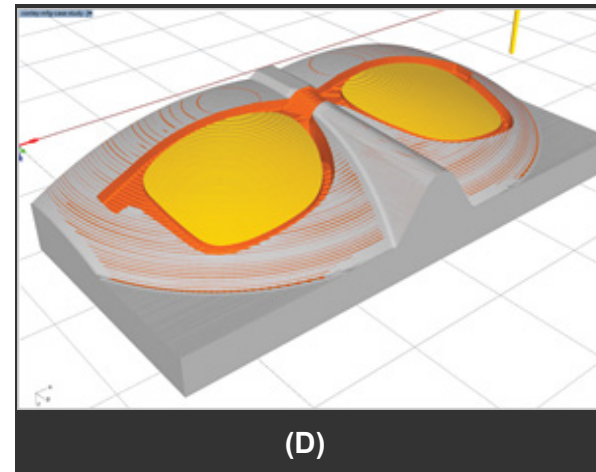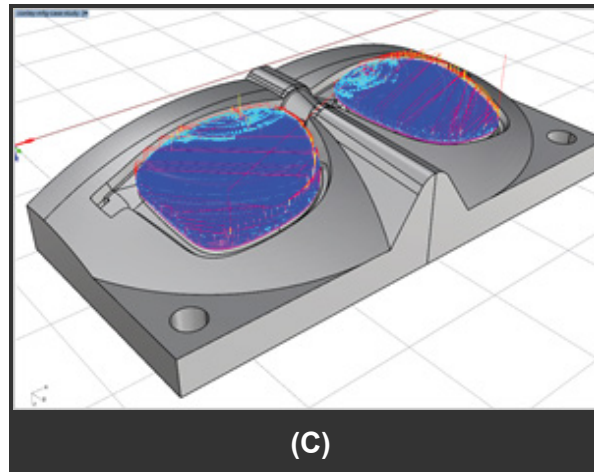
The toolpaths are shown on the left. The cut material simulation are shown on the right.
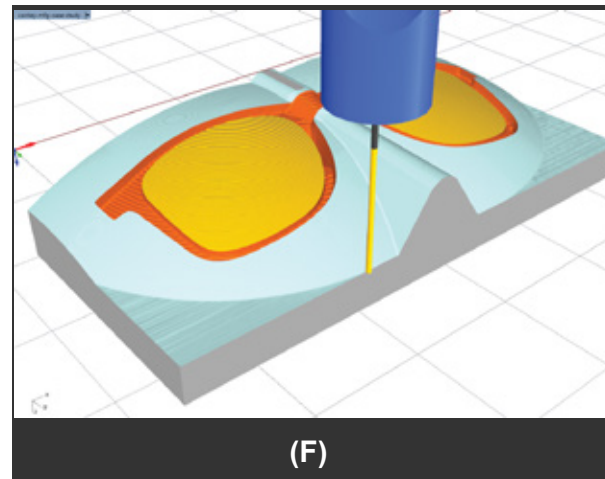
You might ask "why is a separate operation used for the inner island regions?" This is to take advantage of the additional Surface Boundary Condition parameters available in RhinoCAM. With the boundary condition is set to PAST, the cutting tool will automatically extend past the selected surface boundaries. Couple this with GUIDE 3 surfaces being displayed and the tool follows the guide surface during the extension rather than rolling down and over the parting line! This technique is further illustrated in the finishing toolpath section below.

Finishing the Parting Surfaces

The 3 Axis Parallel Finishing strategy is used for the parting surfaces. They are generated with GUIDE 1 & 4 displayed. Again, the parting surface boundaries are used with the Boundary Condition set to PAST. Once the tool traverses past the parting surface boundary (i.e., the parting line), it follows the guide surface instead of riding on the parting line. This is shown up close in the image on the left.

For the best finish, this toolpath is repeated once along the X Axis direction (at zero degrees shown in images A & B below) and again along the Y Axis (not shown). The finishing strategy for the inner islands is shown in images C & D. To complete the parting surface, finishing a 3 Axis Curve Machining toolpath is used to clean up the bi-tangent edges. These are shown in images E & F below.

(A)

(B)

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(C)

(D)

(E)

(F)
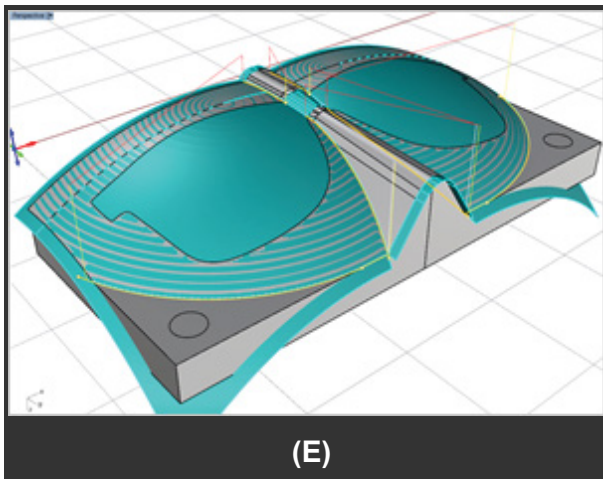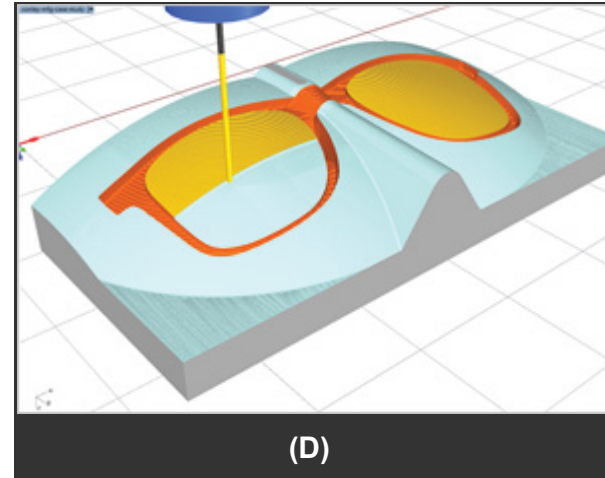
The toolpaths are shown on the left. The cut material simulations are shown on the right.

Finishing the Cavity

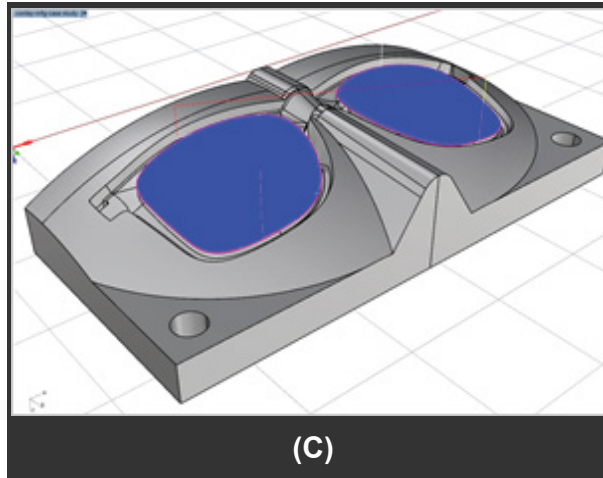Now we get to the cavity! Here we use a combination of 3 Axis Parallel Finishing and 3 Axis Advanced 3D Offset Pocketing strategies. Both of these are generated with GUIDE 7 displayed. You will notice that the guide surfaces extend from the cavity parting line edge upwards. This guide surface only needs to extend upwards by a distance equal to the radius tool. We extended it up further here just to help illustrate the technique.

The first 3 Axis Parallel Finishing toolpath leaves 0.01 of stock, thus it is used as a pre-finishing strategy (images A & B). The second 3 Axis Advanced 3D Offset Pocketing toolpath is the actual finishing strategy with stock set to zero (images C & D). The resulting quality of the parting line using the guide surfaces technique is clearly visible. See the section It's all about the Parting Line section above!
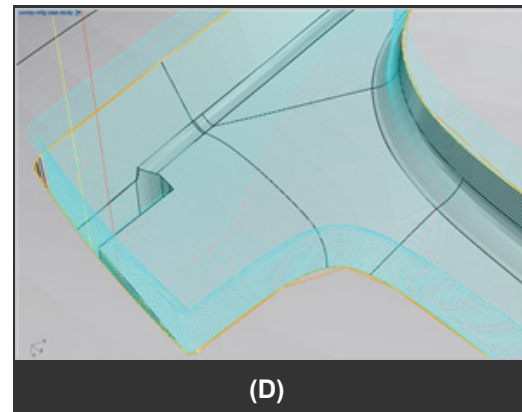

(A)

(B)

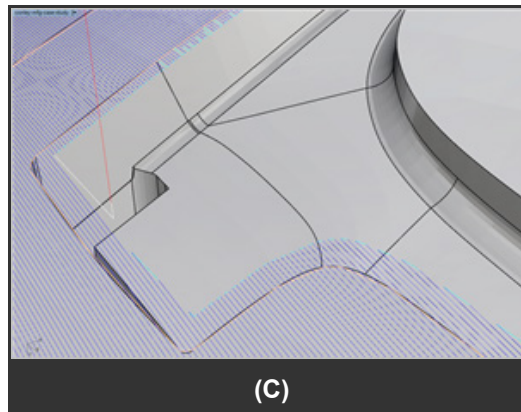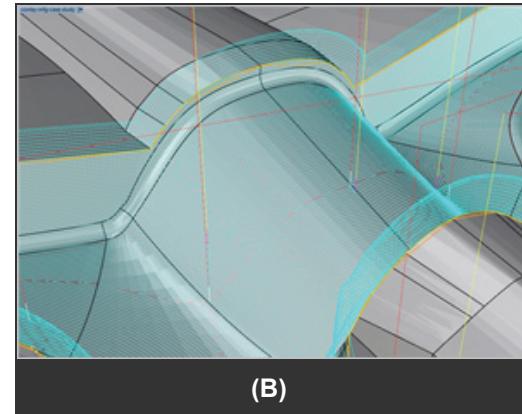| (C) | (D) |
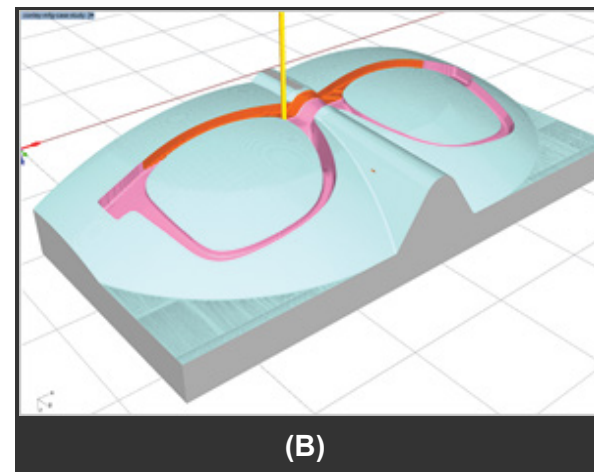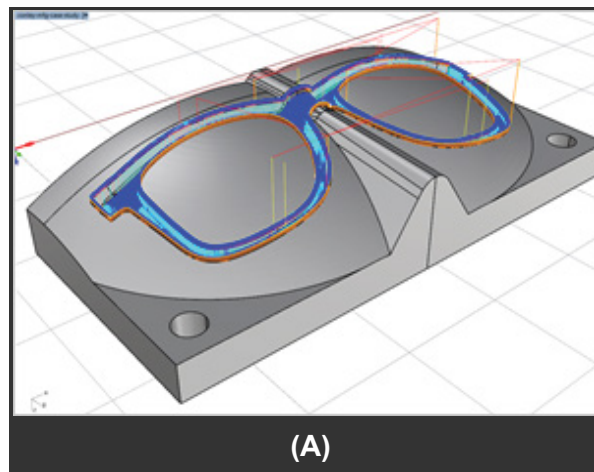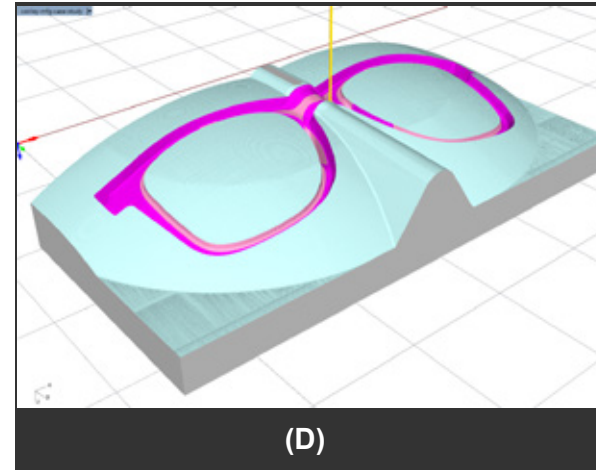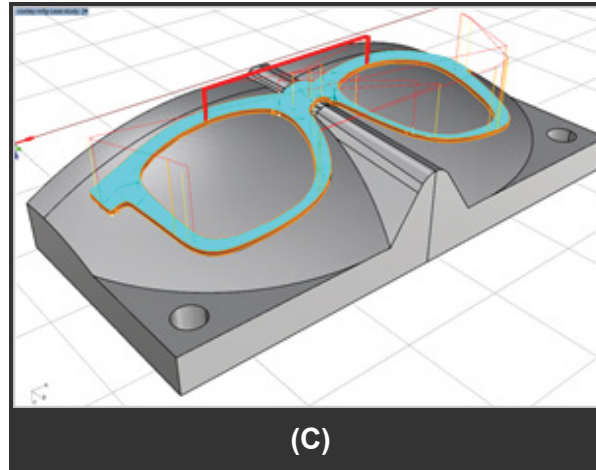
The toolpaths are shown on the left. The cut material simulation is shown on the right.

![RhinoCAM MecSoft logo]

A Closer Look

Here are some close-up images of the finishing toolpaths at the cavity parting lines. The guide surfaces are not displayed.

(A)

(B)

(C)

(D)

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Watch the Cut Material Simulation
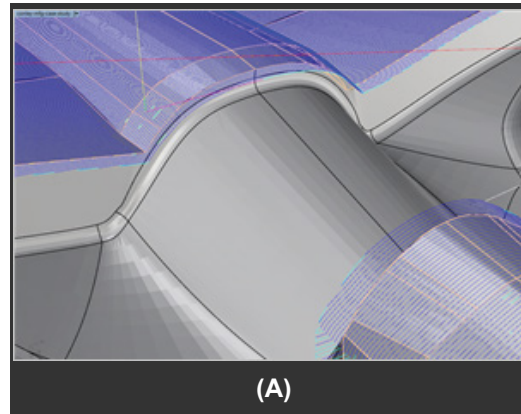
Electrode Machining

Here is an optional electrode design for the convex cavity illustrated above. In electrical discharge machining (EDM), the desired cavity is burned away from the insert blank by a series of rapidly recurring current discharges between two electrodes that are separated by a dielectric liquid. One of the electrodes is called the tool-electrode or simply the "electrode," while the other is called the workpiece-electrode or "work piece." In this approach, the workpiece (shown on top in the image on the right below) is machined without the cavity, while the electrode (shown on the bottom) is machined separately. EDM is used in areas that are difficult or impossible to machine directly.

(A)

(B)
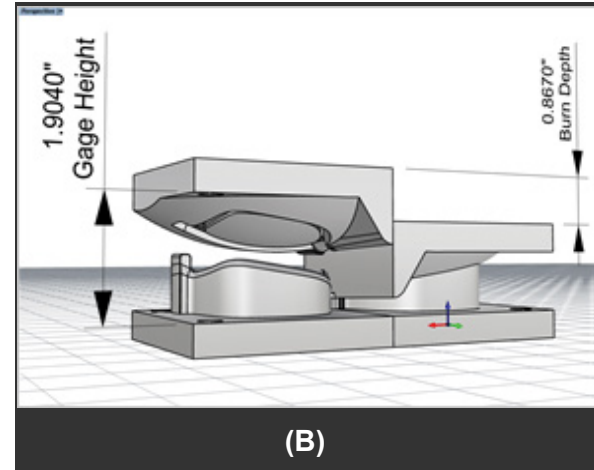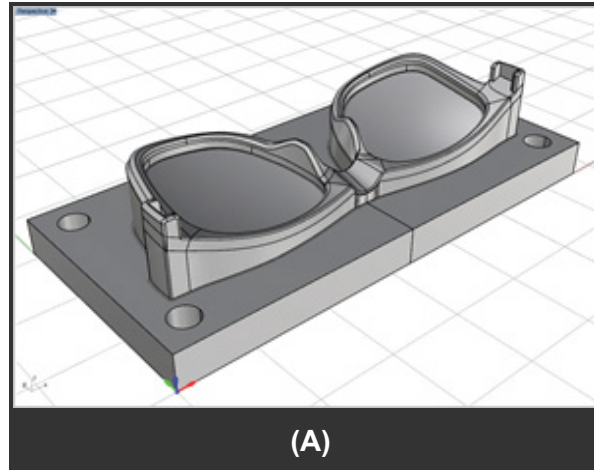
More about Conley Manufacturing

Al Grifka is CNC Manager at Conley Manufacturing located in Shelby Township just north of Sterling Heights, MI. Al performs precision tool & die machining and manufacturing for the automotive, aerospace and consumer products markets using RhinoCAM CNC software on the companies Haas VF2-3 Axis Machining Centers. We encourage you to visit them online at conleymanufacturing.com.

Here are some sample aluminum mold components from Conley Manufacturing:

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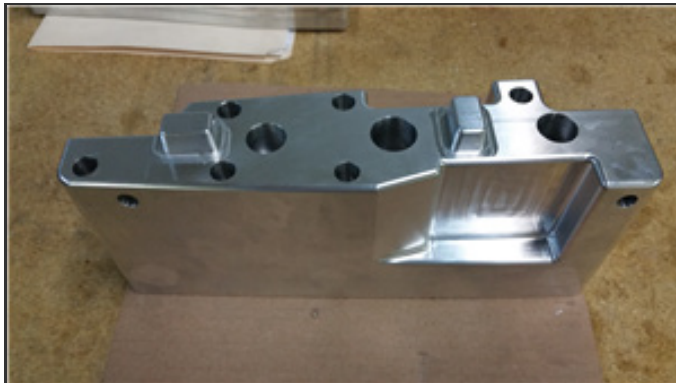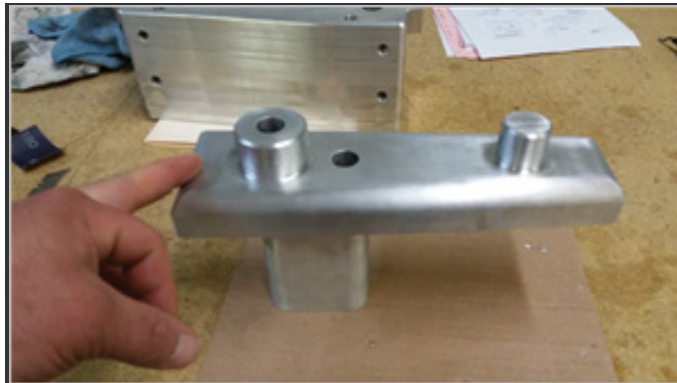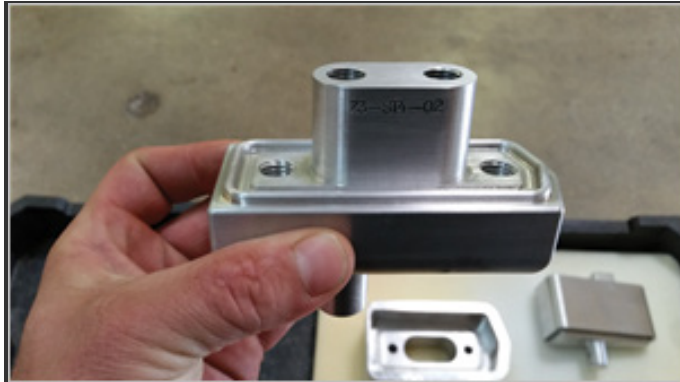
More about RhinoCAM

RhinoCAM - MILL is available in 5 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.

- **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.