

Rex Smith, Vice President of MSN[®] Operations (Retired) uses RhinoCAM to build 1/8 Scale Heisler Steam Locomotive!

Rex Smith (Portland, OR) was a Corporate Vice President of MSN[®] Operations at Microsoft until his retirement in 2002. Rex was also the COO of the first startup company to bring free email service over the world wide web. That company, Hotmail.com was co-founded by Rex's son [Jack Smith](#) and [Sabeer Bhatia](#) in 1996 and later acquired by Microsoft in January of 1998. Prior to that Rex was a successful Electrical Engineer in computer, calculator and microchip design with [Hewlett-Packard](#), and [Apple Inc.](#) Taking a side-trip from the development world, Rex also headed up manufacturing for [Sun Microsystems](#) in the late '80's.



The RhinoCAM Difference

Since his retirement Rex has assembled a well-equipped workshop in Portland, OR where he currently provides *build-to-print* milling and turning services to local industries in his spare time. With no previous CAD or CAM experience Rex has successfully implemented [Rhino from McNeel & Associates](#) and [RhinoCAM from MecSoft Corporation](#) for the past 5 years. From his workshop Rex also spends time on his passion for scale model railroads where he is in the process of manufacturing a working 1/8 scale replica of the [Heisler Steam Locomotive](#)! Read more history of the Heisler below! Rex's 1/8 scale Heisler is a three-truck engine with an undercarriage frame that is 6.56" wide x 91" long and stands 20" high. The width of the rails (wheel to wheel span) is 7.5". [Here is a video of a similar completed working model](#).



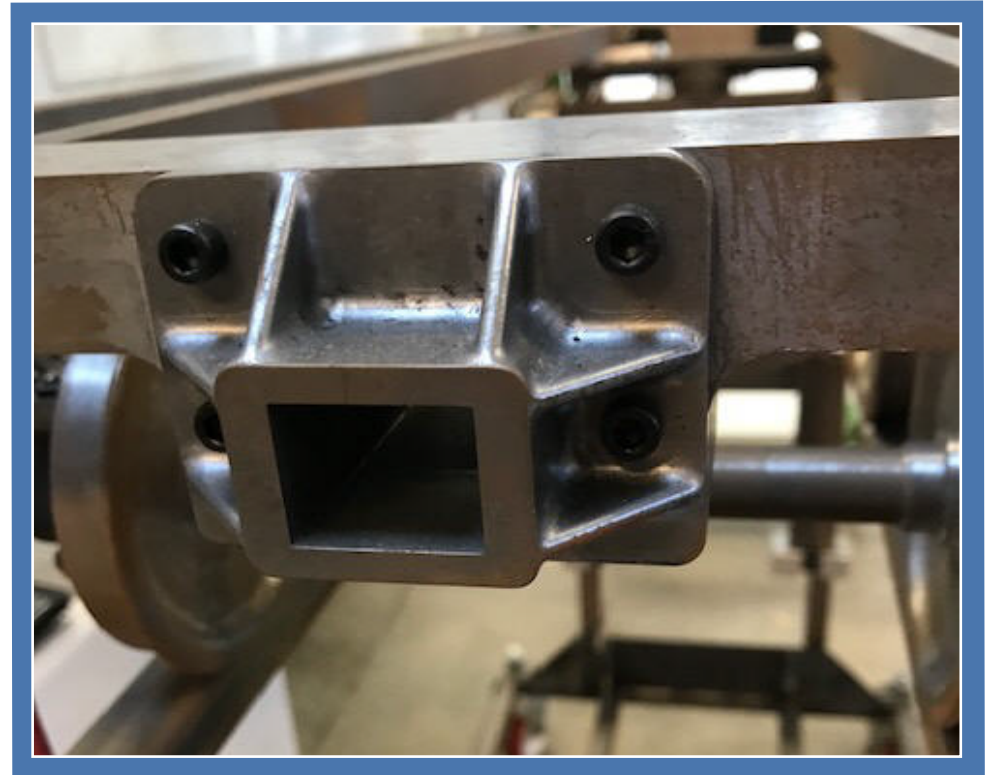
"I've been totally happy with RhinoCAM. When your software is working for you there is no need or desire to change. I really like the technical support. To have a problem and be able to send you guys an email with a copy of the file and get an answer back within an hour - that's just fantastic!"

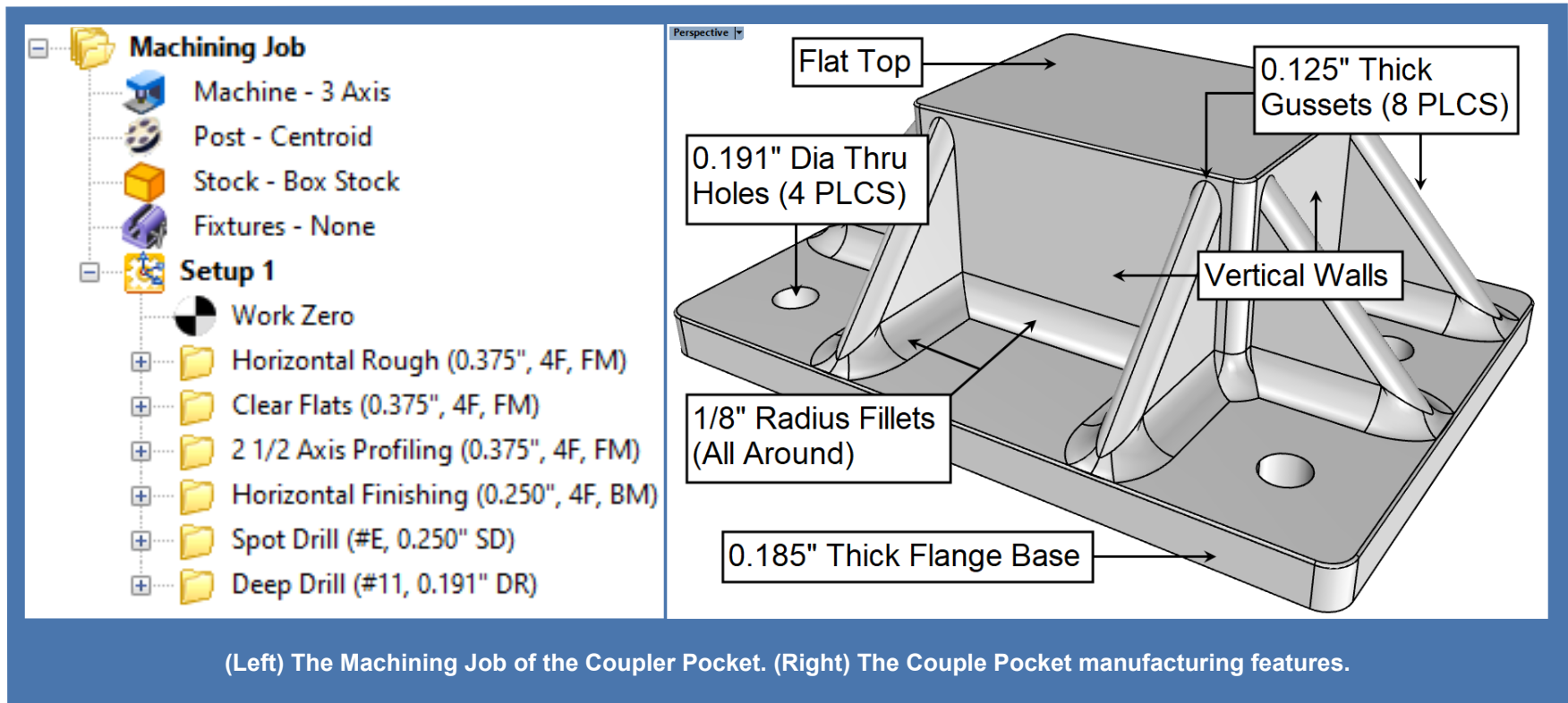
*Rex Smith
Corporate Vice President of MSN® Operations, (Retired)
Manufacturer & Steam Locomotive Enthusiast
Portland, OR*

The Coupler Pocket Project

The part for this project is the coupler that will be used to connect the engine with its trailing cars. The actual completed part is shown on the right. The part dimensions are 3" long x 2.07" wide x 1" high with features that include a horizontal top, vertical side walls, $\frac{1}{8}$ " thick gussets, a flat base flange, $\frac{1}{8}$ " fillets and four thru mounting holes. You can refer to the illustration below.

The machining job shown below on the left consists of a 3 Axis setup, a box stock measuring 3.25" long x 2.375" wide x 1.01" high that is centered about the part in the X and Y and aligned flush with the bottom of the part in Z. The toolpath operations include 3 Axis Horizontal Roughing, 3 Axis Horizontal Finishing, 2½ Axis Profiling and Drilling that will be posted to a Centroid CNC controller.





Machining Job

- Machine - 3 Axis
- Post - Centroid
- Stock - Box Stock
- Fixtures - None
- Setup 1**
 - Work Zero
 - Horizontal Rough (0.375", 4F, FM)
 - Clear Flats (0.375", 4F, FM)
 - 2 1/2 Axis Profiling (0.375", 4F, FM)
 - Horizontal Finishing (0.250", 4F, BM)
 - Spot Drill (#E, 0.250" SD)
 - Deep Drill (#11, 0.191" DR)

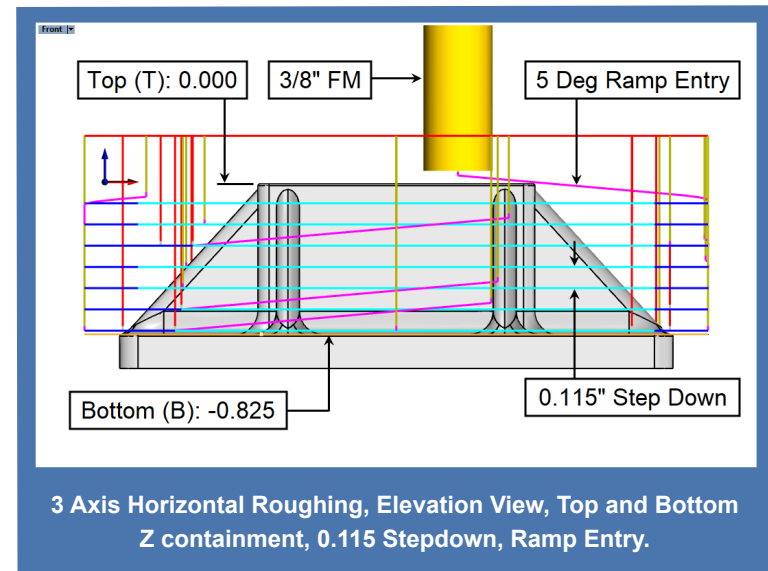
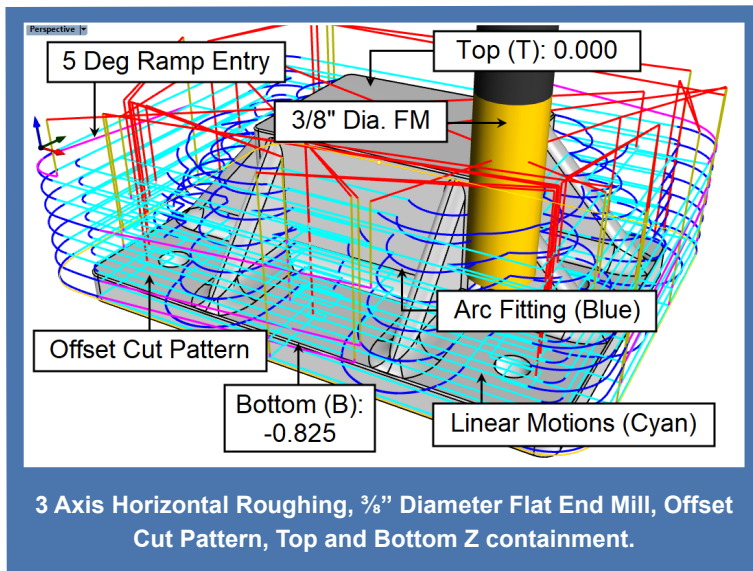
Manufacturing Features:

- Flat Top
- 0.191" Dia Thru Holes (4 PLCS)
- 0.125" Thick Gussets (8 PLCS)
- Vertical Walls
- 1/8" Radius Fillets (All Around)
- 0.185" Thick Flange Base

(Left) The Machining Job of the Coupler Pocket. (Right) The Couple Pocket manufacturing features.

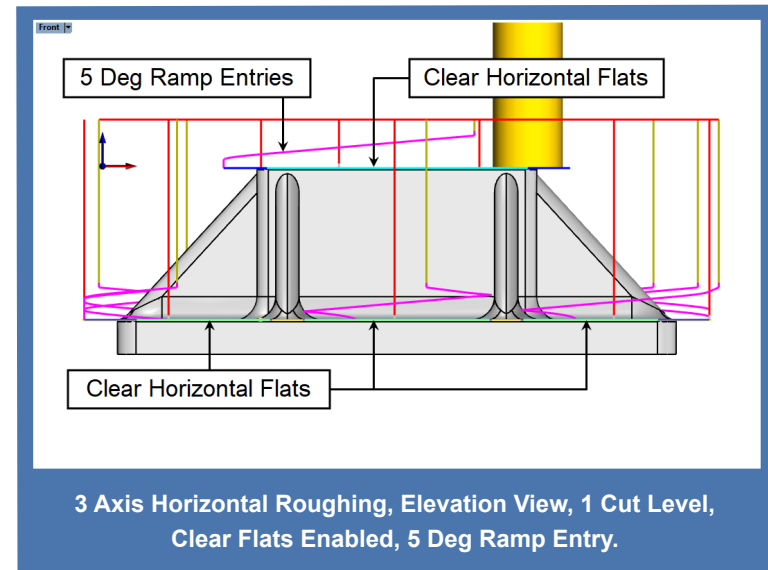
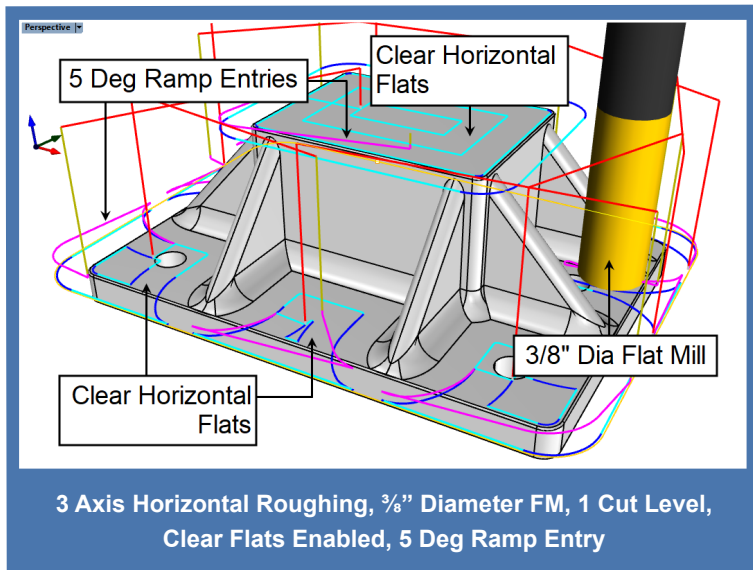
3 Axis Horizontal Roughing

This project starts off with a 3 Axis Horizontal Roughing operation for bulk material removal using a $\frac{3}{8}$ " diameter flat end mill. It is contained within the perimeter of the part in X and Y. In the Z axis the toolpath is contained between the upper flat face and the top of the base flange. The cut pattern is an offset of the outer perimeters, a mixed cut direction and a 5-degree ramp entry at each cut level. The cut start is on the outside with an XY stepover of 55% of the tool diameter. The stepdown control is set to 0.115" per cut level and a cut level ordering of Depth First. Note that Clear Flats is not enabled for this initial roughing operation. This will leave 0.1" of stock on the flat areas. You can refer to the illustrations below.



3 Axis Horizontal Roughing, Clear Flats

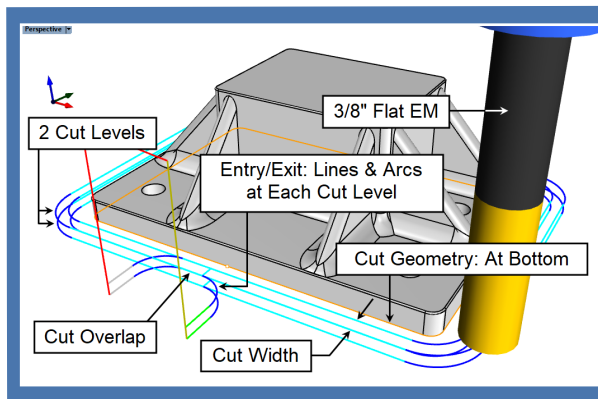
A second 3 Axis Horizontal Roughing operation is used exclusively to clear the flat areas to their finished depth. What is interesting here is the cut level parameters. Instead of providing an exact stepdown distance or percentage which would produce multiple cut levels, the number of levels is set to 1. This will force one cut level at the lowest Z which is at the top of the base flange. Then with Clear Flats enabled from the Cut Levels tab, it forces a second cut level at the top flat face. The remaining parameters are identical to the first roughing operation. Again, you can refer to illustrations below.



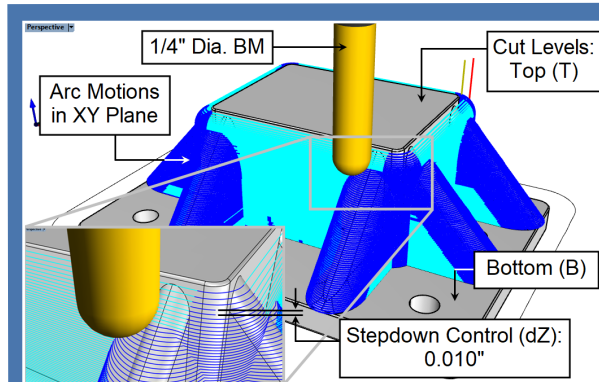
2½ Axis Profiling & 3 Axis Horizontal Finishing

The combination of these two operations will finish all of the vertical walls of the coupler except for the mounting holes. The 2½ Axis Profiling operation uses the same ⅜" flat end mill as the two previous roughing operations. The selected control geometry is the bottom outer perimeter of the base flange. A climb cut direction is used with the cut side being on the outside of the part.

Note the multiple XY stepover passes in the left side illustration below. This is achieved by setting the Cut Width to 0.1 and a stepover to 0.1. For cut levels, the Location of Cut Geometry is set to At Bottom with a Total Cut Depth of 0.185" and Rough Depth/Cut of 0.0925" resulting in two cut levels. Entry/Exit is set to Lines & Arcs with a Tangent approach and departure motions and Radial engagement and retract motions with a 0.25: cut overlap at each cut level. Arc Fitting is also enabled as shown in the blue cut motions.



2½ Axis Profiling,
⅜" FM, Climb Cut,
0.100" Cut Width,
0.185" Cut Depth at
2 Cut Levels,
Linear Approach &
Departure, Radial
Engage & Retract.

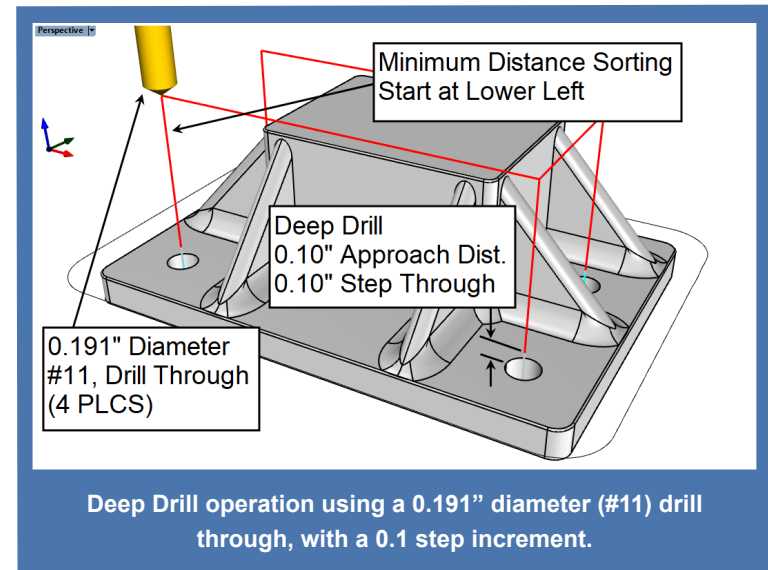
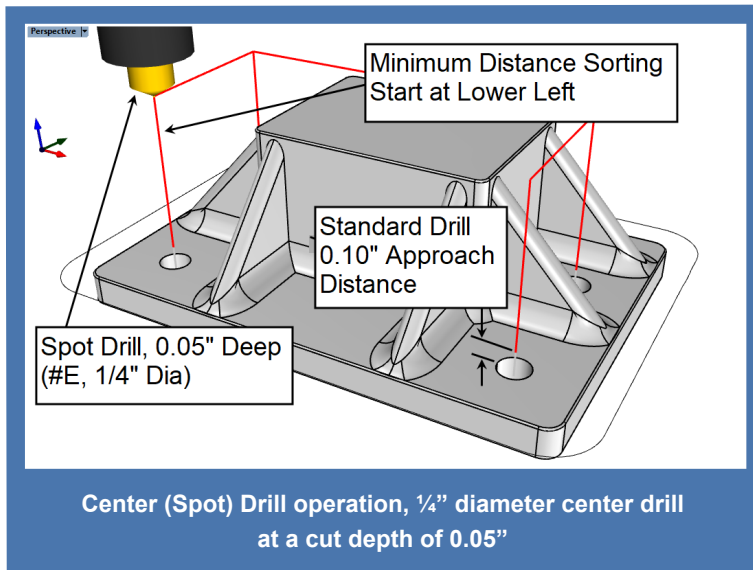


3 Axis Horizontal
Finishing, ¼"
Diameter BM,
0.010" Stepdown
(Dz), Cut Levels
Top and Bottom
Z Containment,
Arc Fitting.

In the right-side illustration above we see a 3 Axis Horizontal Finishing operation using a ¼" diameter ball mill that finishes the vertical walls of the part. This toolpath is contained in the Z axis between the top flat face of the part and the top flat face of the base flange. Stock allowance is zero and Stepdown Control (dZ) is set to 0.01" resulting in a smooth surface finish. Entry/Exit is set to none and Arc Fitting is enabled as shown in the blue cut motions.

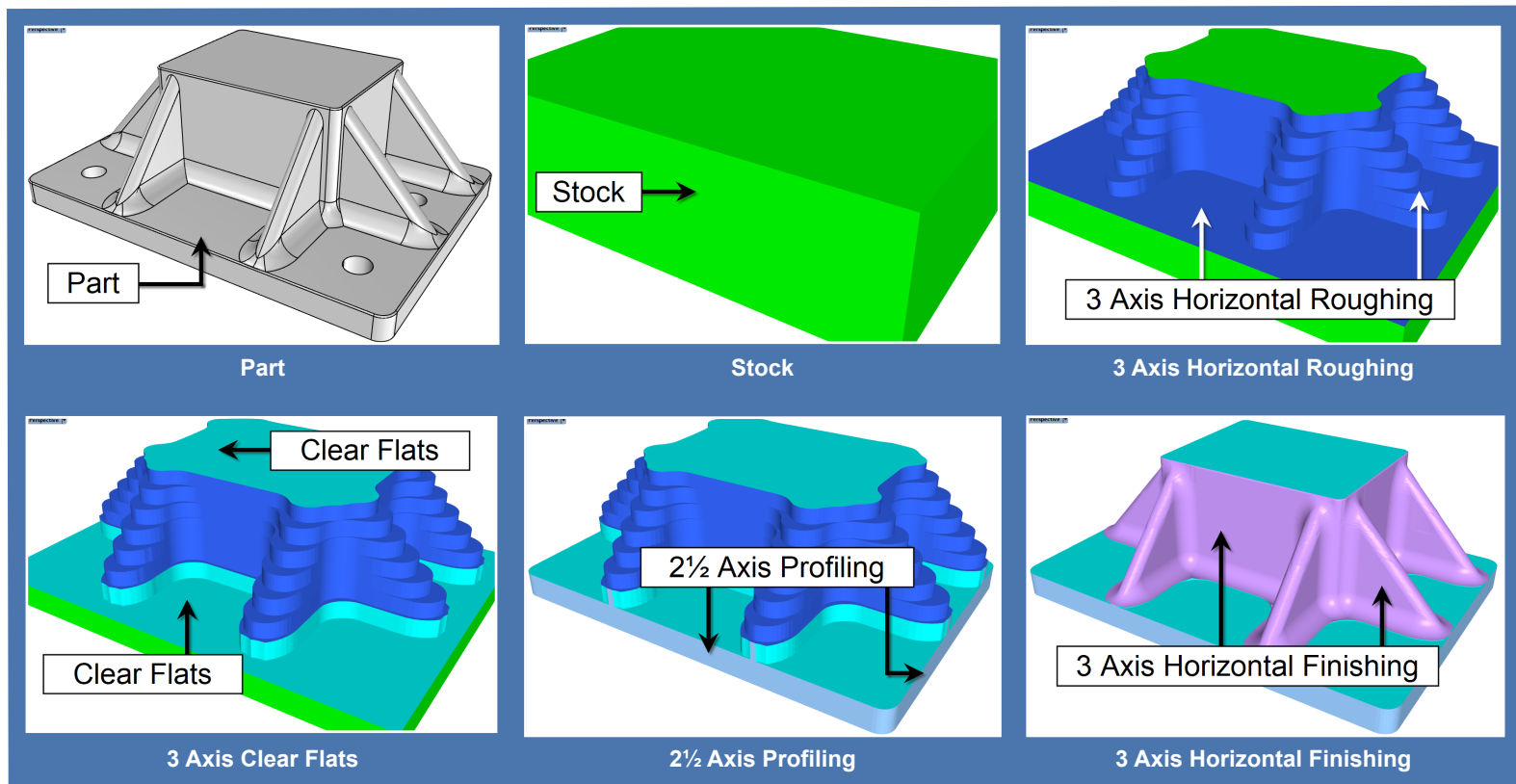
Center (Spot) and Deep Drilling

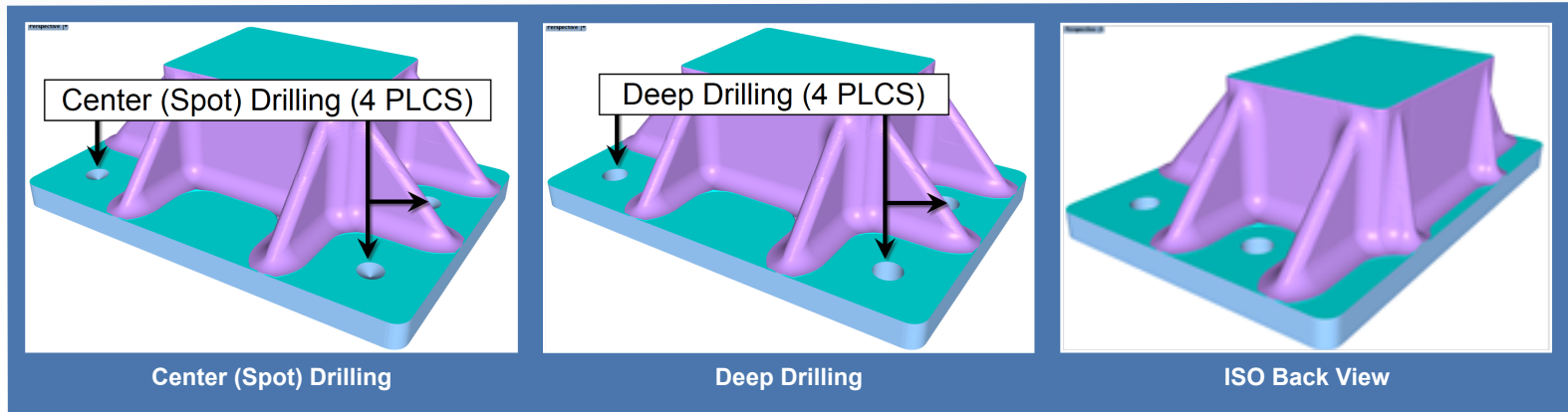
The last two operations in the Machining Job are Drill toolpaths. The first uses a 1/4" diameter center or spot drill tool at a depth of 0.05". The control geometry selected is the top perimeter of each of the 4 holes making the Location of Cut Geometry to be At Top and an Approach Distance of 0.1". The second is a Deep Drill operation using a 0.191 #11 drill tool using the same control geometry. The Drill Depth is set to 0.25 which is the total thickness of the base flange with Add Tool tip to Drill Depth enabled ensuring a clean thru hole. In Deep Drilling you can also set a Step Increment which in this case is 0.1".



Coupler Pocket Cut Material Simulations

The illustrations below show the cut material simulation of the Coupler Pocket at each step in the machining job beginning with the part and stock on the upper left and continuing with the roughing, finishing, profiling and drilling operations.



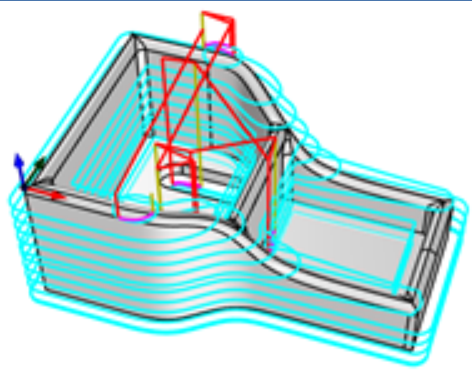
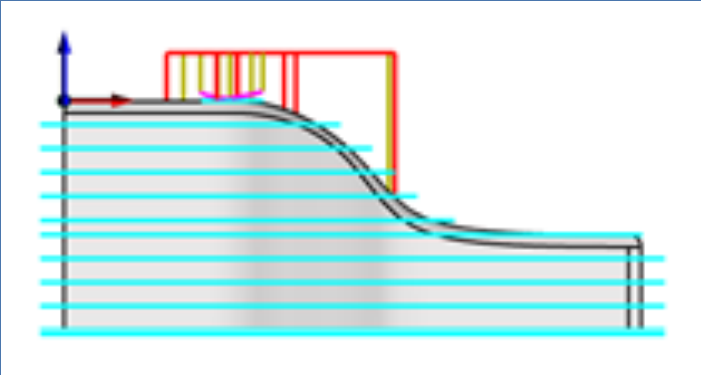


The Tender Step Project

Here is another part that Rex machined with the help of RhinoCAM. This tender step mounts to the sides of the engine and car chassis shown in the image on the right. The part measures 3" long x 2" wide x 1.2" high. The machining job consists of 3 Axis Horizontal Roughing with a 1/2" flat end mill, 3 Axis Horizontal Finishing with a 1/4" flat end mill, 2 1/2 Axis Profiling for the slots and a final Horizontal Finishing using a 1/4" ball mill.



- [-] **Machining Job**
 - [+] Machine - 3 Axis
 - [+] Post - Centroid
 - [+] Stock - Part Box Stock
 - [+] Fixtures - None
 - [+] **Setup 1**
 - [+] Work Zero
 - [+] 1/2" Roughing
 - [+] **Flat Finishing**
 - [+] Rough Slots
 - [+] Finish Slots
 - [+] Horizontal Finishing

The tender step machining job consists of 2 1/2 and 3 Axis toolpaths. The "Flat Finishing" operation is selected and shown on the path. It is a 3 Axis Horizontal Finishing operation using a 1/2" flat end mill.

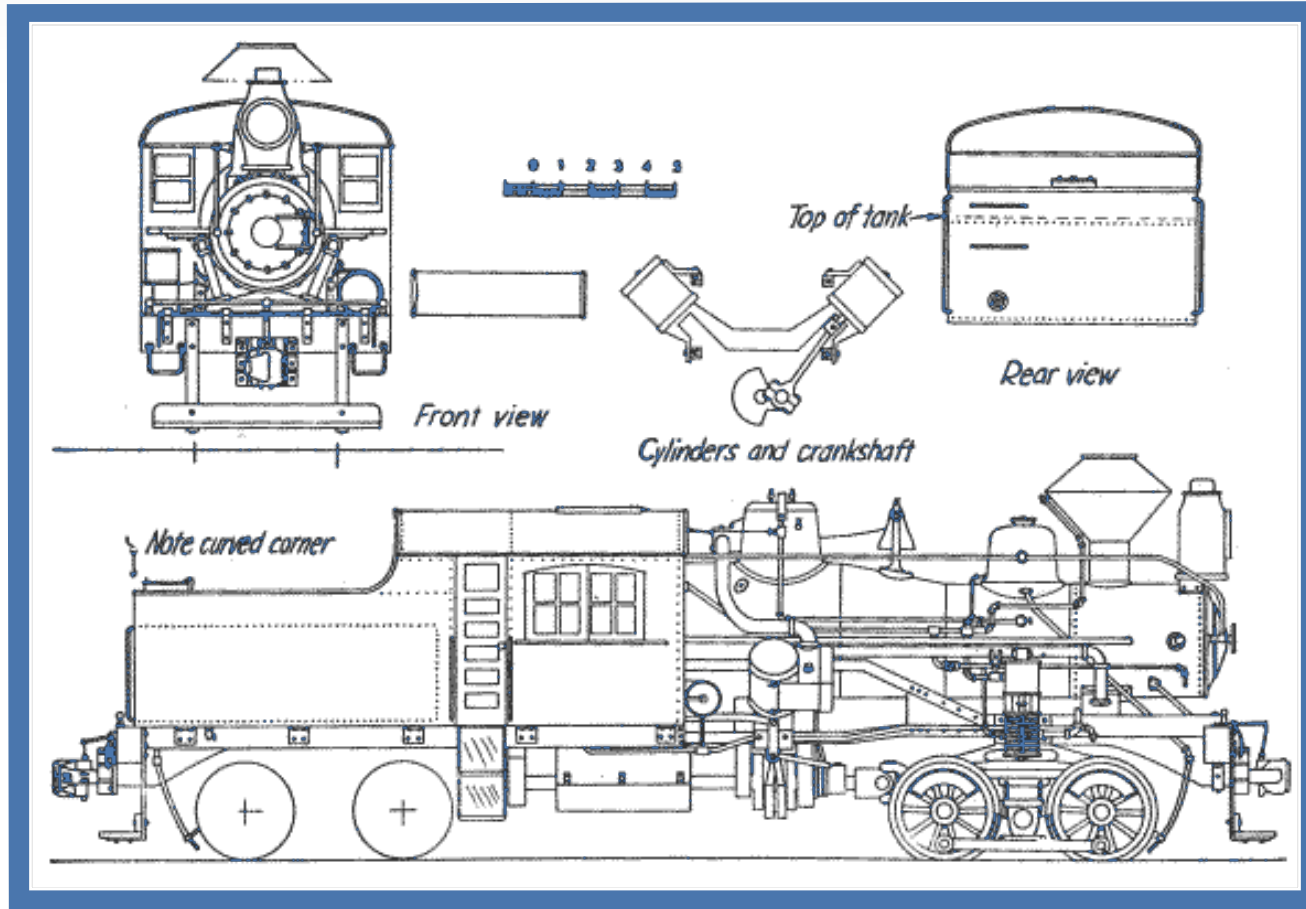
More about the Heisler Steam Locomotive

The Heisler Steam Locomotive is circa 1890's. During the heyday of the American timber industry of the upper Midwest, a locomotive was needed that could generate enough torque to haul the heavy loads loggers required.

Manufactured by the Stearns Manufacturing Company, the Heisler sported a V2-cylinder steam driven engine whose piston cylinders protruded out the sides of the engine. These are indicated in the images and illustrations below.

In traditional steam locomotives of the time, the pistons drove only the front carriage wheels of the engine directly. The V2 pistons of the Heisler drove a central longitudinal drive shaft that in turn gear drove each of its sets of wheels carriages. The Heisler was also lighter and able to articulate better around tighter corners. While not very fast, it was able to accommodate smaller tracks which could be installed and moved quickly.





This 1949 drawing of the Heisler Steam Locomotive comes courtesy of
[MODEL RAILROADER magazine, Milwaukee, WI](#)

Heislors were produced mostly in two and three truck variants in sizes ranging from 17 to 95 short tons. Roughly 625 Heislors were produced, of which some 35 still exist. [Charles L. Heisler](#) received a patent for the design in 1892, following the construction of a prototype in 1891. See [Heisler locomotive](#) for more information.



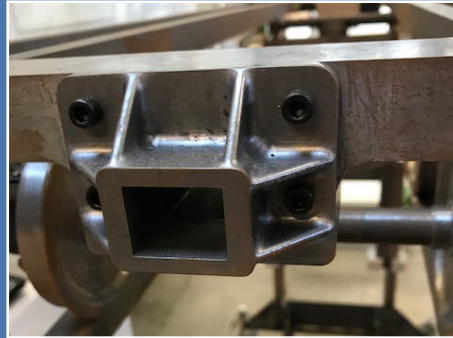
(Left) The two-truck Heisler locomotive Tuolumne, arrives at the depot in Felton, California in the summer of 1993. Photograph by Robert A. Estremo, copyright 1993. (Right) The Tuolumne engine, Felton, California. Image taken August 1, 2004 by en>User:Leonard G.

Rex Smith Shop Pics

Here are more shop pics from Rex Smith, Portland, OR.



(Left) The 1/8 scale Heisler V2 engine replica under construction in Rex's shop.
(Right) The Heisler engine #6 in action at the Cass Scenic Railroad, Elkins, WV.



The coupler pocket mounted on the Heisler chassis.



Tinder steps mounted on the Heisler coal car chassis.



The Heisler V2 engine at 1/8 scale.



Stainless steel header/exhaust rings for automotive clients.

More about Rex Smith

Rex Smith graduated from Oregon State University in 1971 with a BSEE, and received his MSEE from Stanford in 1976. Rex was added to their [College of Engineering Hall of Fame in 2006](#) when they wrote:

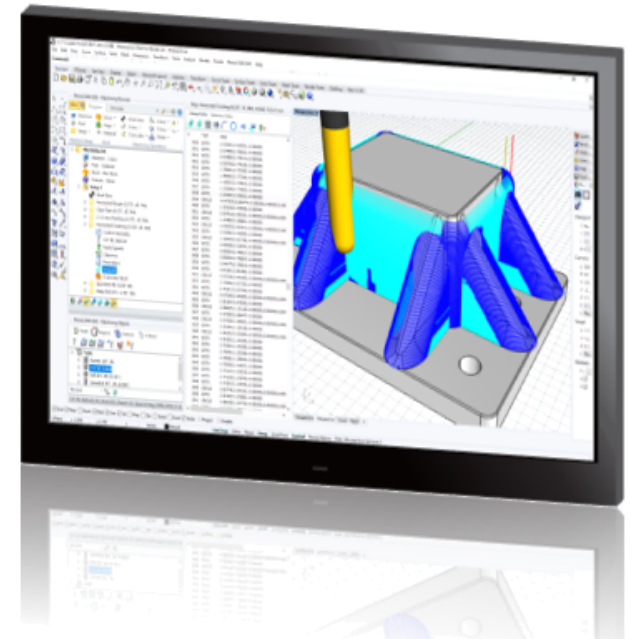
“Rex’s history at Hotmail is substantial. He was the fifth person to join the company and served as chairman of the board and chief operating officer. He was instrumental in developing the infrastructure, operations, and network of Hotmail. Before Hotmail, Rex worked with various companies including FutureTel, Hewlett-Packard Co., Apple Computer Inc., and Sun Microsystems. He was also involved with several start-up companies and served as an entrepreneur in residence at OSU.”



More about RhinoCAM Configurations

RhinoCAM - MILL is available in 5 different configurations (Express, Standard, Expert, Professional and Premium). The parts shown here were programmed using the Professional configuration. Here are some additional details about each of the available configurations. For the complete features list and current pricing visit the [RhinoCAM Product Page](#) and [RhinoCAM Professional eStore 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.

For the complete list of features visit the [RhinoCAM Product Page](#)

For current pricing visit the [RhinoCAM eStore Page](#)

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