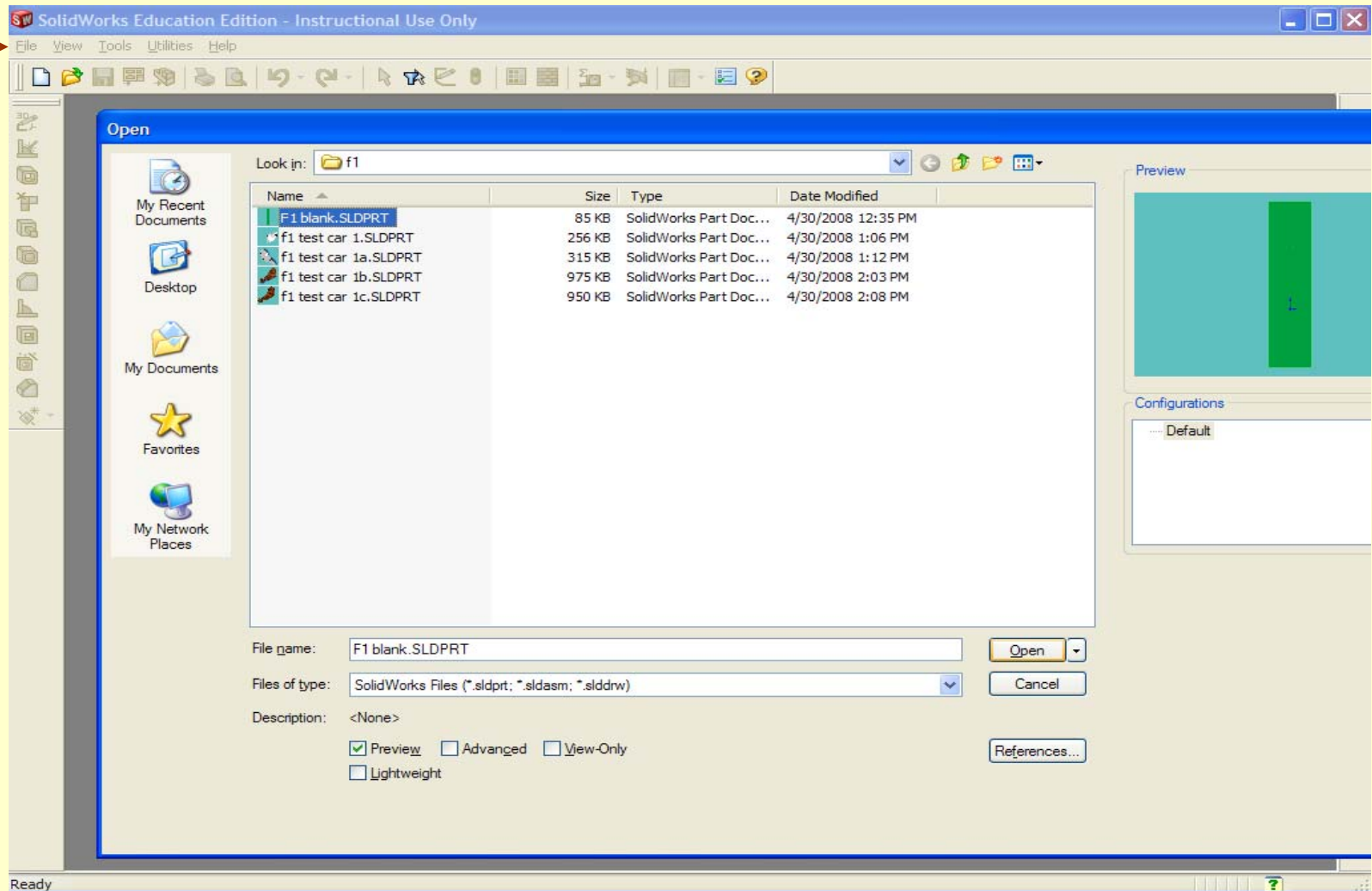




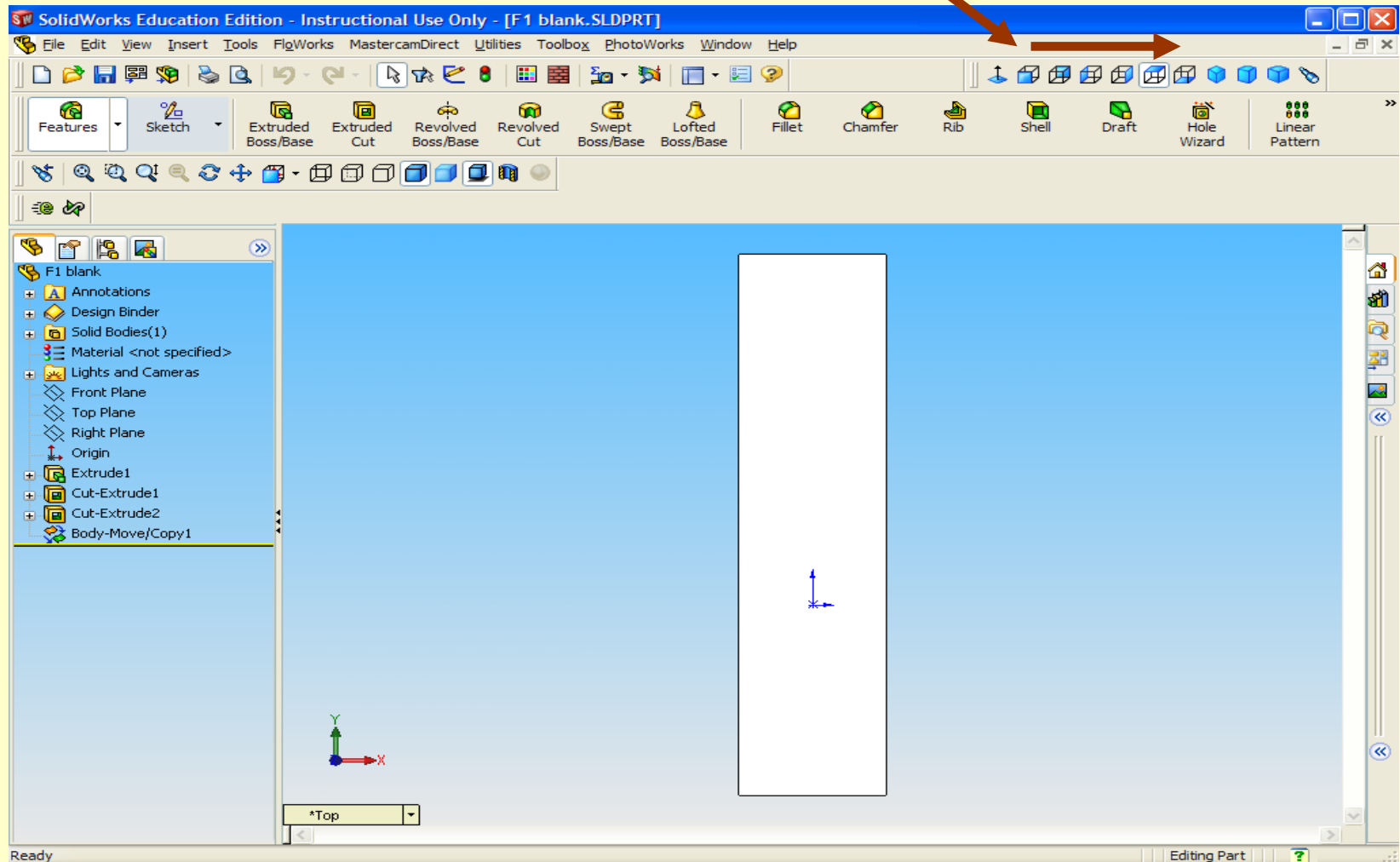
Design Projects using SolidWorks 2007 and Mastercam X2

F1 Car

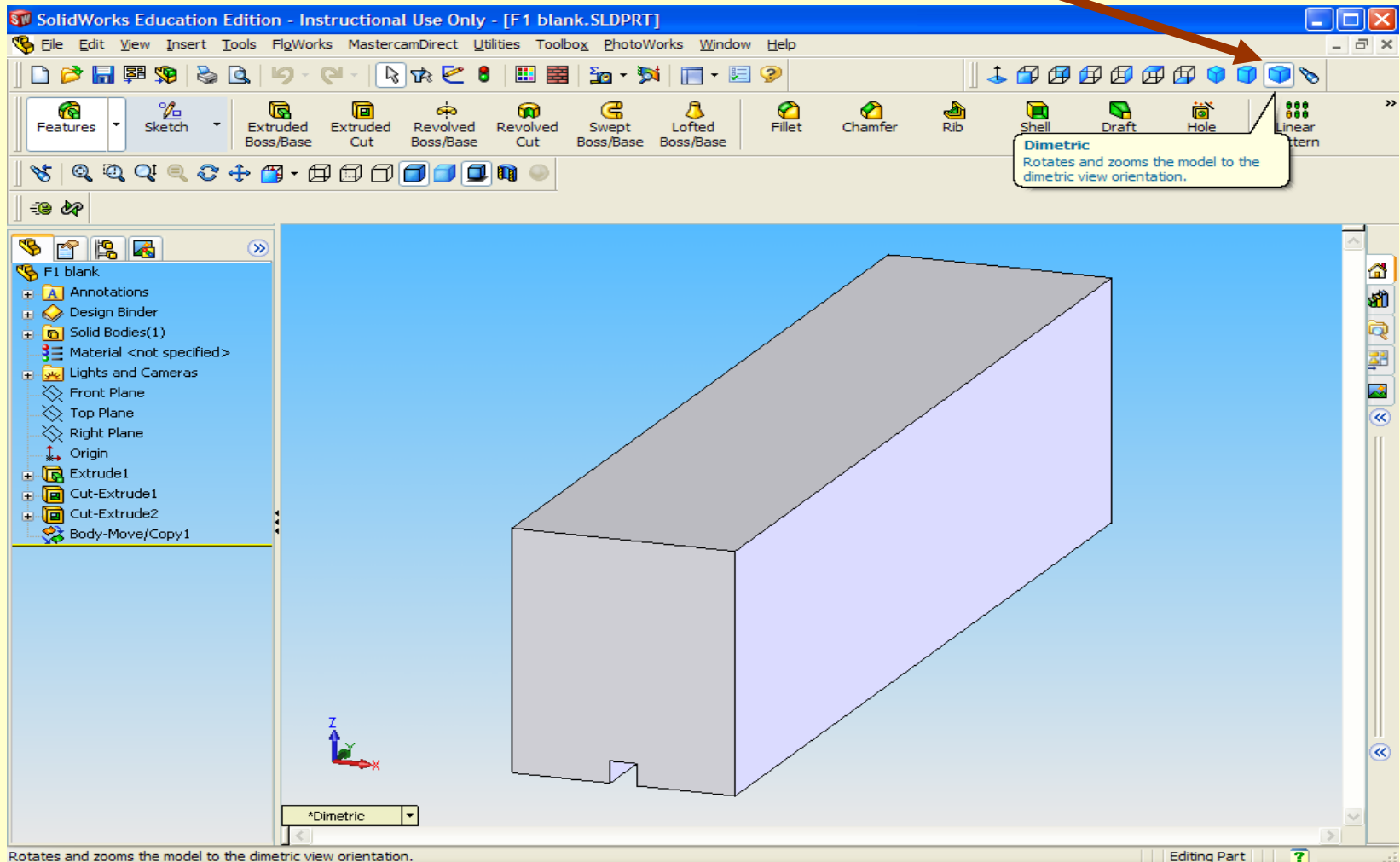
1. Click File > Open then select "F1 Car Blank.SLDPRT"



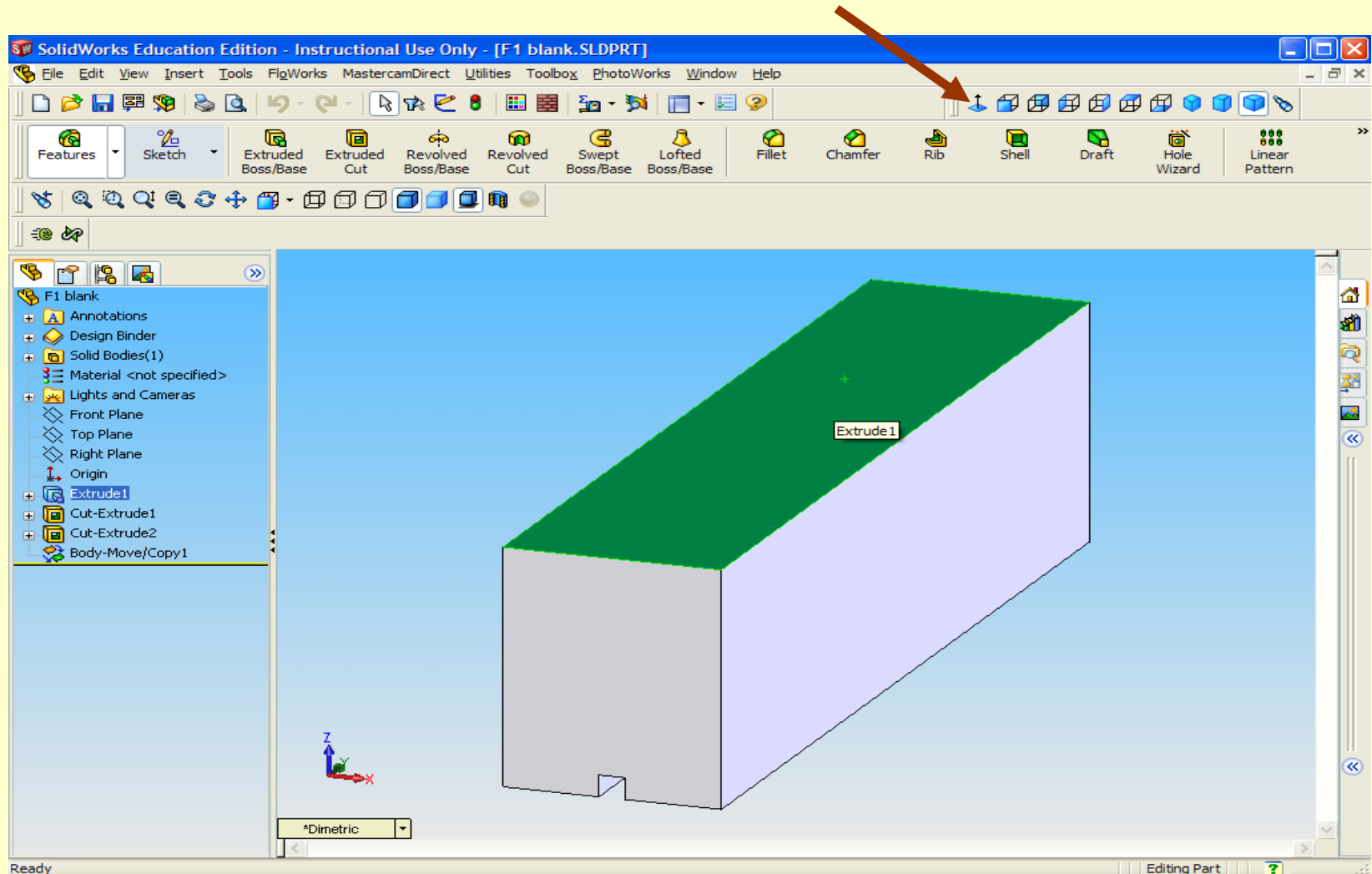
1. Click on the view buttons to familiarize yourself with the views.



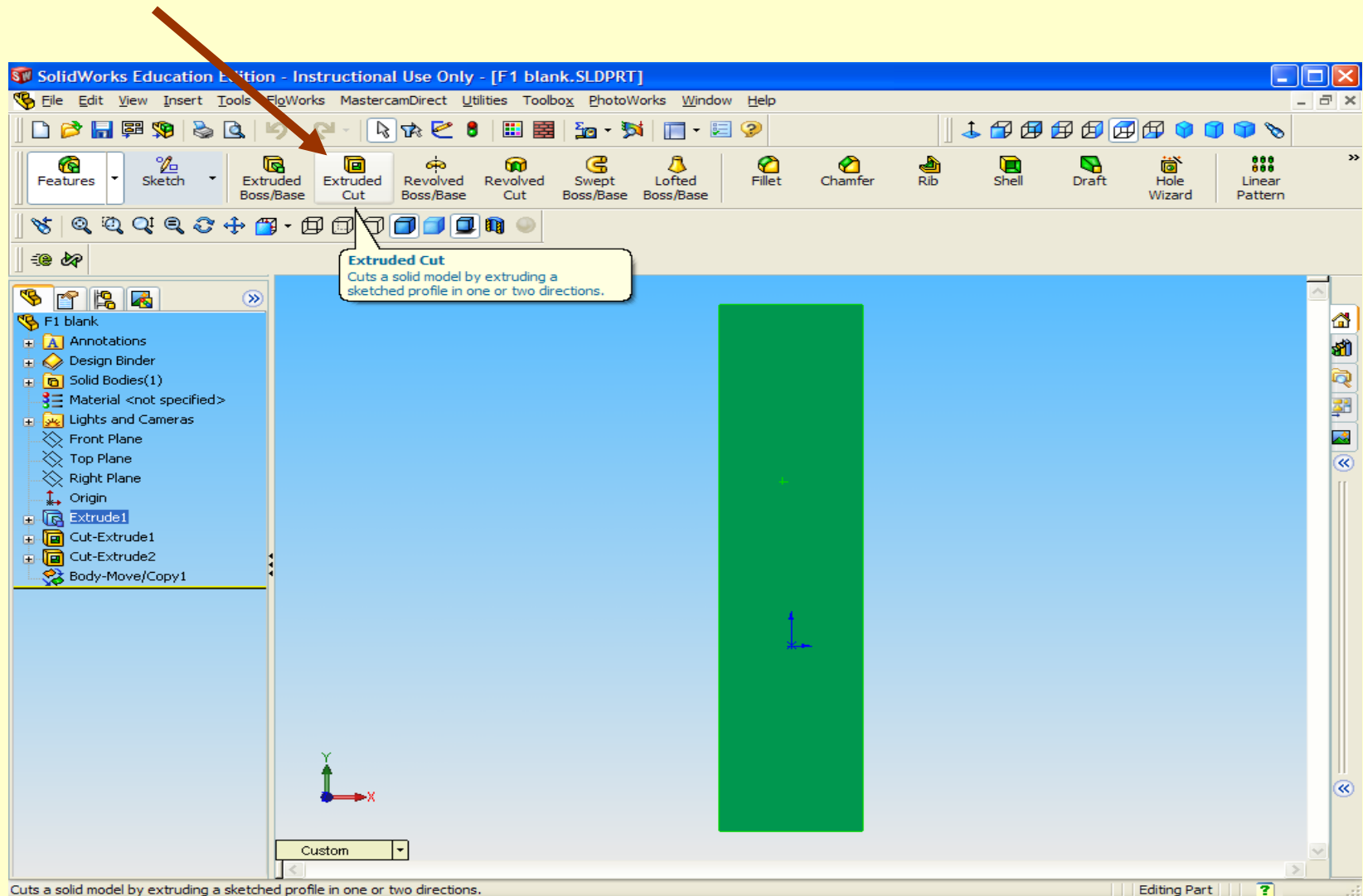
1. Click on Dimetric view for a perspective view of the stock.



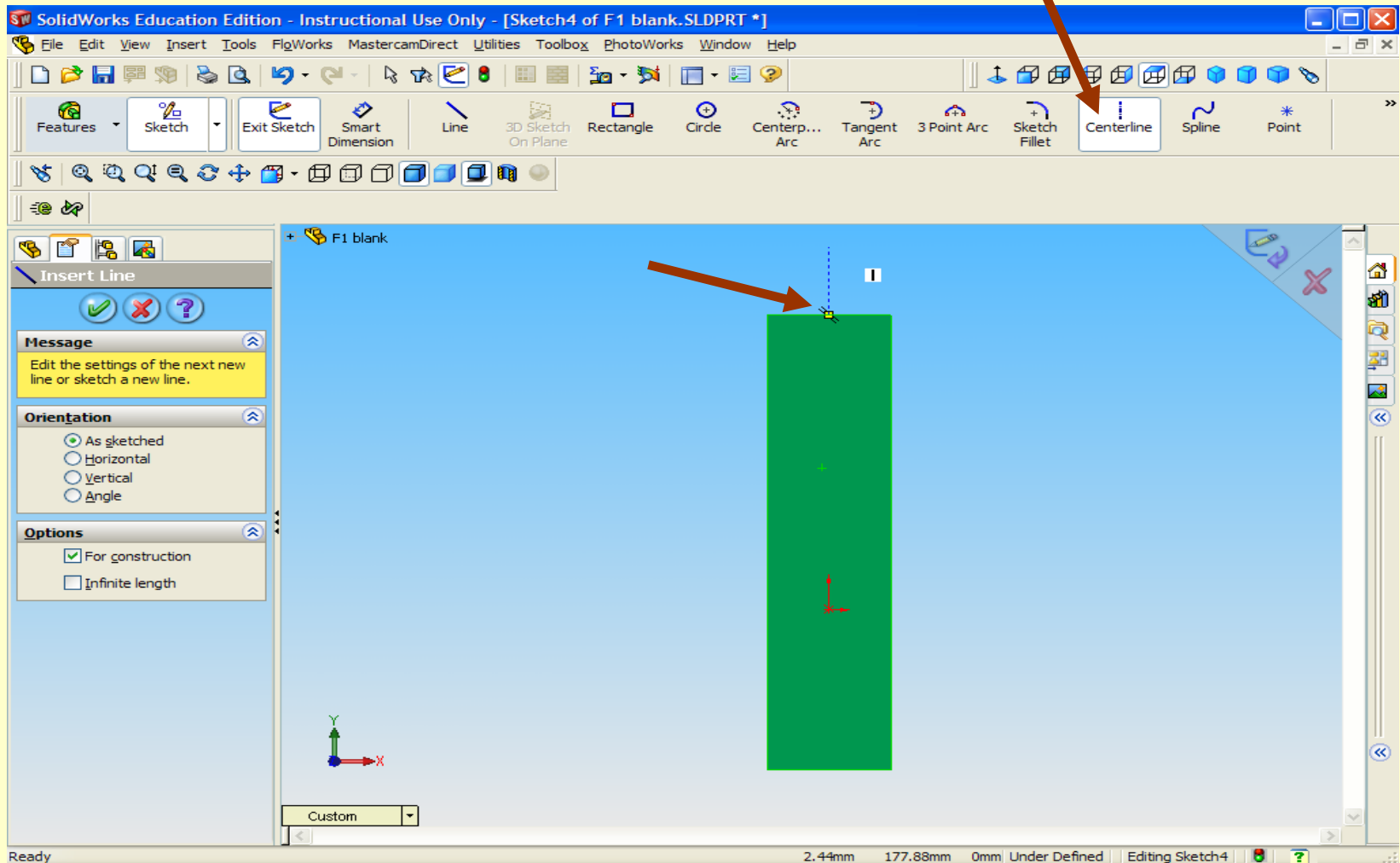
1. Click on the top surface of your block, it turns Green.
2. Click “Normal To” and your view will move to reference the top surface.



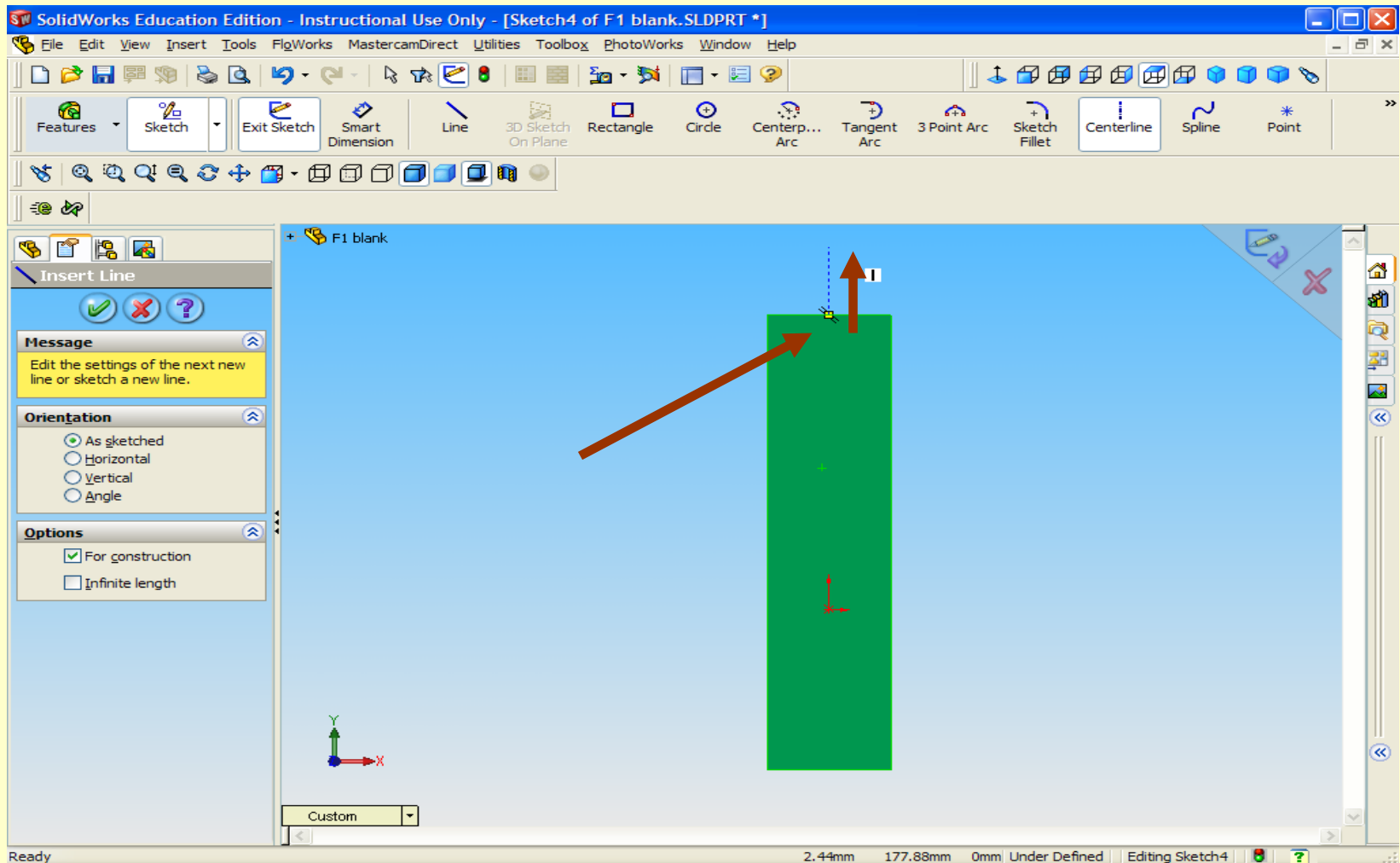
1. Click Extruded Cut in the Features Toolbar



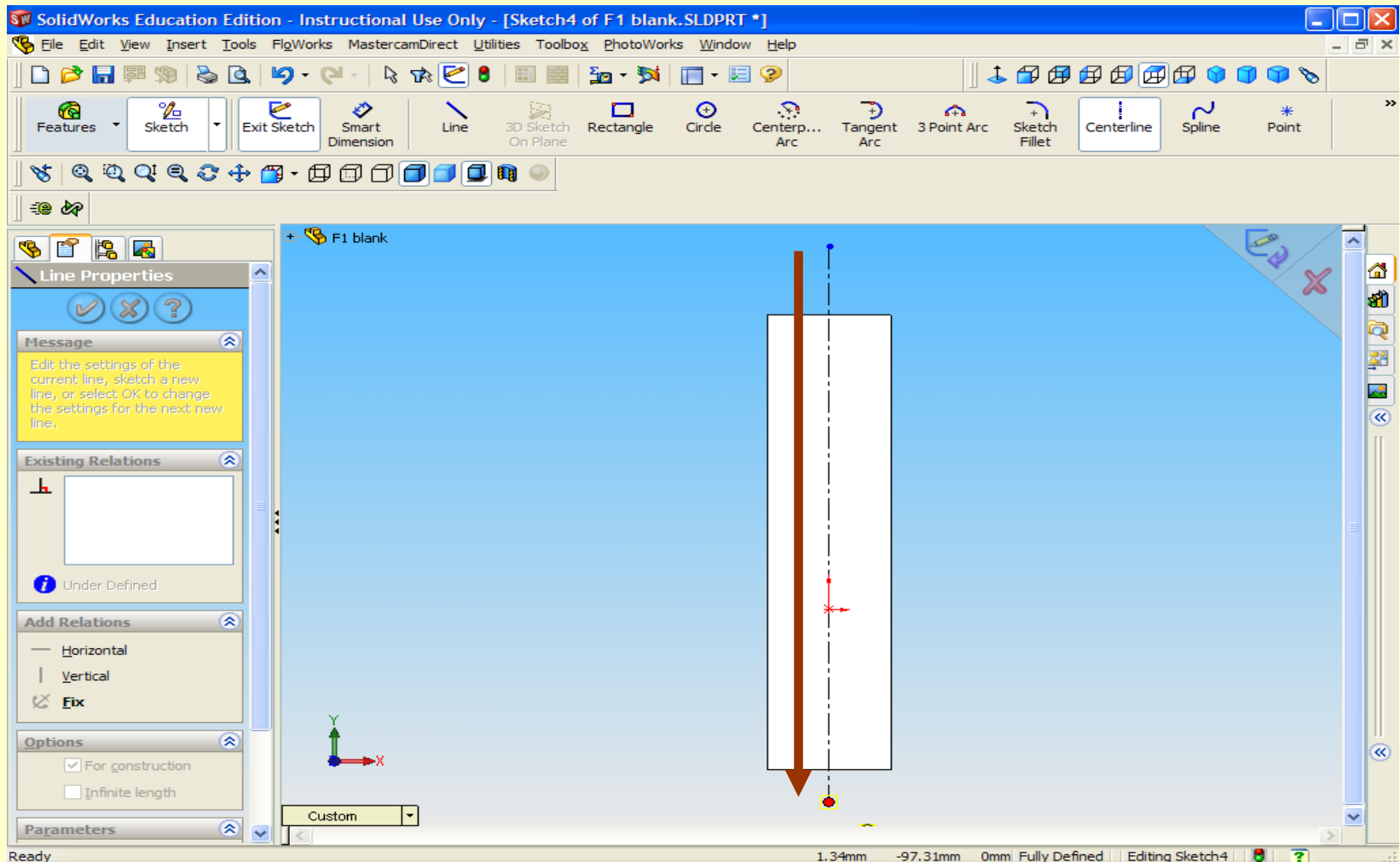
1. Click on Centerline tool
2. Without clicking, move your cursor close to the top edge's midpoint.
3. The midpoint should highlight.



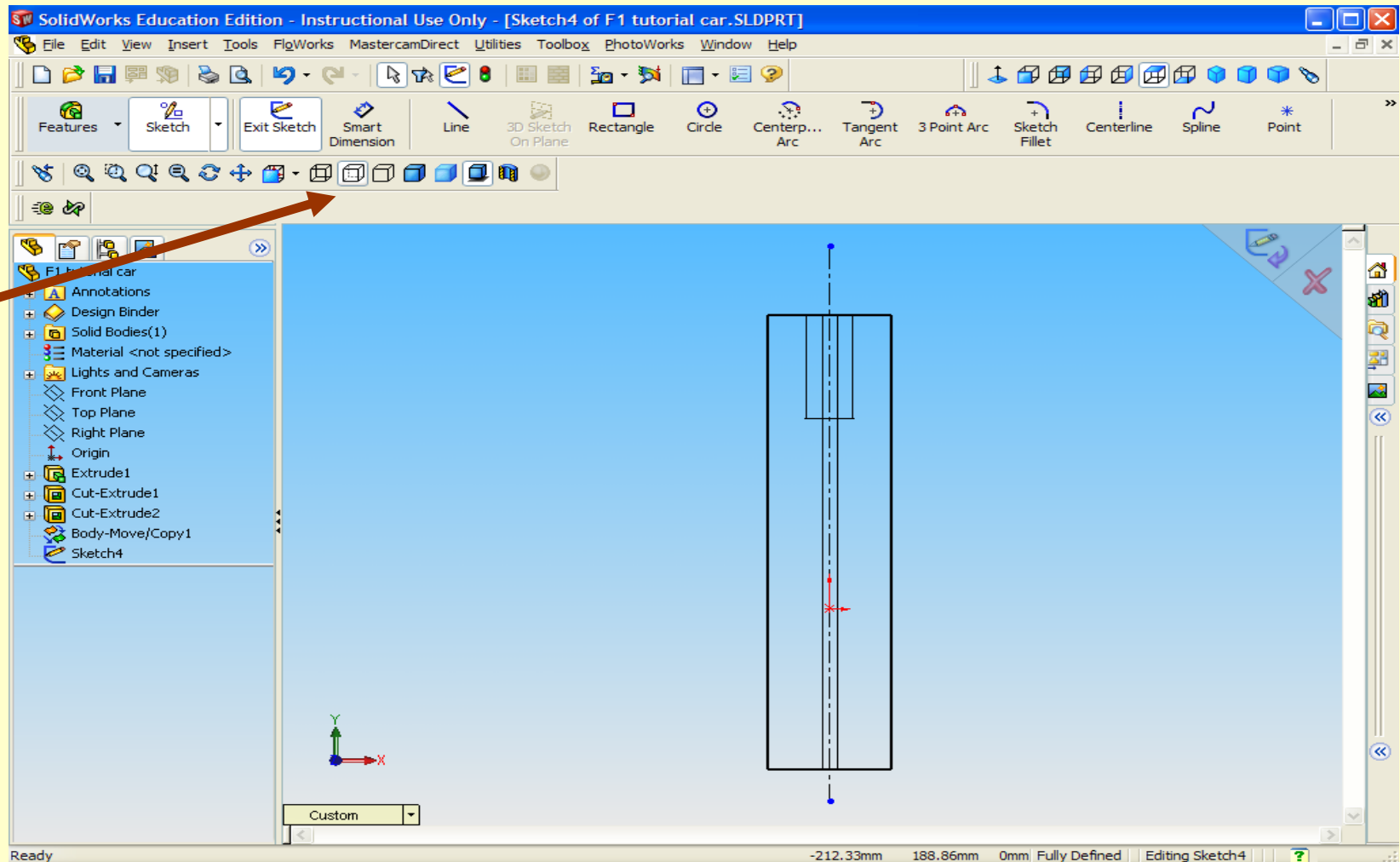
1. Drag the cursor, without clicking, above the box.
2. Now click.



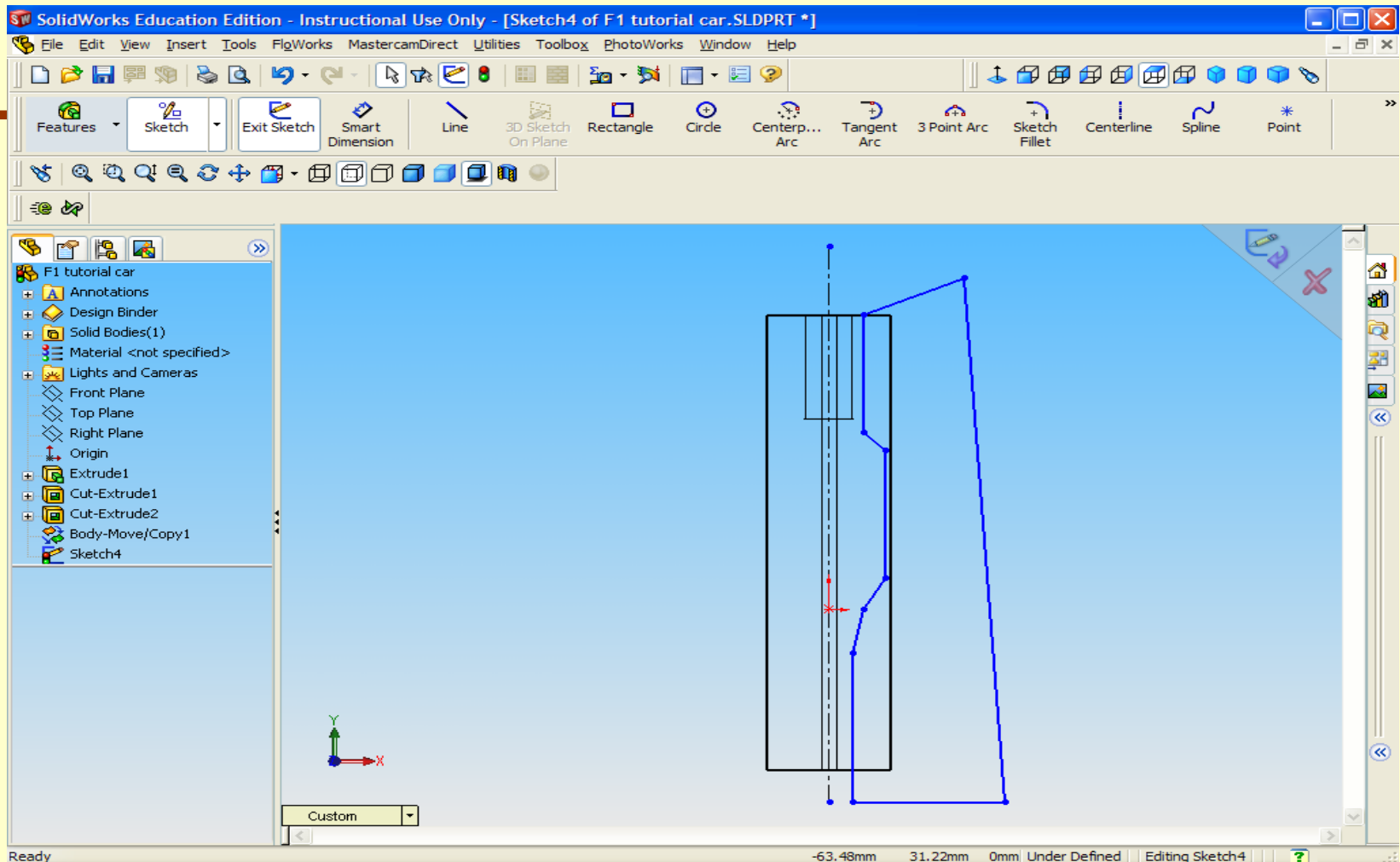
1. Now drag your cursor as straight as possible, to directly below the midpoint of the bottom of the box. Moving slowly will allow the line to snap to a vertical automatically.
2. Click when below the bottom midpoint.



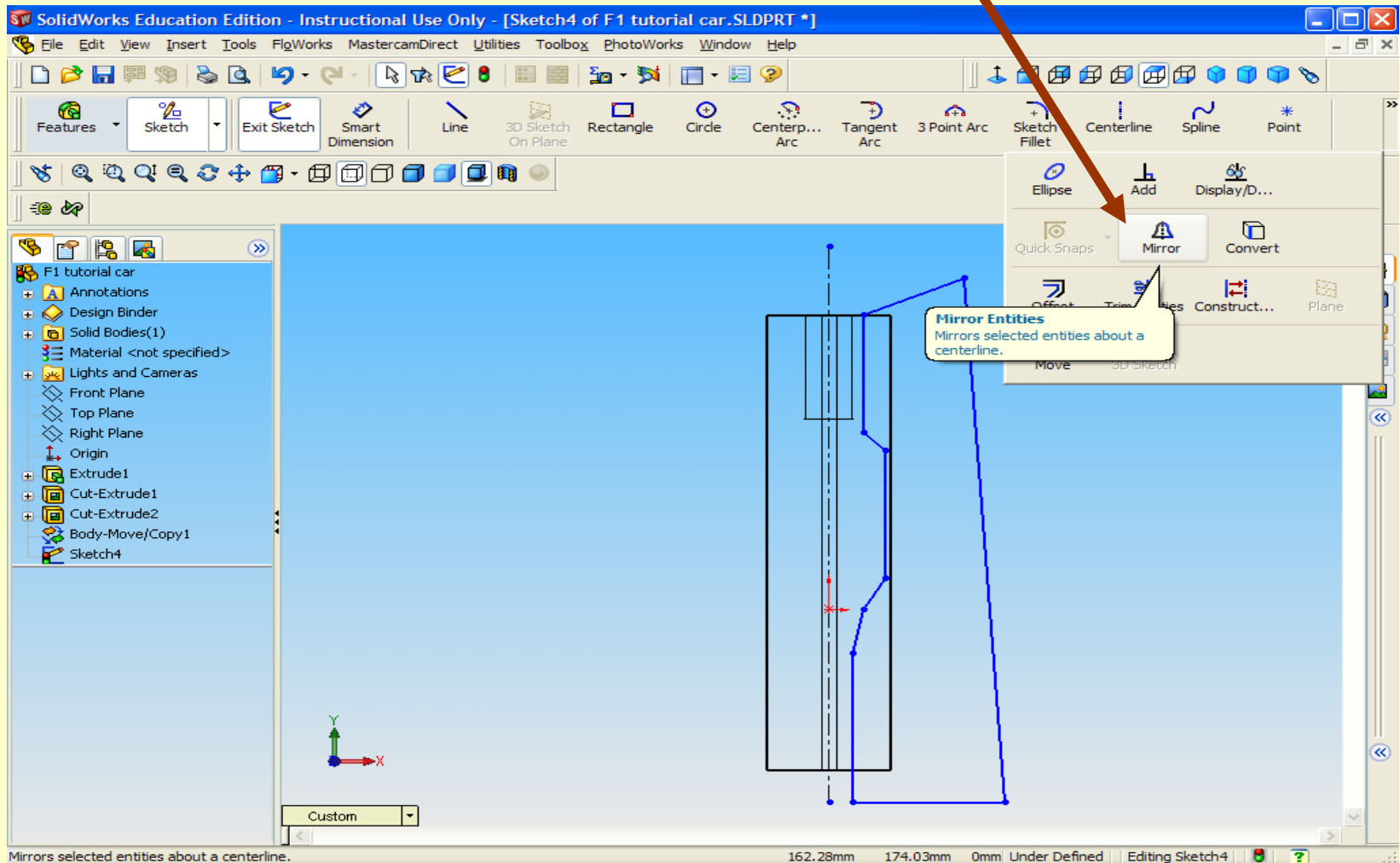
1. Click on Hidden Lines Visible to see the co2 cartridge hole.



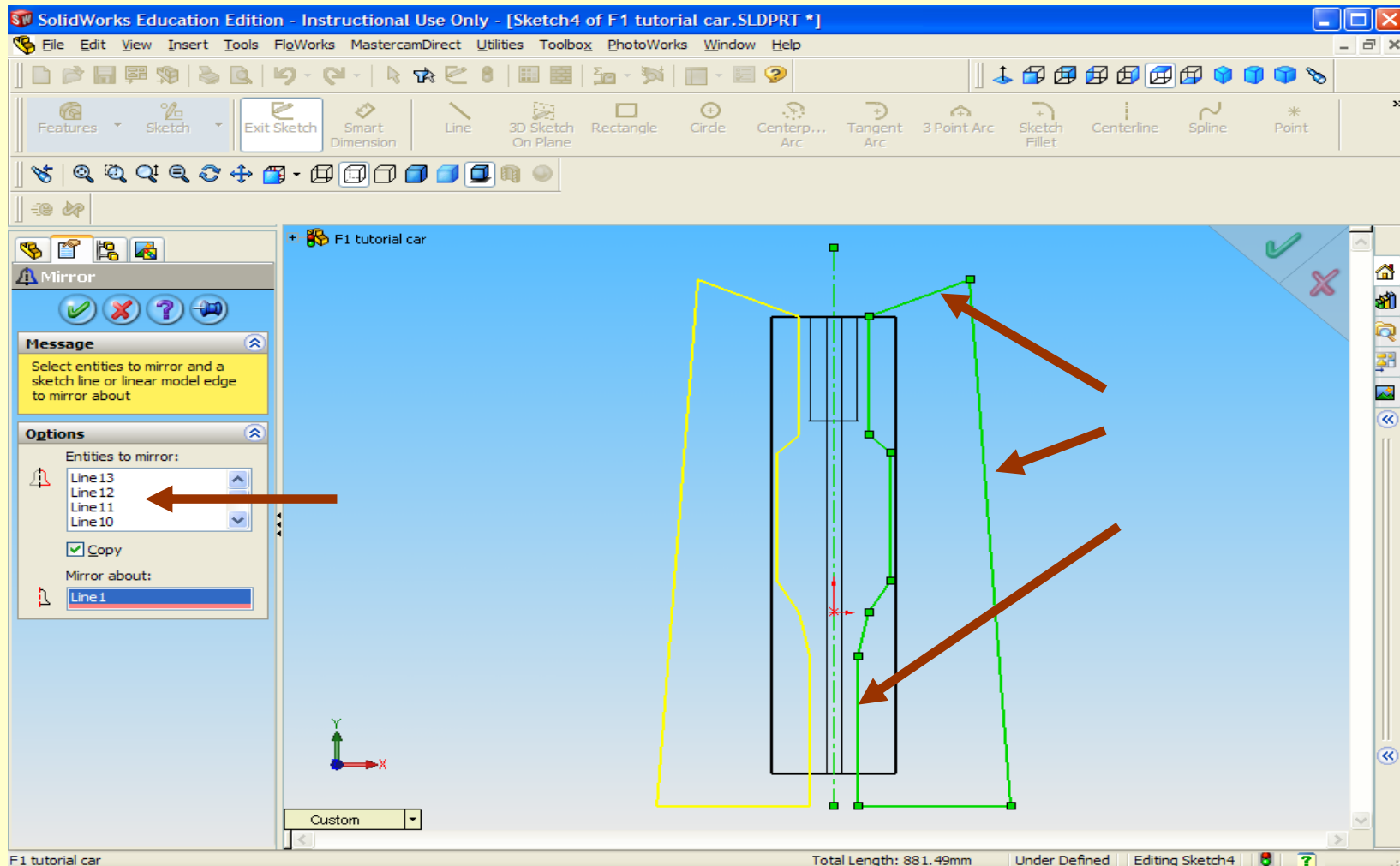
1. Click the LINE tool then draw a profile of your car.
 2. Close the geometry with lines outside of the stock area.
- ***Think of this as a cookie cutter to cut away the stock material.



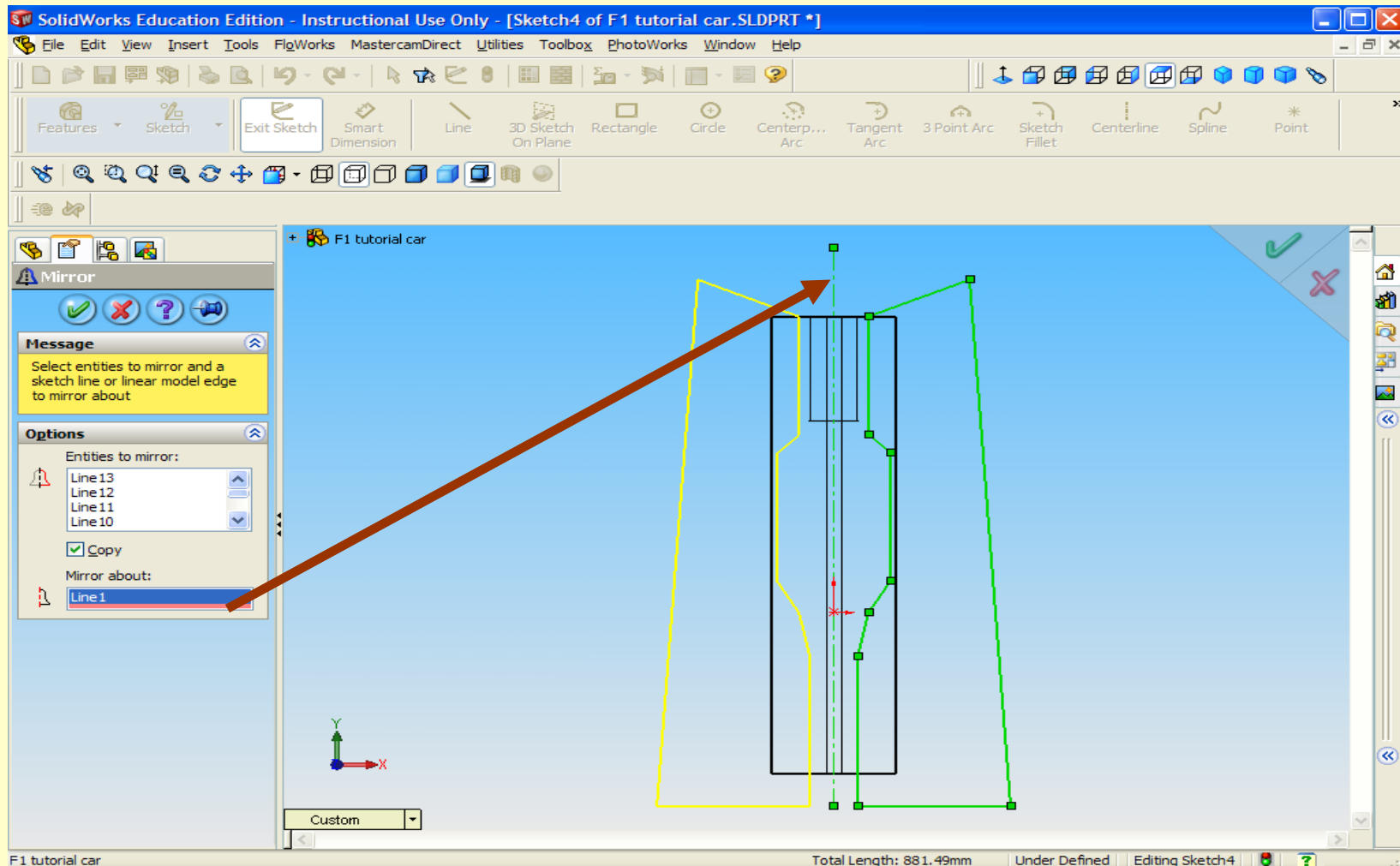
1. Click on the Mirror tool.



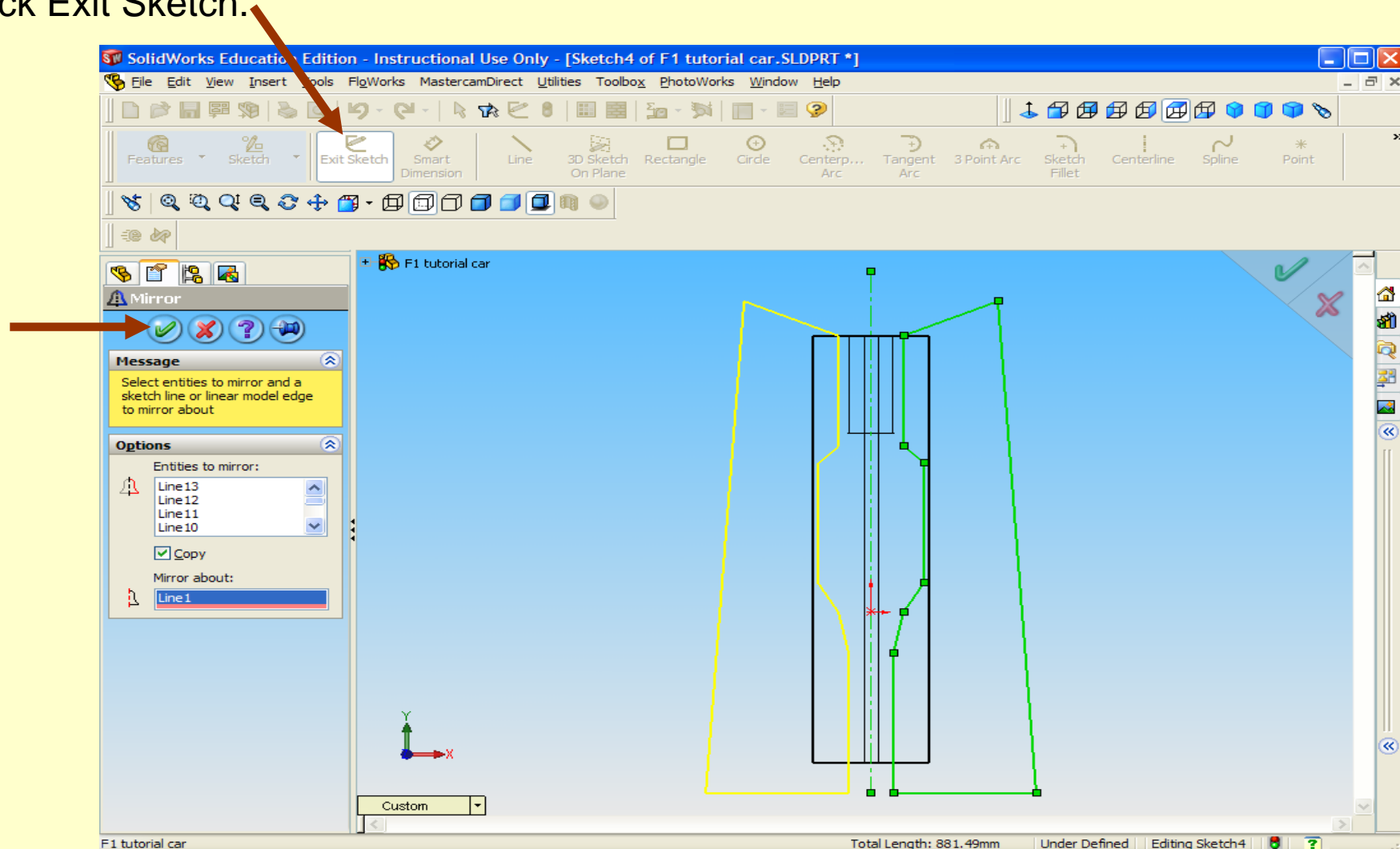
1. The “Mirror” window appears.
2. Click each segment of line of your cookie cutter shape. They will appear in the “entities to mirror” box.



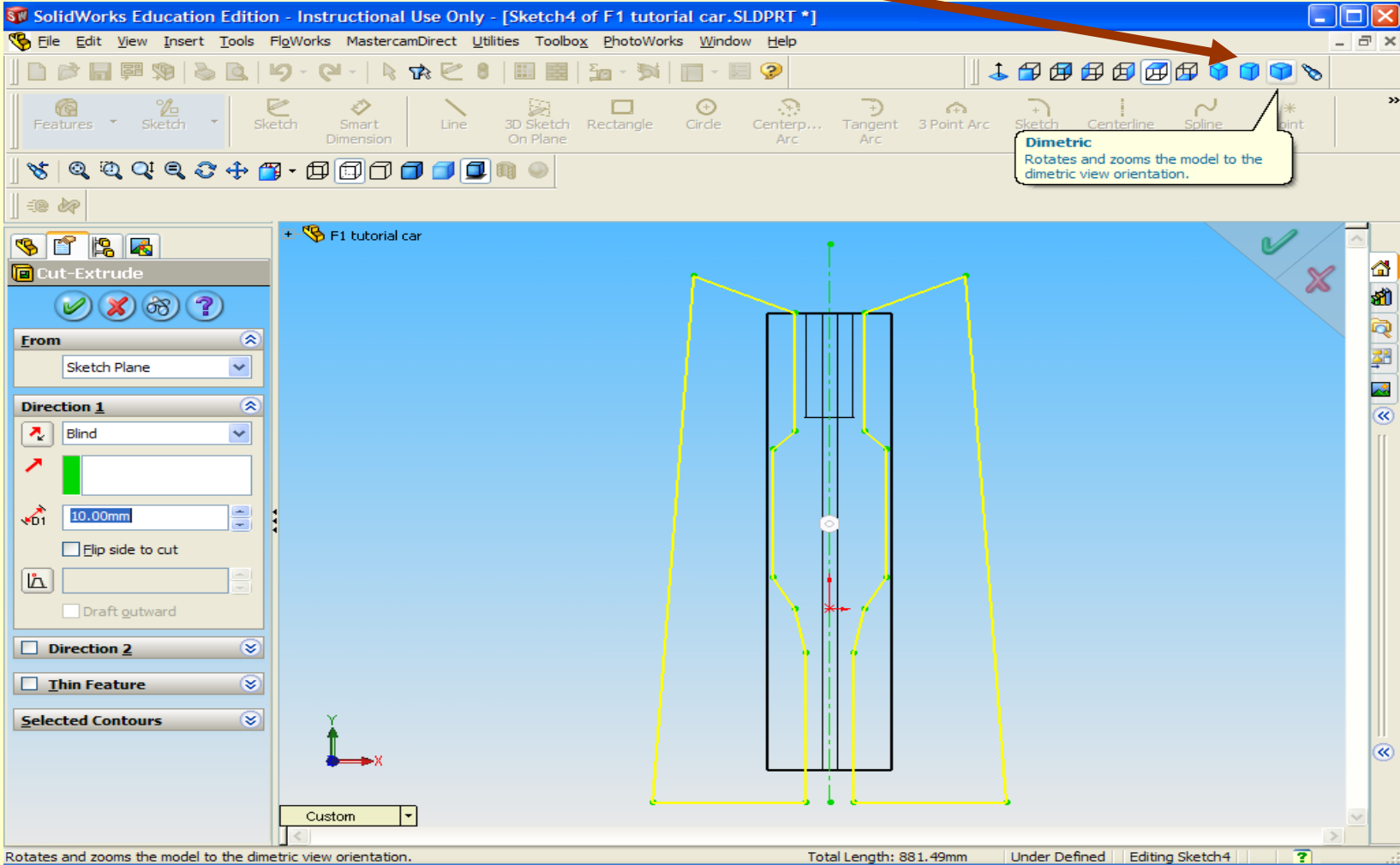
1. Click in the box, Mirror About, then click on the centerline you drew.



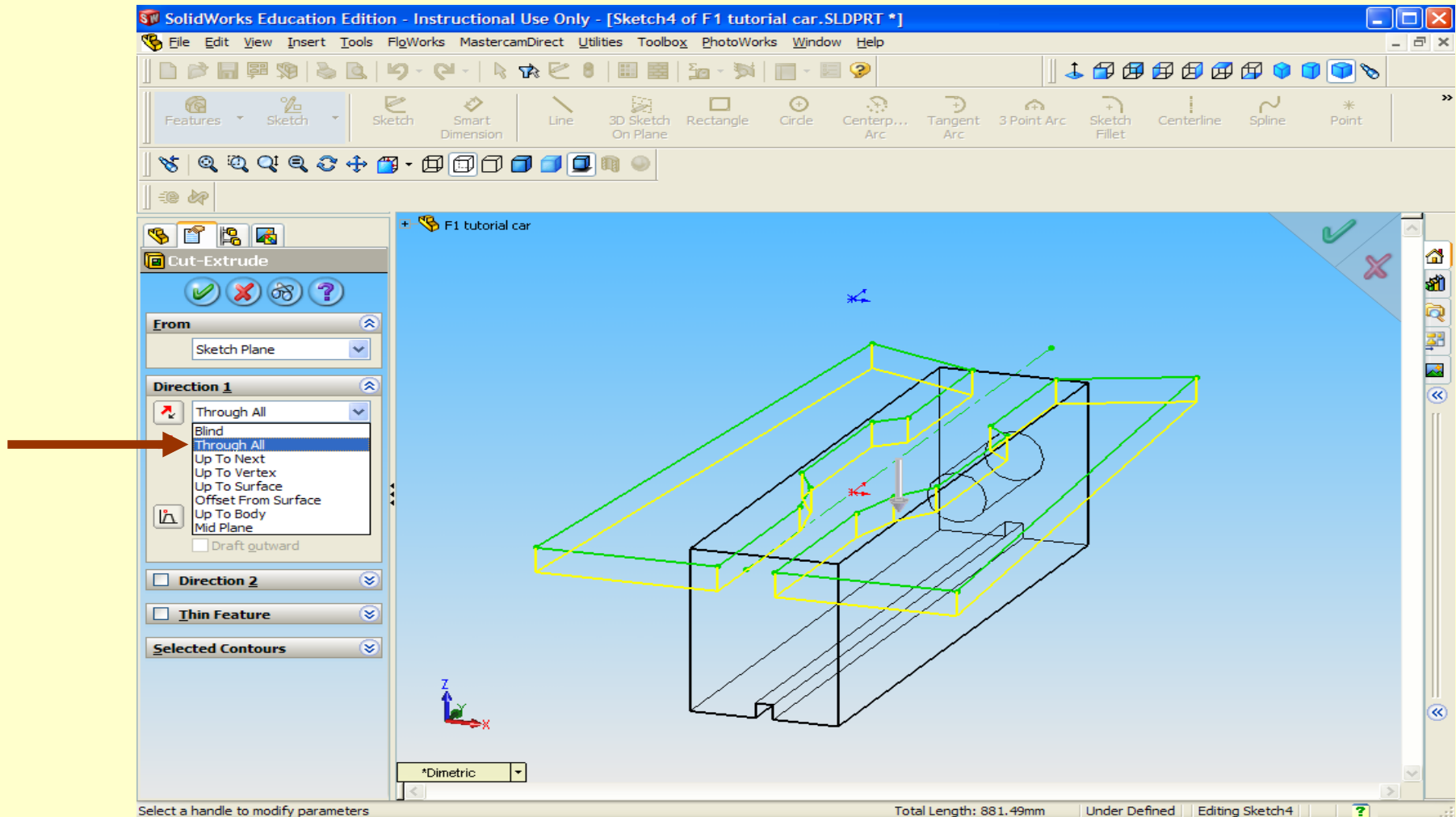
1. Finally click the Green Check.
2. Click Exit Sketch.



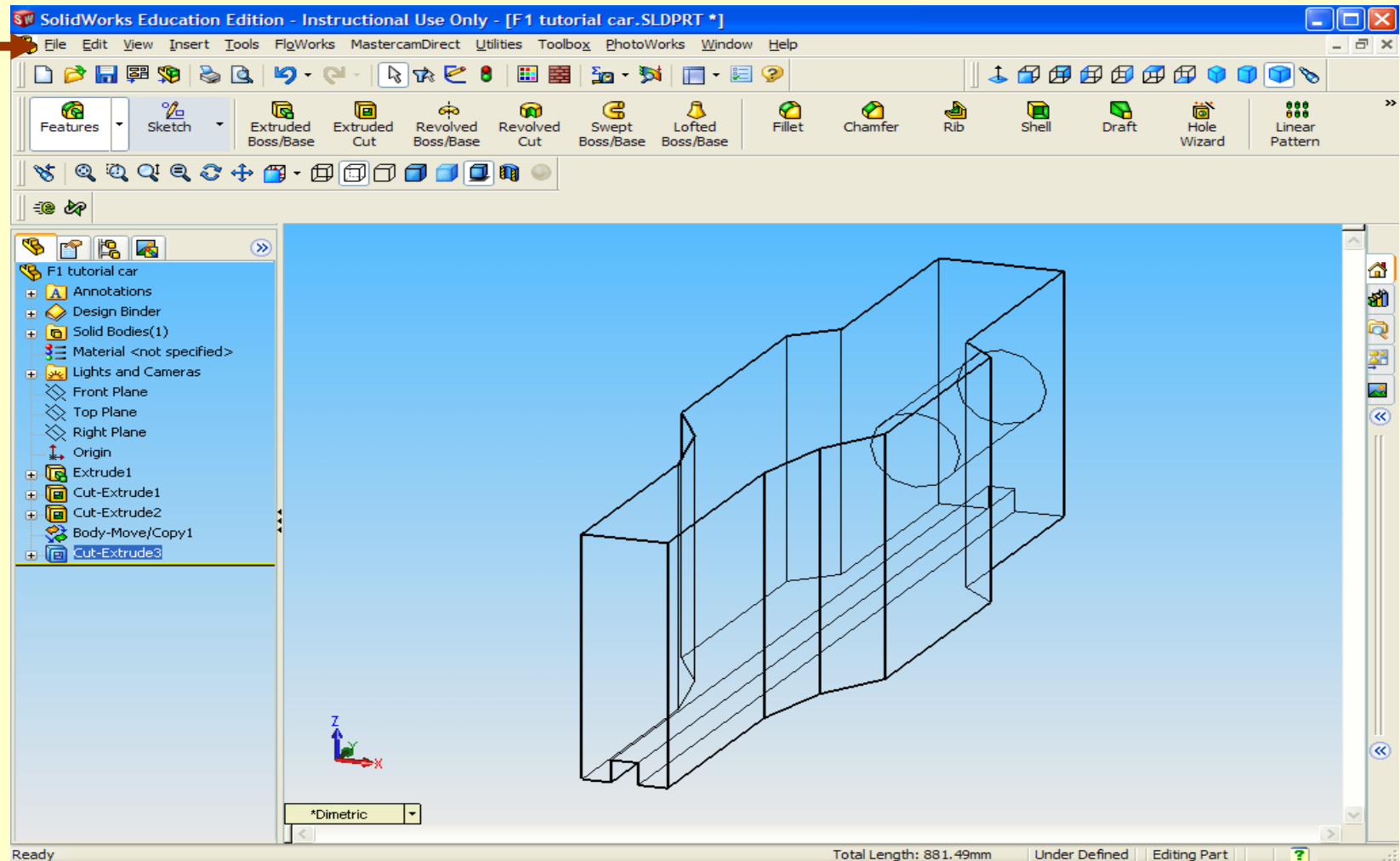
1. Click on Dimetric or another perspective view before proceeding.



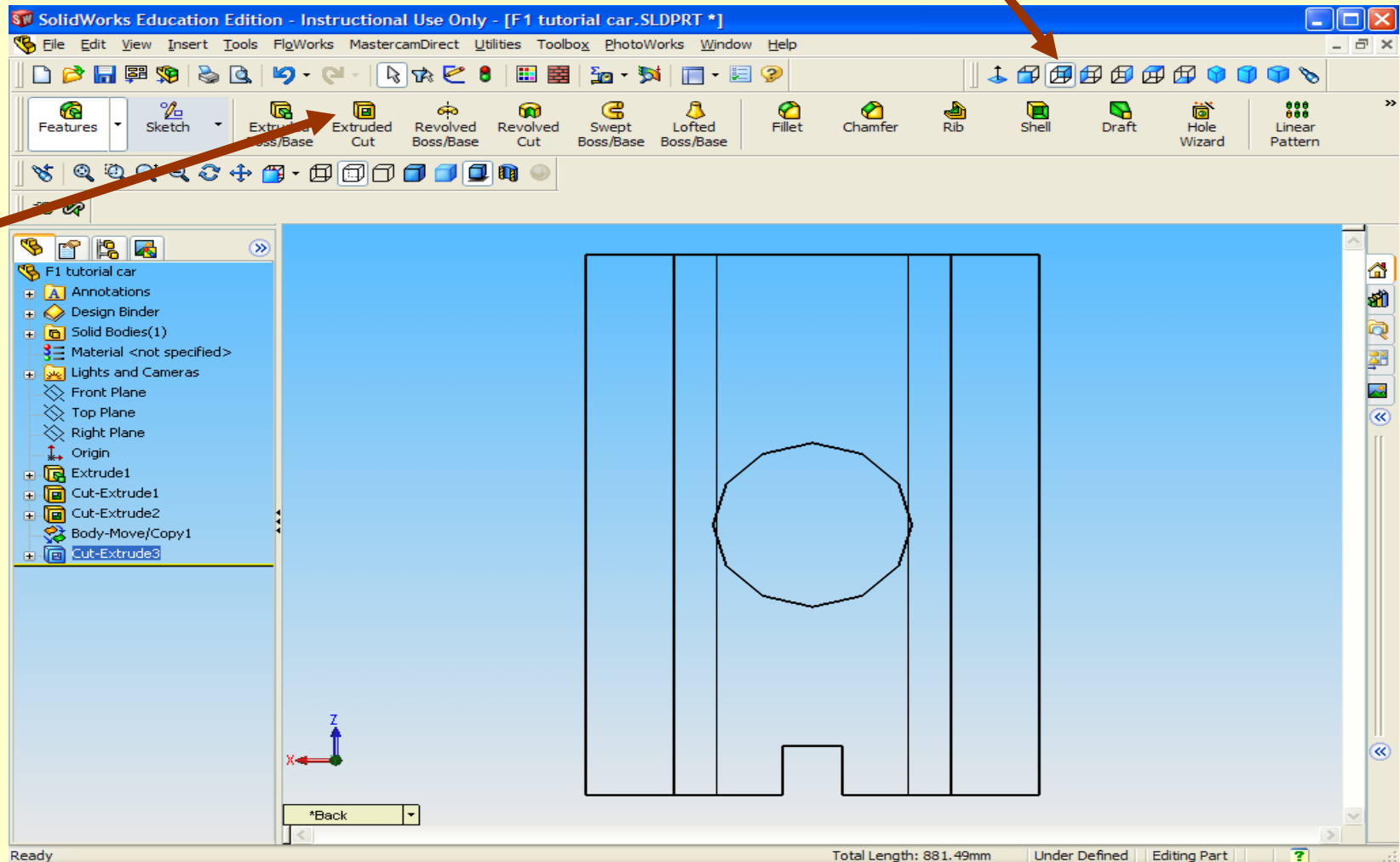
1. Select Through All from the drop down.
2. Then click the Green Check.



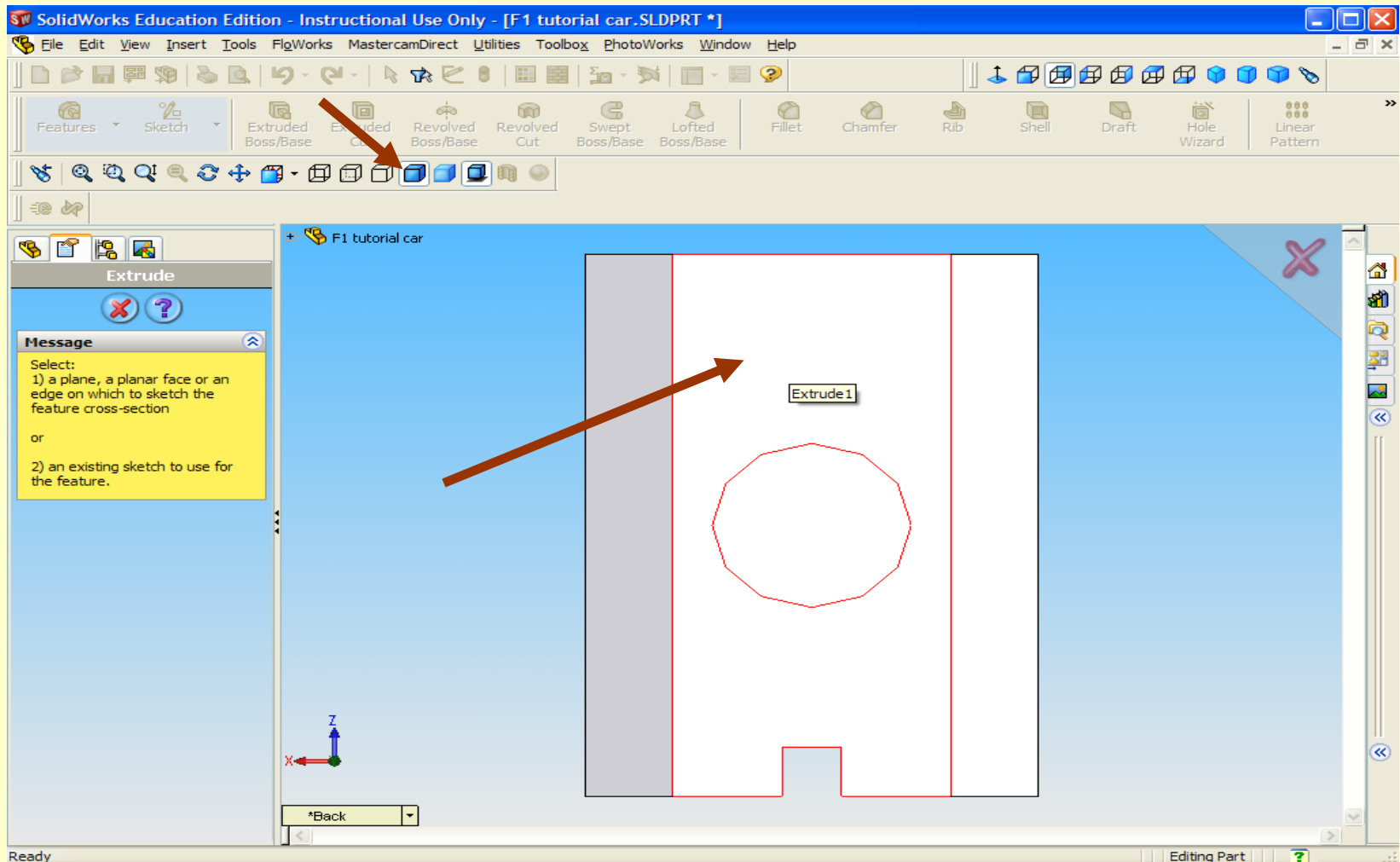
1. Click file SAVE AS... to name and save your work.



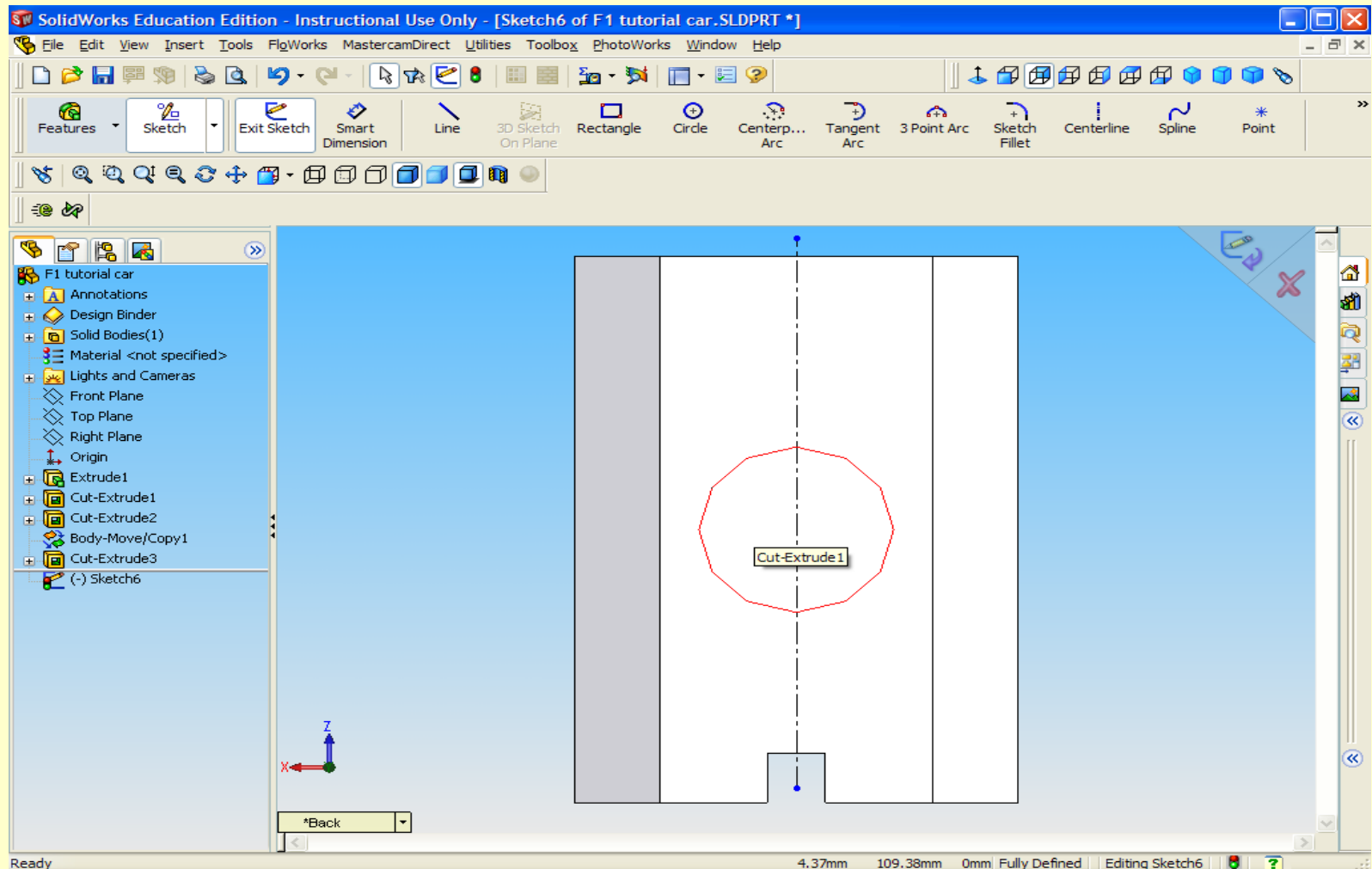
1. Click on BACK view.
2. Then select the EXTRUDED CUT tool.



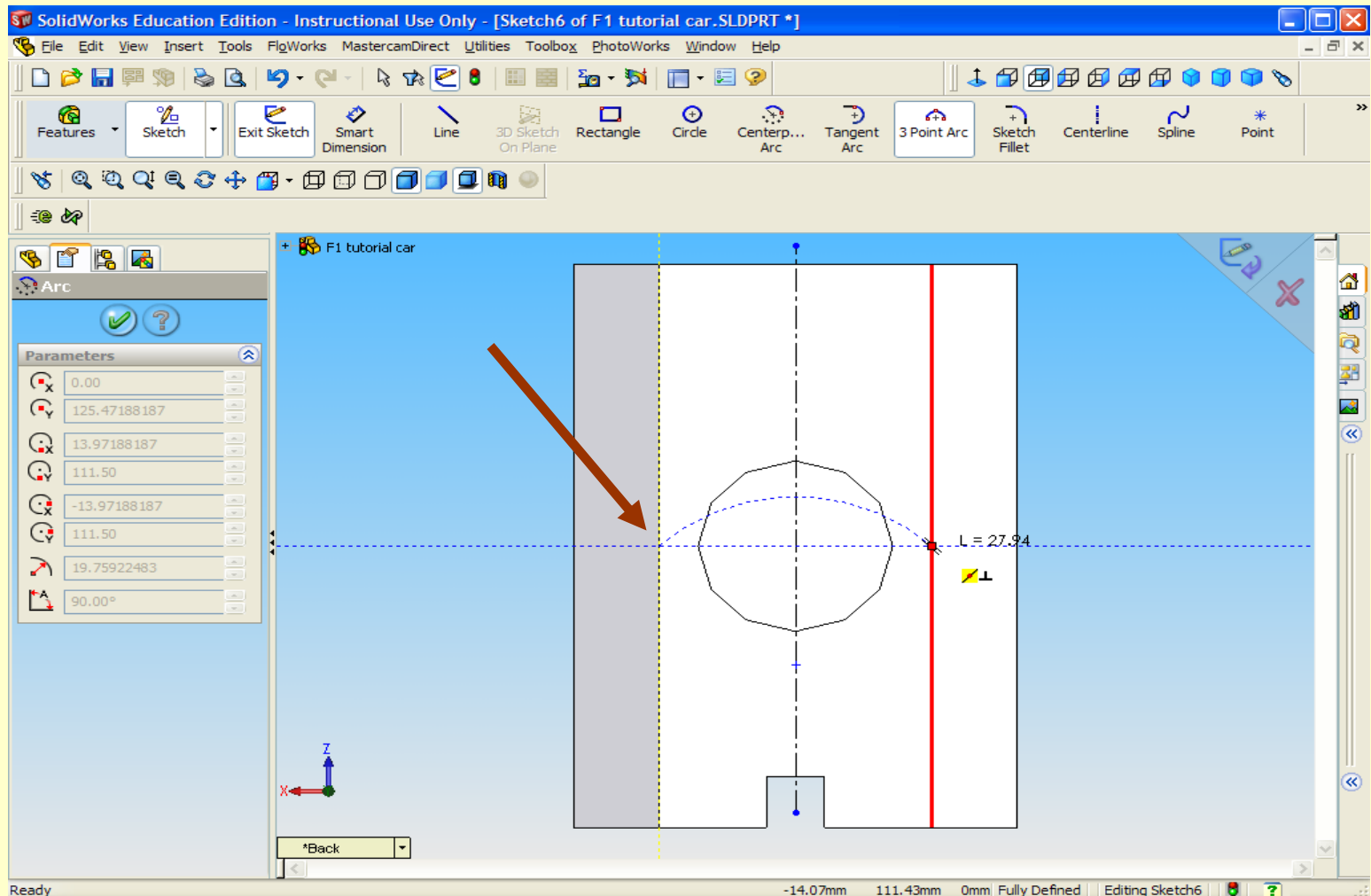
1. A window will ask you what surface you are working on.
2. Click on the “SHADED WITH EDGES” icon.
3. Then Click on the back surface of your stock. Click again to turn it green.



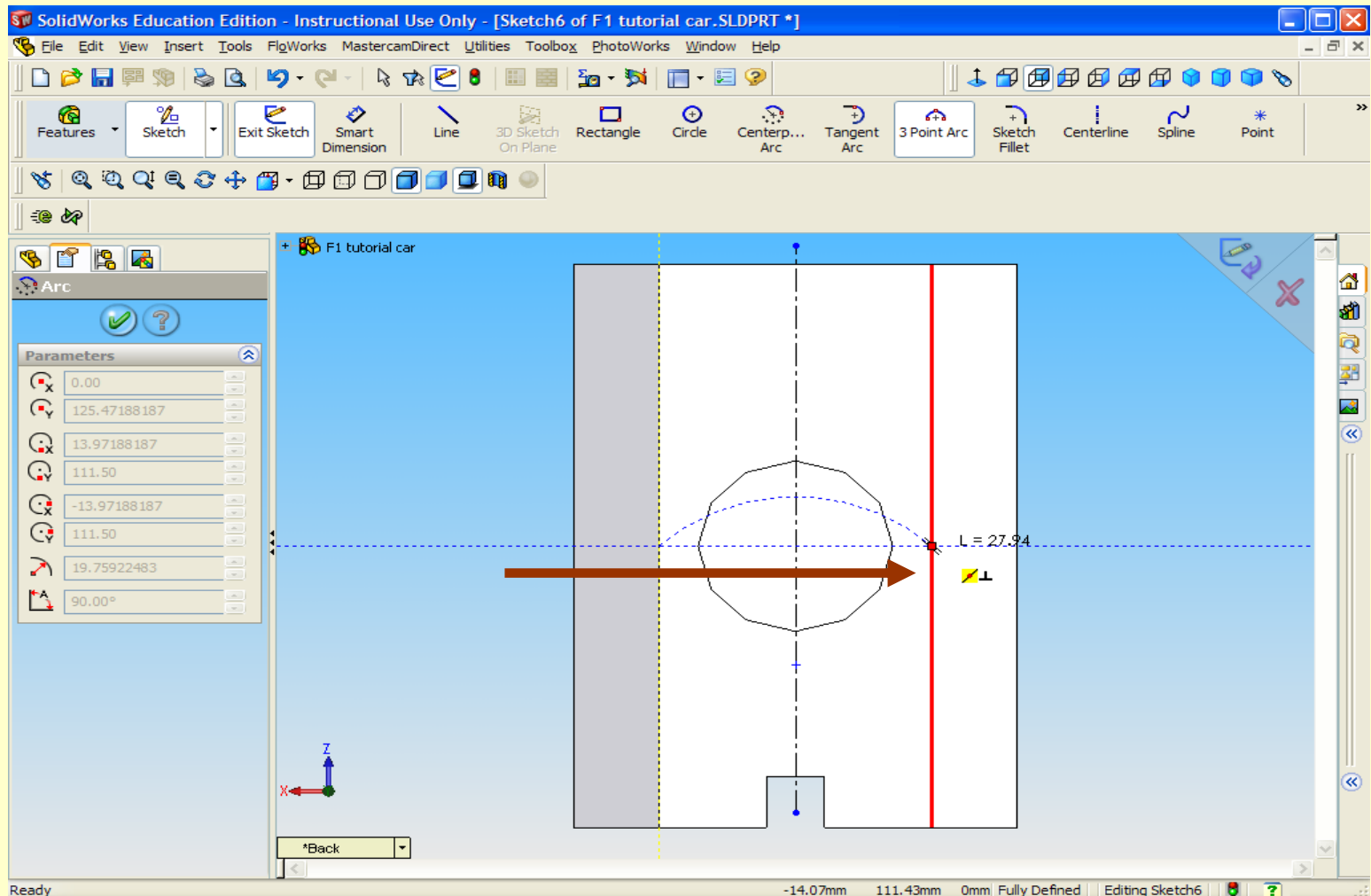
1. Create a centerline again referencing midpoints slowly above and below the stock.
2. Then use the 3 Point Arc and other geometry tools to create a cutting shape around the cartridge hole.



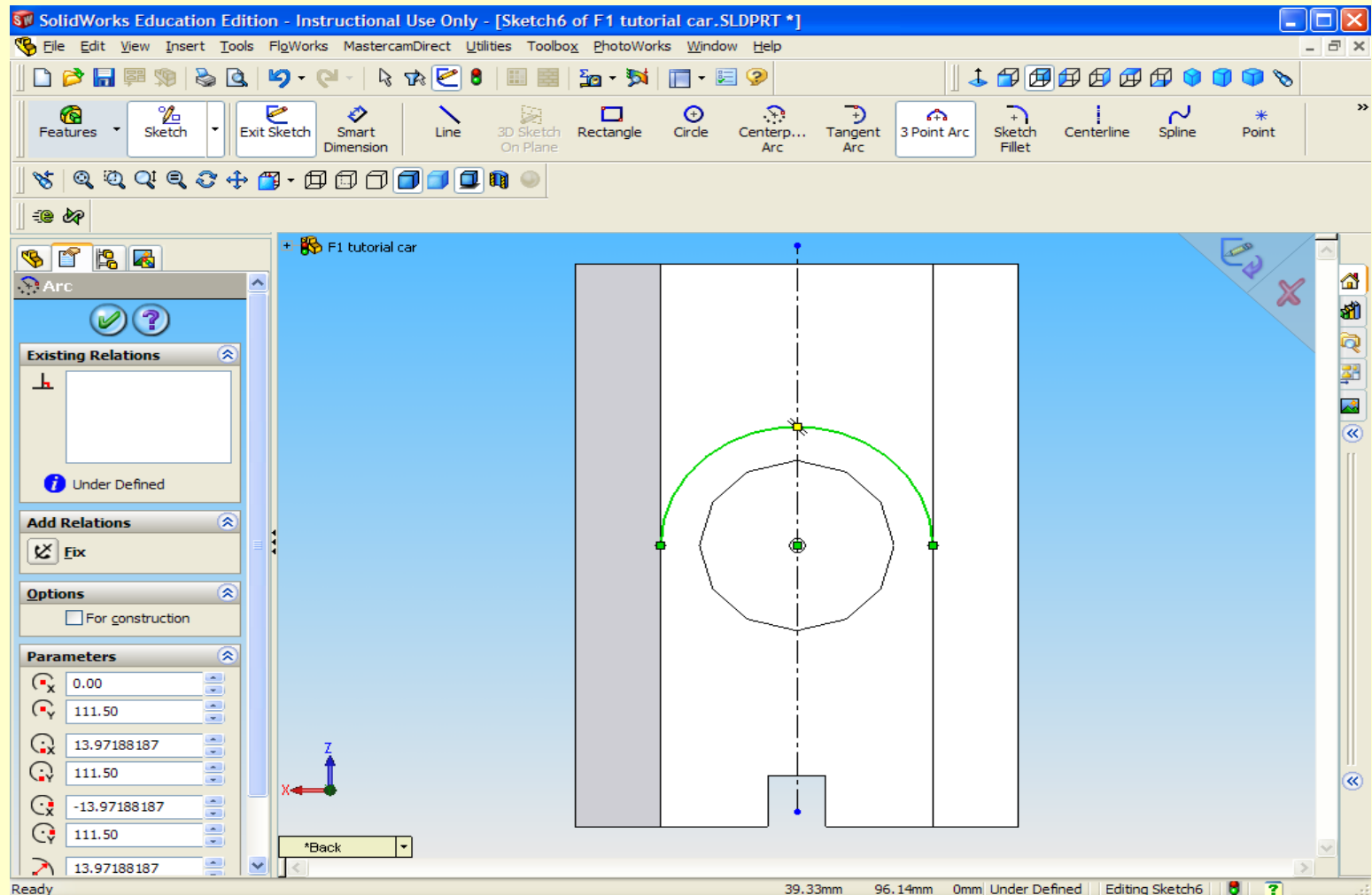
1. Click off to the left of the hole's midpoint.
- ***It is easier to find the intersection of that midpoint and the vertical edge of your first extrusion.



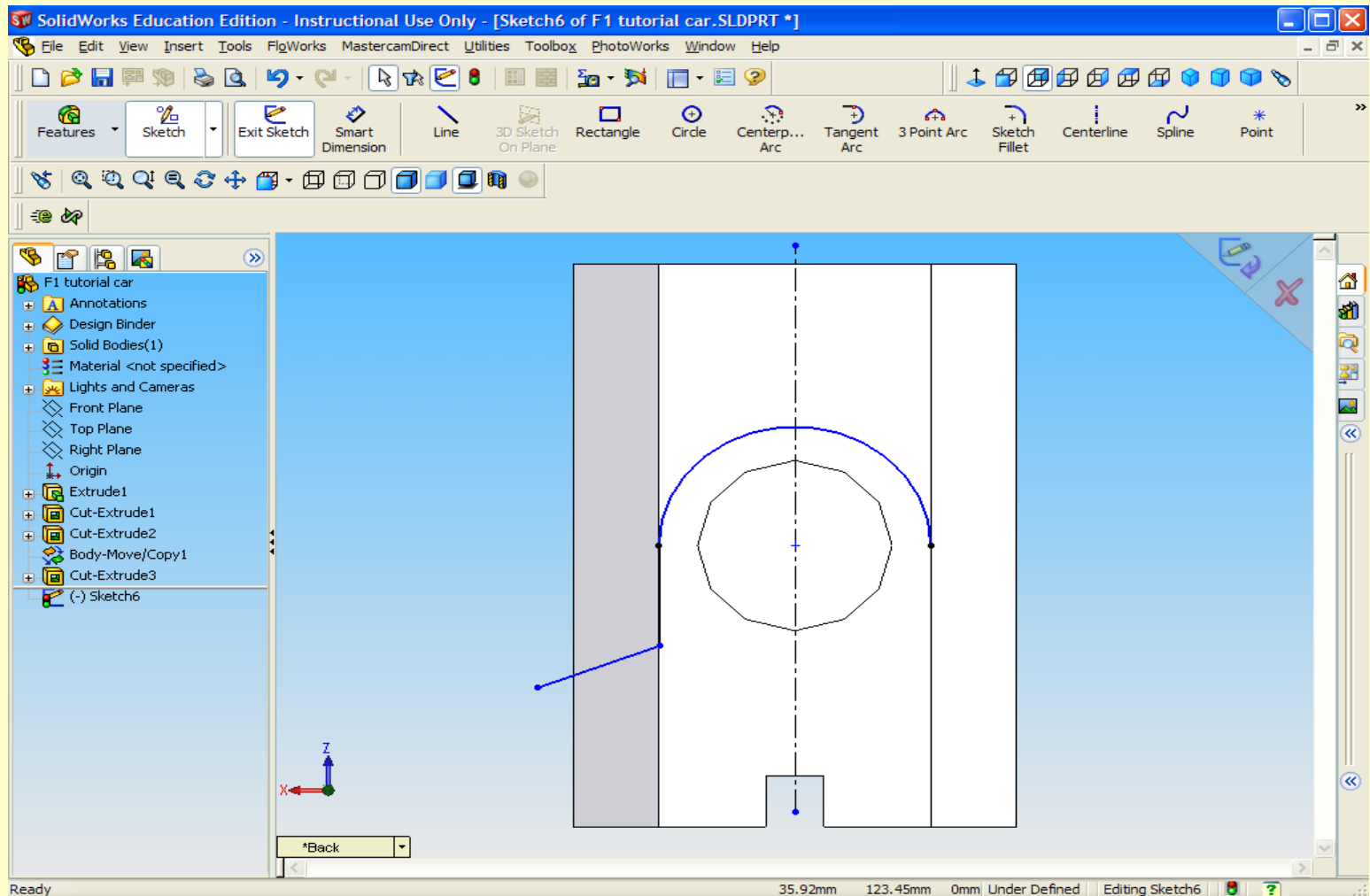
1. Then drag your cursor over to the symmetrical right intersection, and click for the 2nd point of your 3 Point Arc.
2. The third point should snap appropriately above the hole.



1. Click the Green Check.
2. Now click on the LINE tool.
3. Draw a line down from the left end of your arc. Then a line out from that.

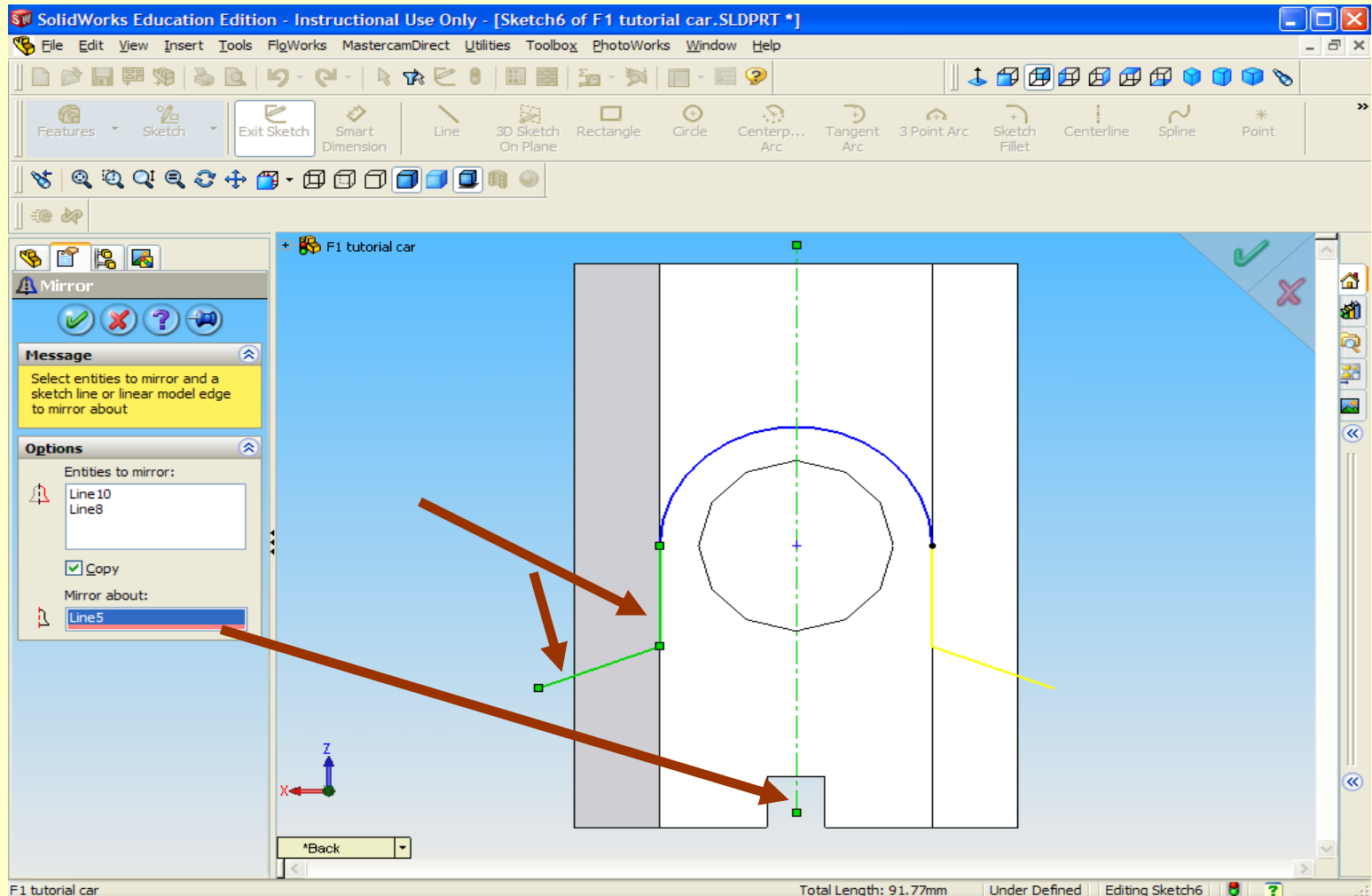


1. Hit the ESC key once you have the line outside of your stock.
2. Click "MIRROR" tool again.

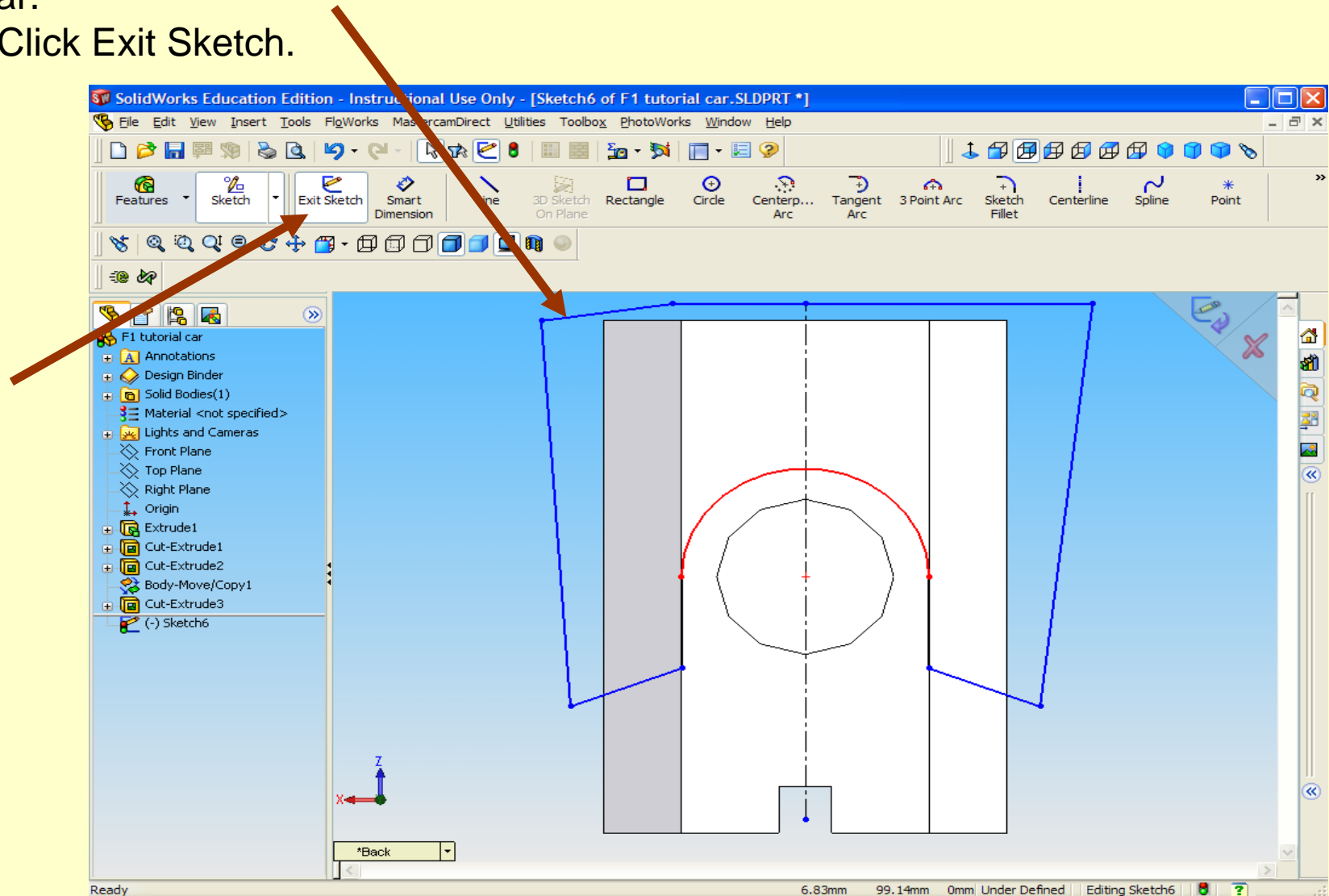




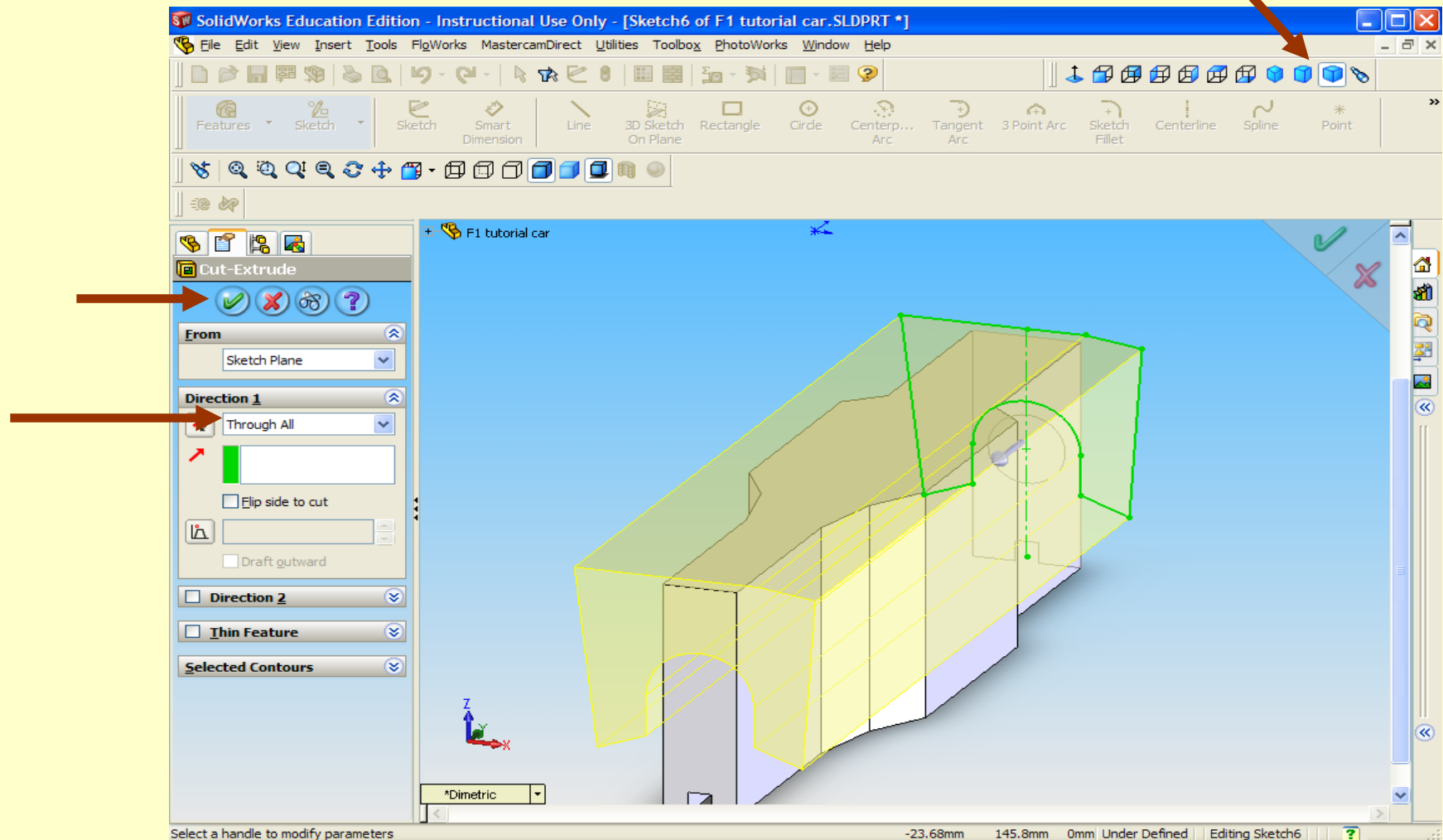
1. Select the two lines only
2. Then Click in the MIRROR ABOUT box.
3. Then Select the centerline. Click the green Check mark.



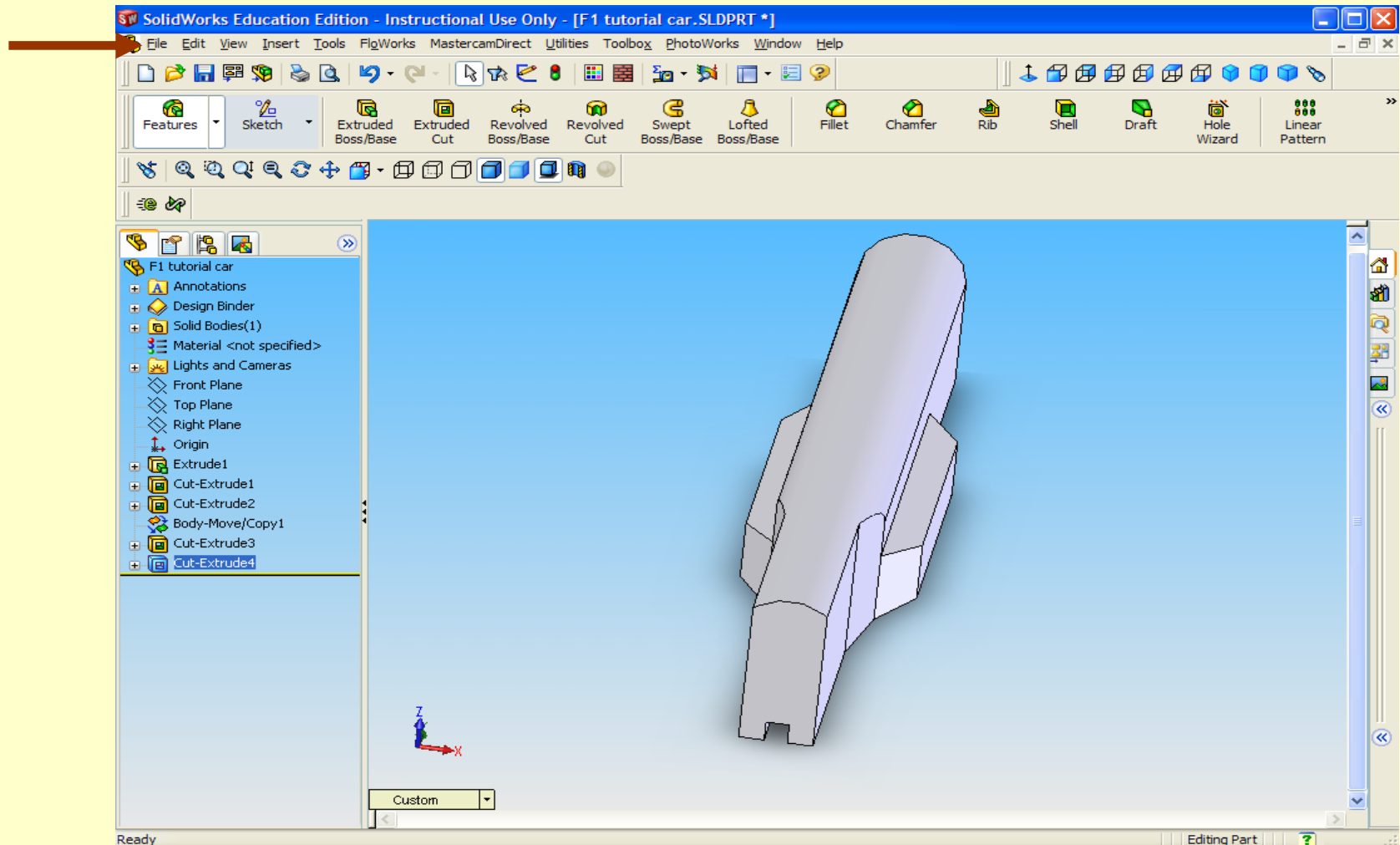
1. Use LINE tool to enclose the cutter shape, clicking any green check marks that appear.
2. Then Click Exit Sketch.



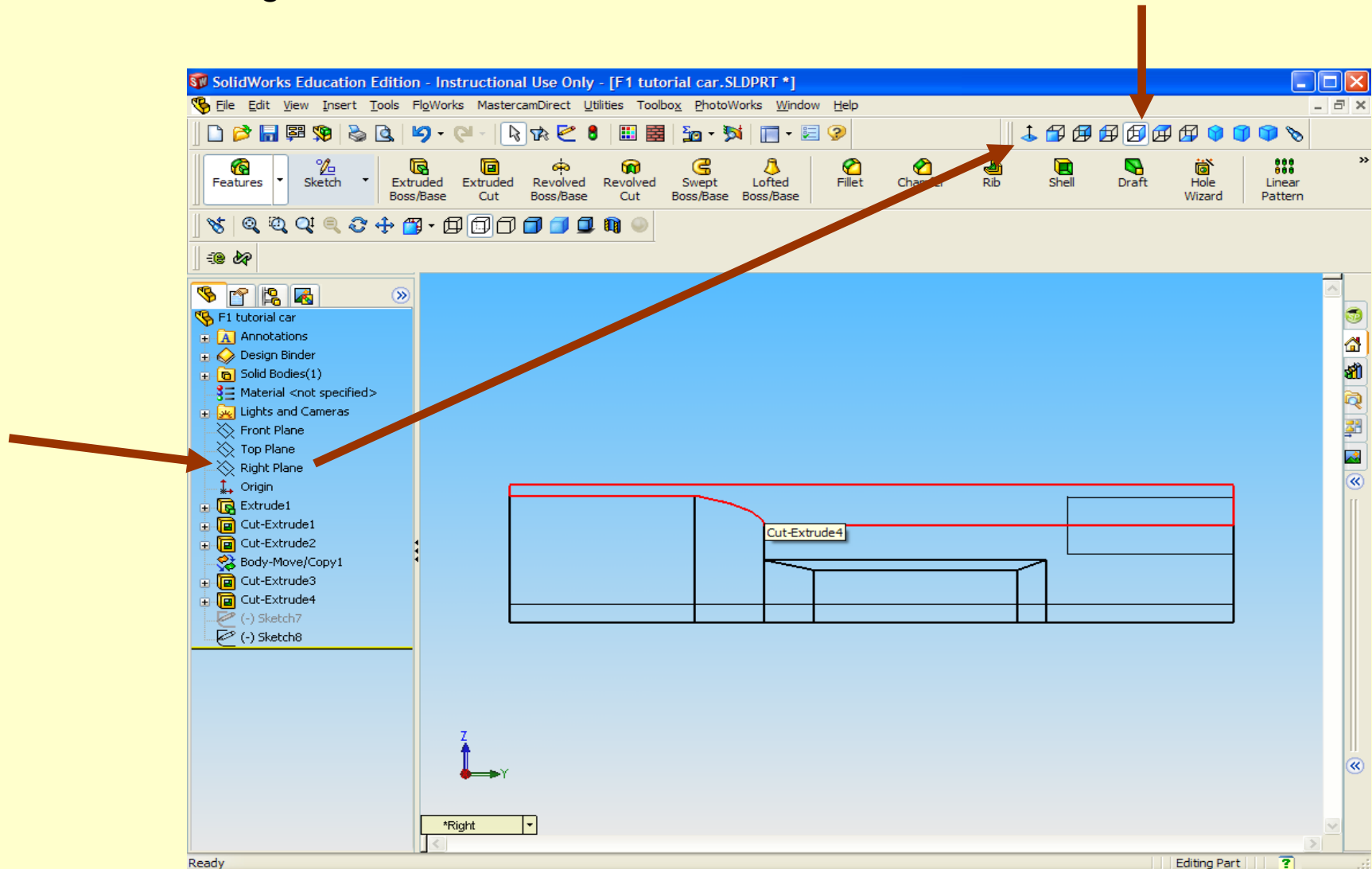
1. Change to a perspective view again.
2. Select THROUGH ALL from the drop down
3. Then click the Green Check.



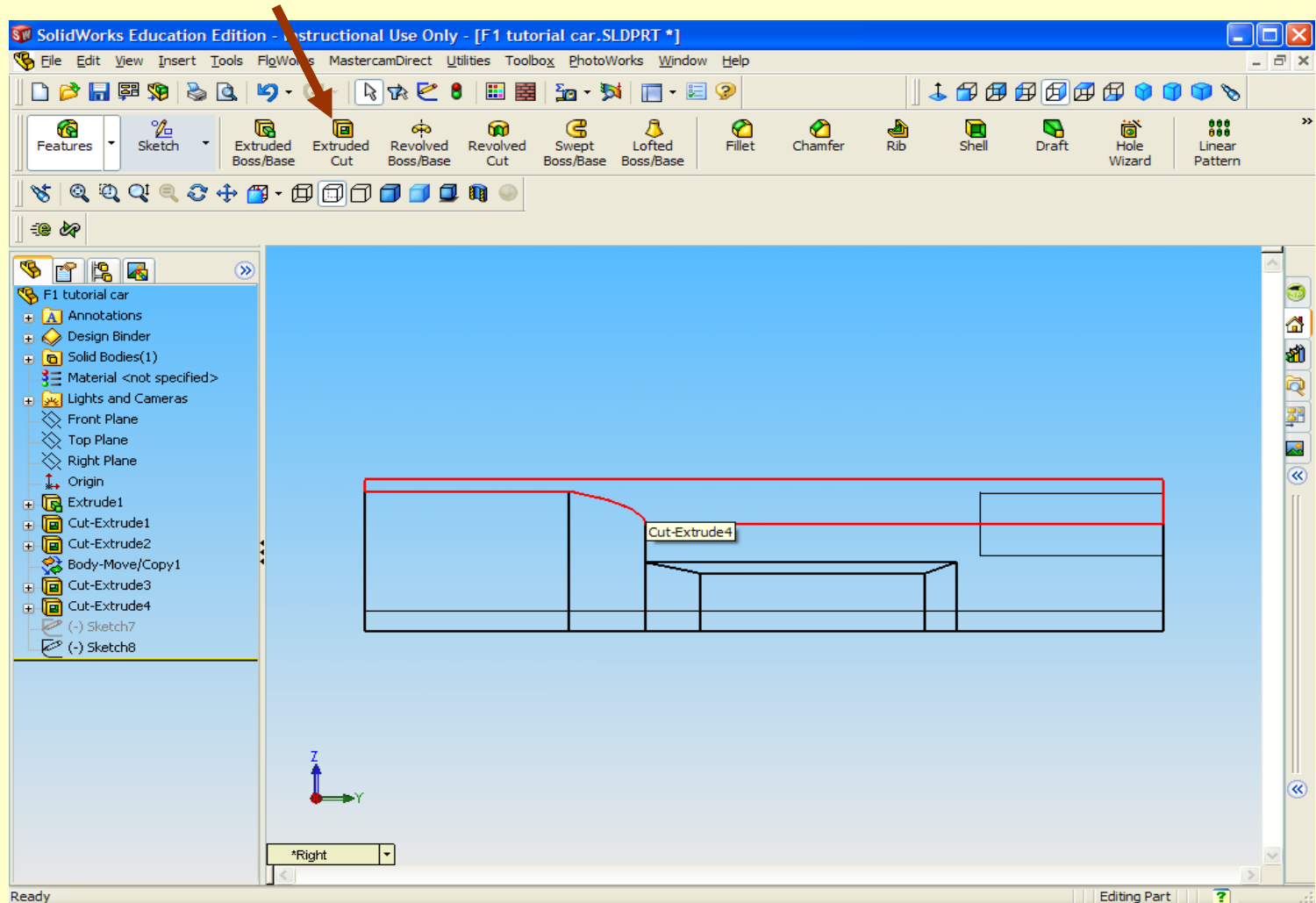
1. Save your work by clicking File, Save as, naming and selecting a location to save the file. It's often helpful to save versions of your part as it gets more complex. Such as "F1carA"...B...C...etc. Rather than overwriting it.



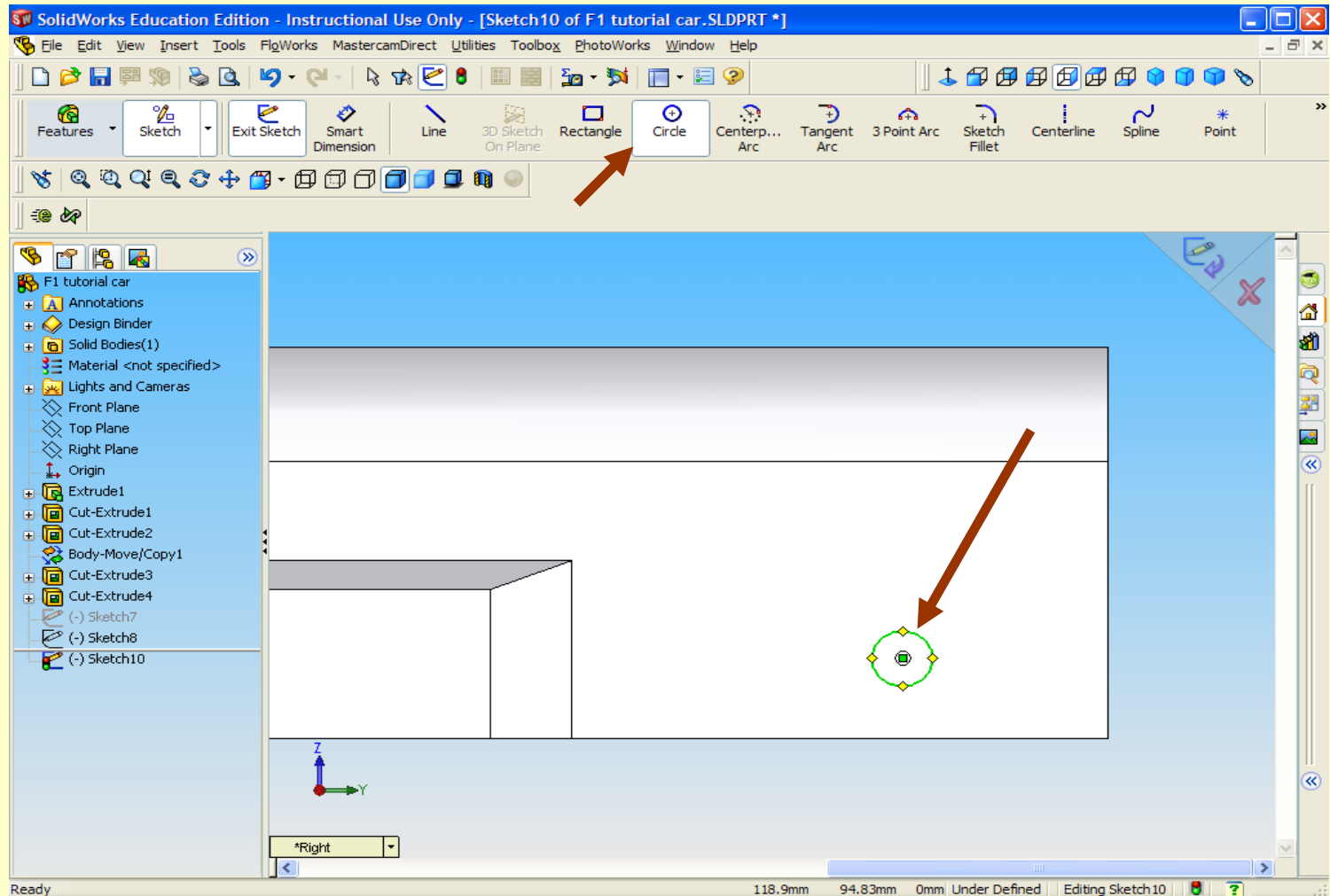
1. Select “Right Plane” then “Normal To” again.
2. Then select the “right view” for a better view.



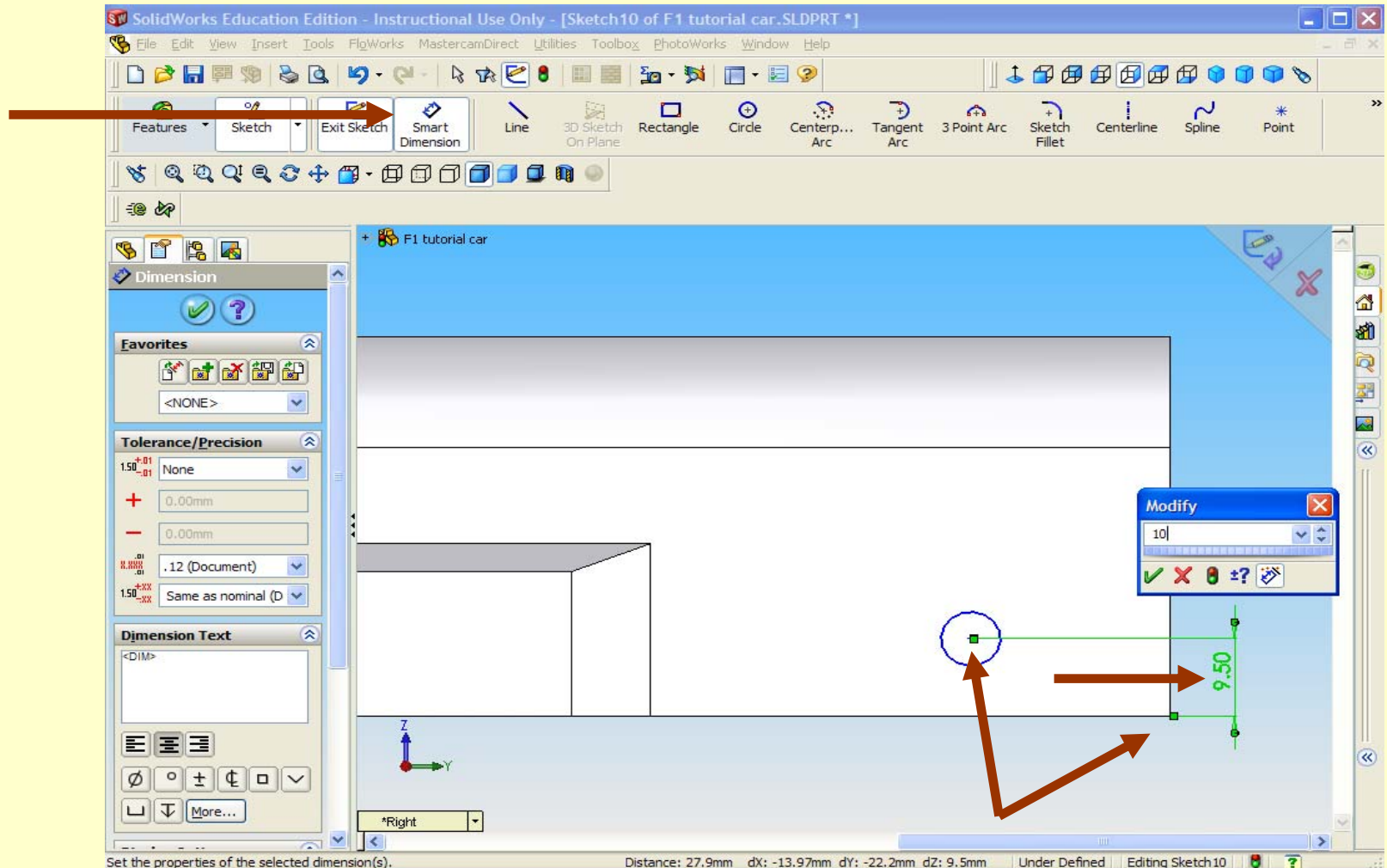
1. We must now sketch the locations for the axle holes.
2. Select Extruded Cut.



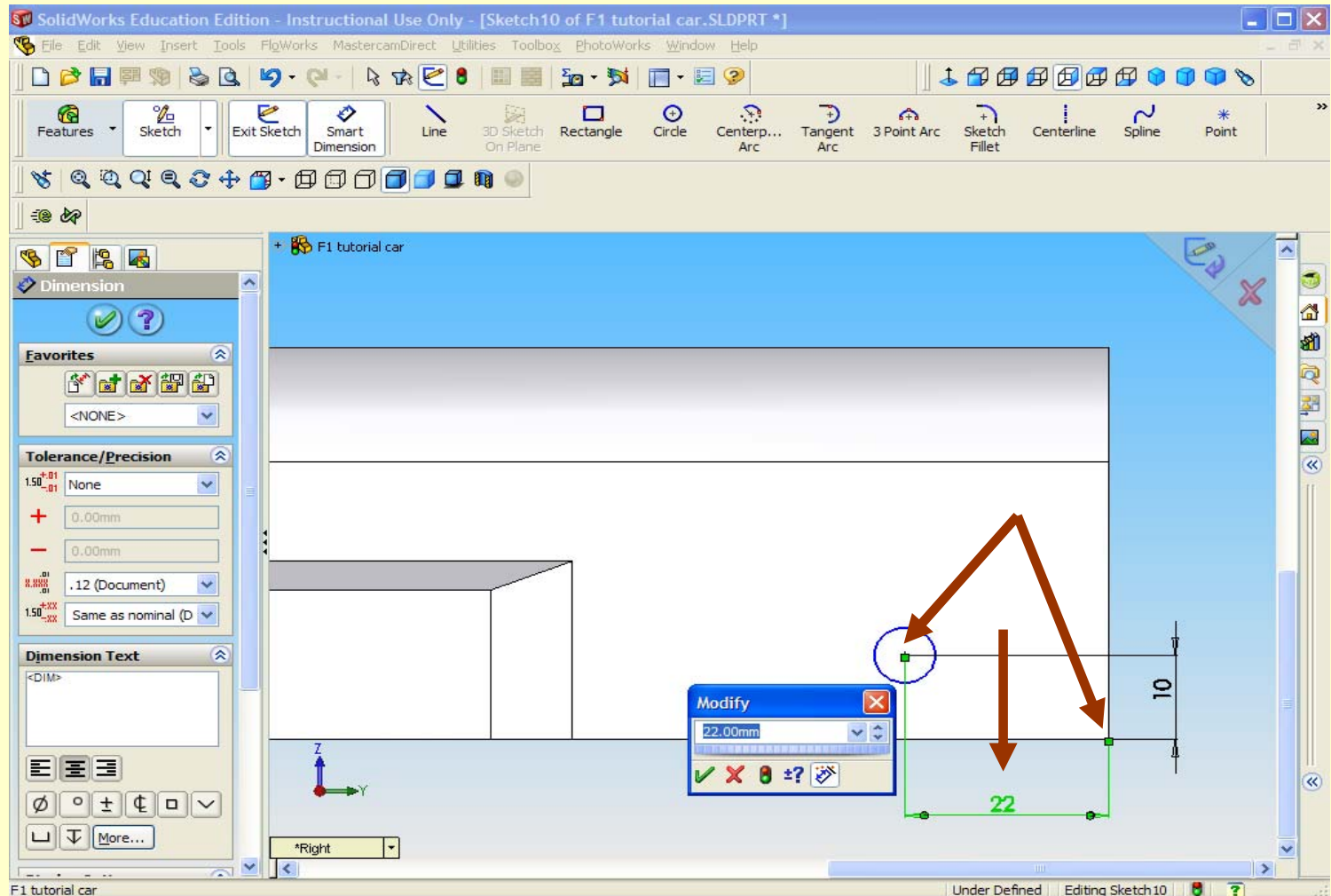
1. Zoom to the rear of the car with your mouse wheel.
2. Select the “Circle” tool.
3. Click, drag, and place one circle.



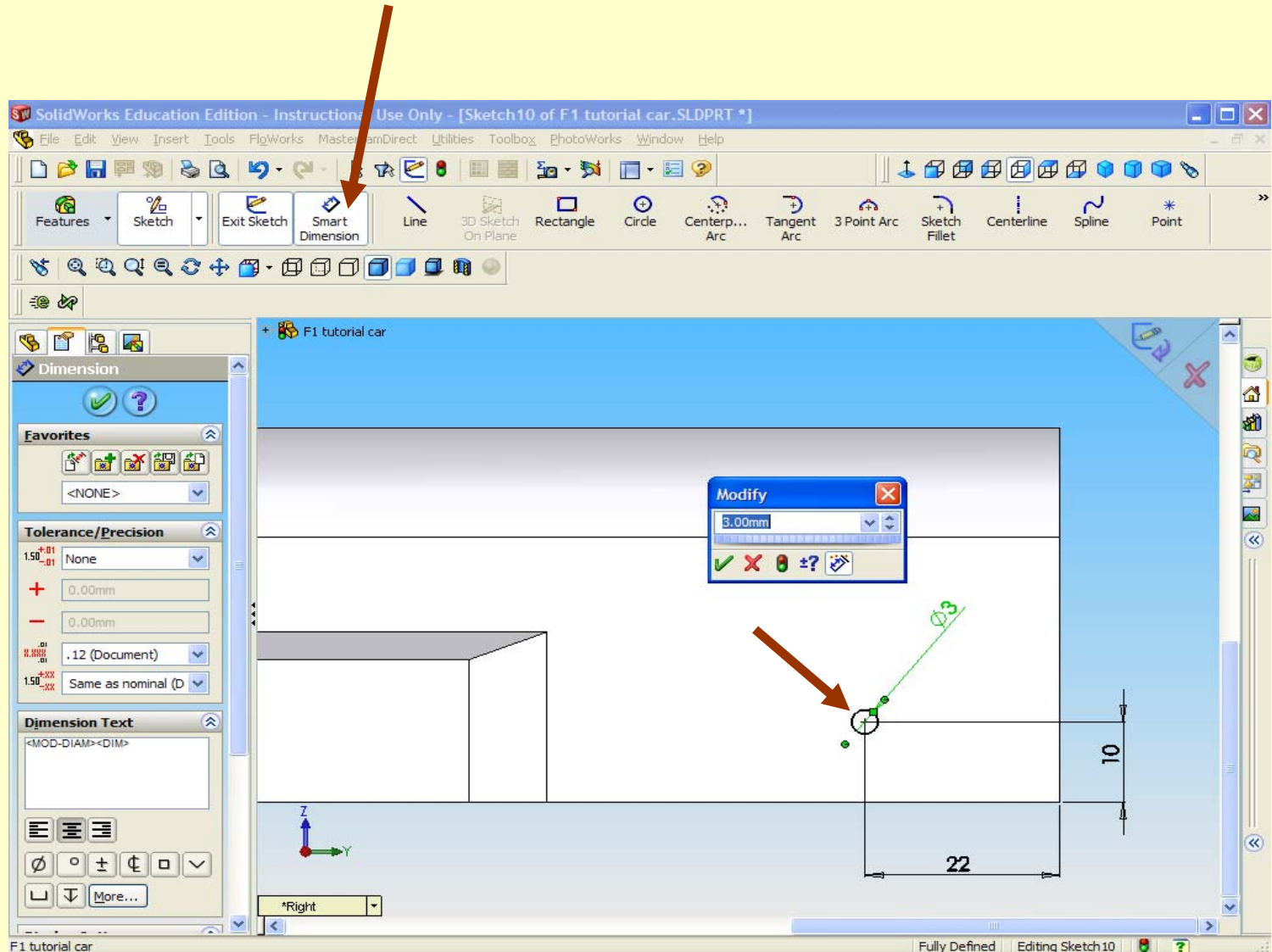
1. Click Smart Dimensions
2. Then click the corner of the car and then center of the circle, then drag right to place the dimension. Then type 10 in the dim window. You may have to double click on it.



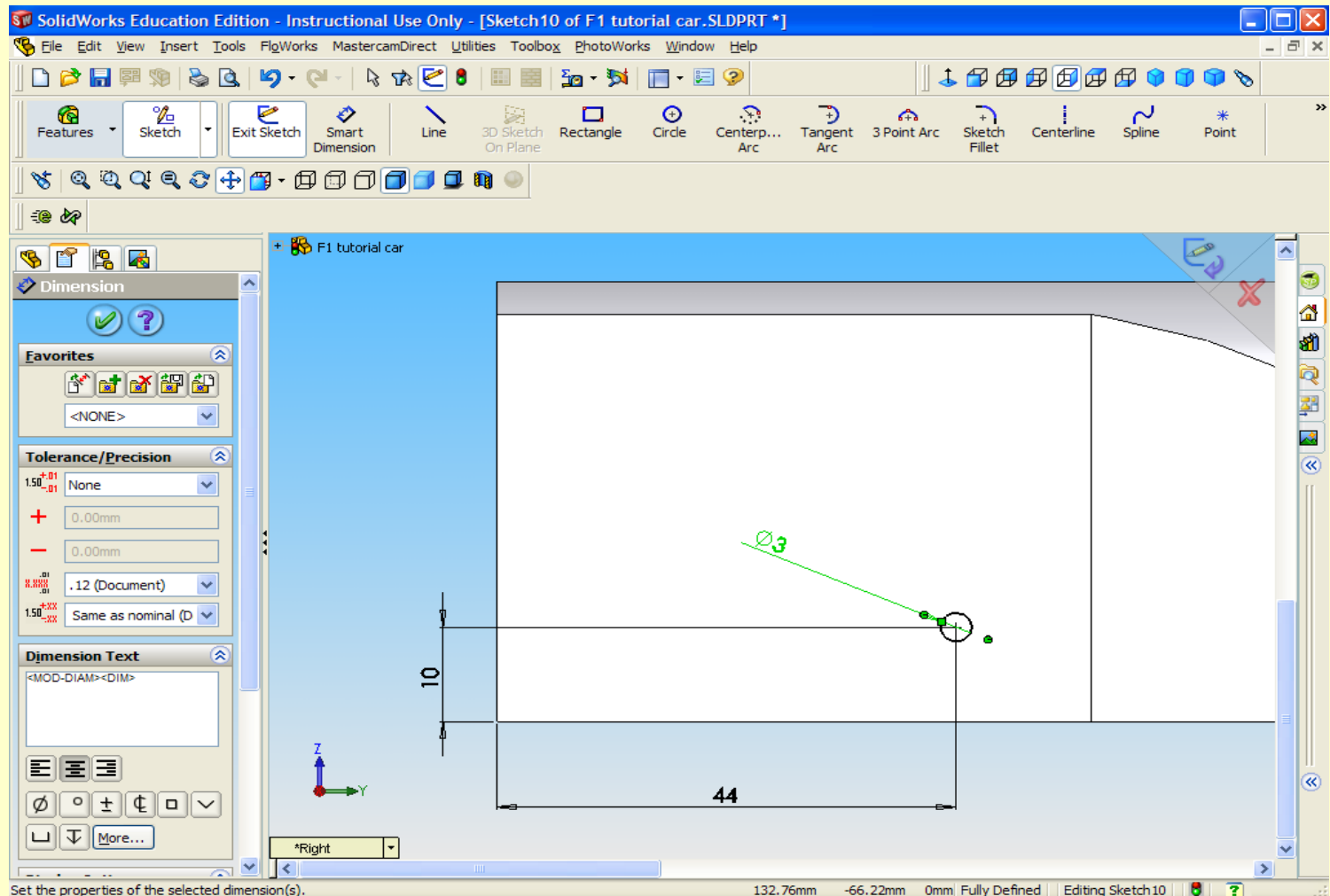
1. Repeat the steps and drag down for the distance from the back. Make this 22.



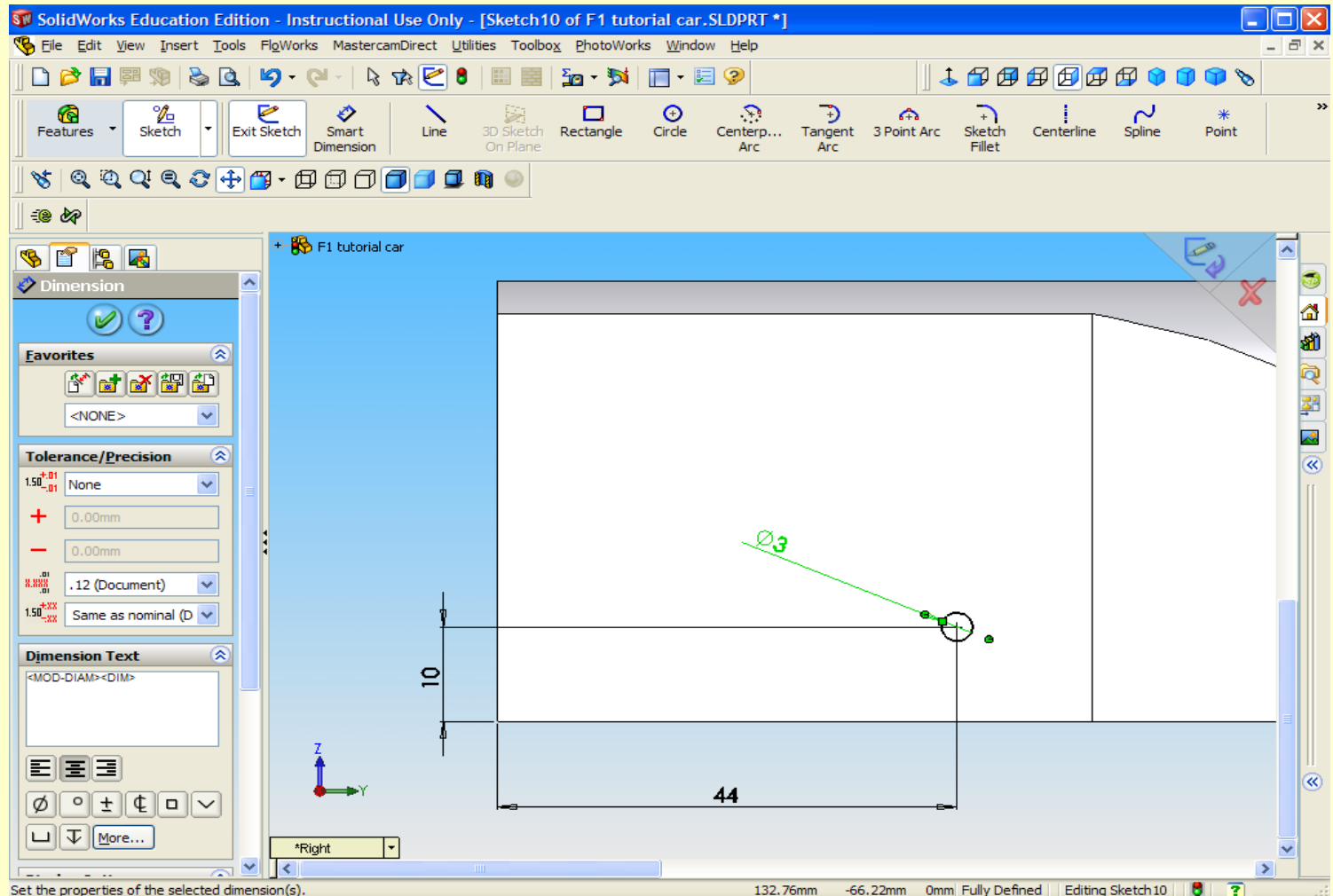
1. You may have to select “Smart Dimension” again and click the circle, make it 3.



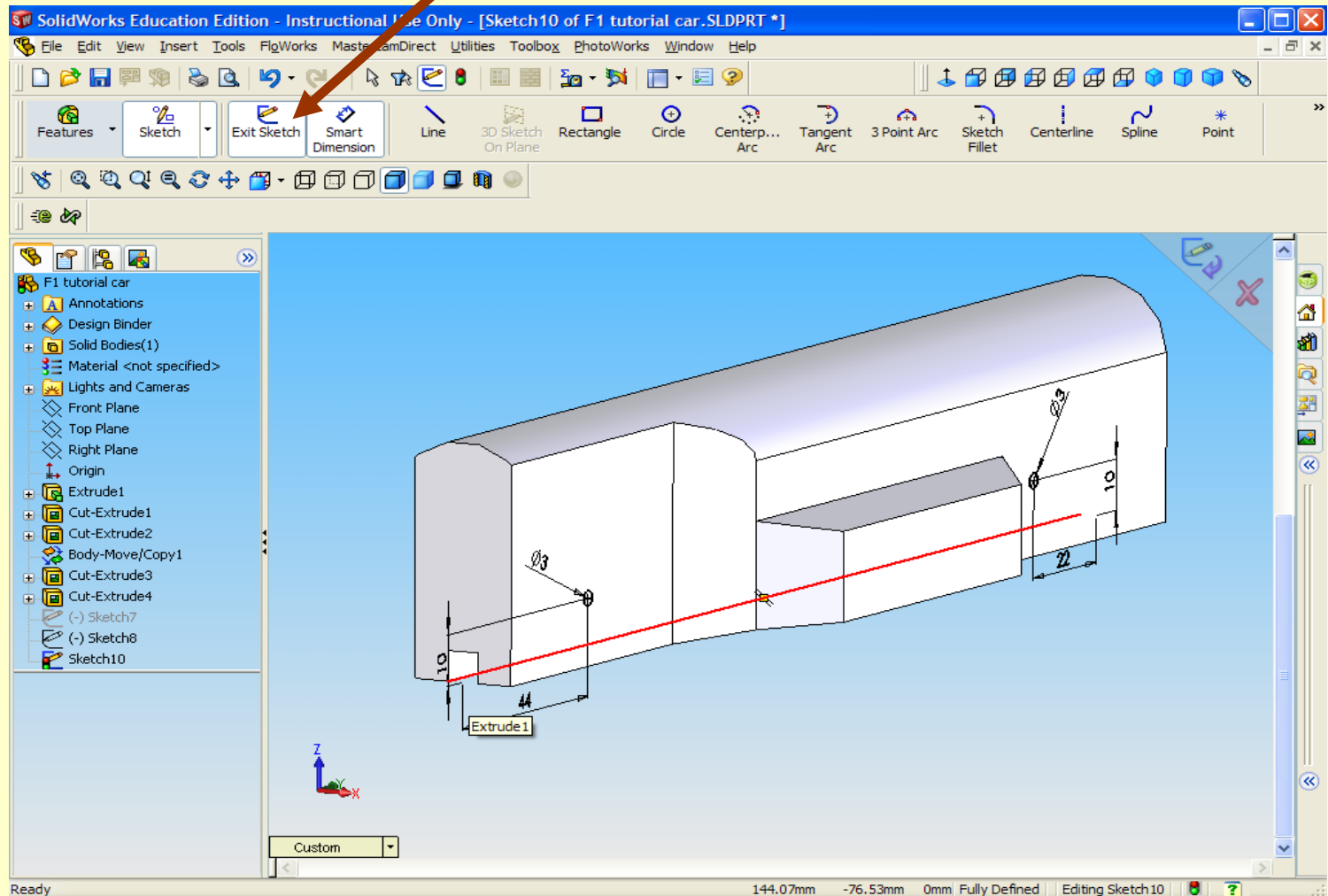
1. Zoom out then back into the front area for the front axle placement.
2. Again use the Circle tool and create a circle, this time with the dimensions below.



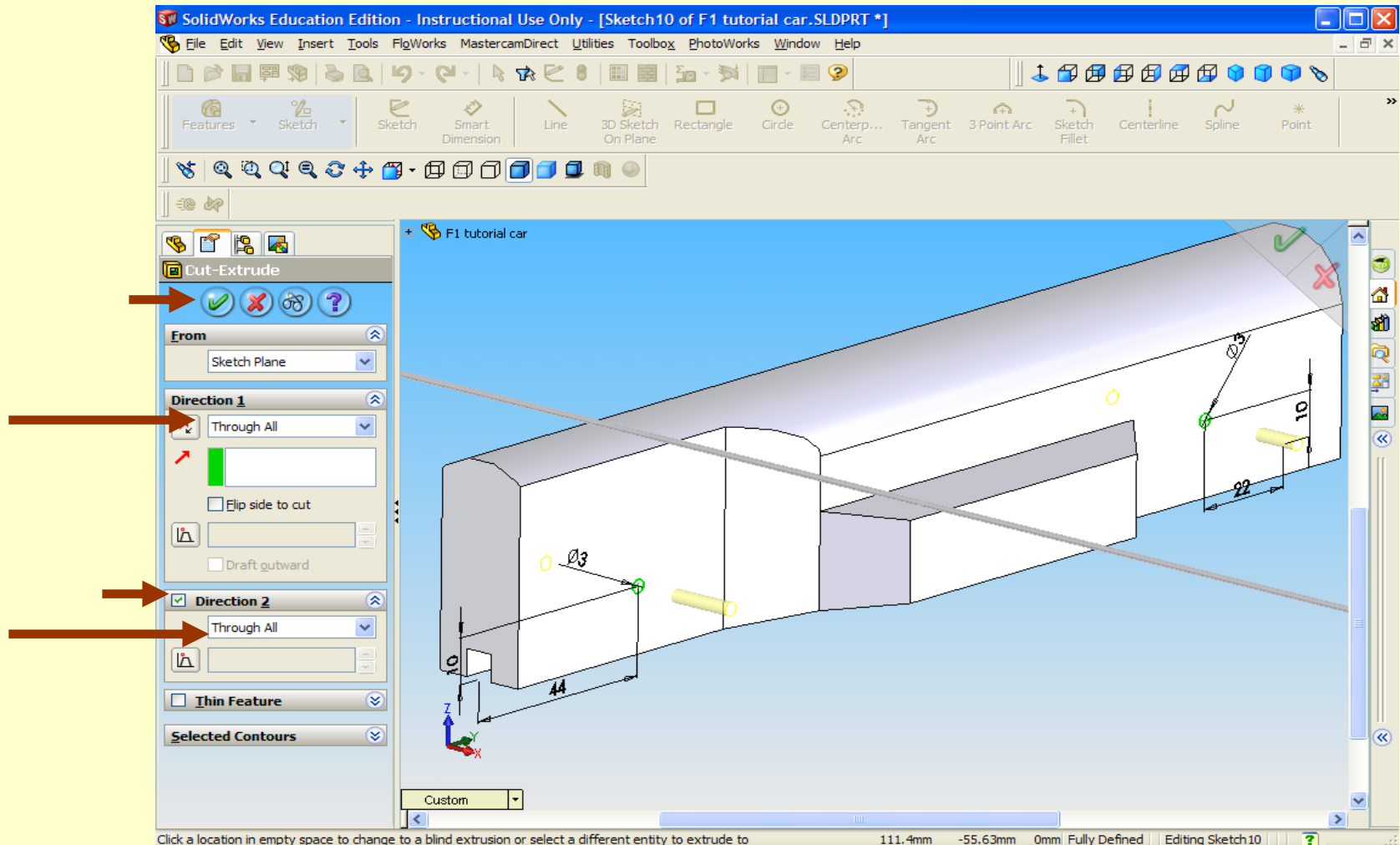
1. Click Smart Dimension the front corner, then the center of the circle.
2. Repeat to dimension from bottom to center. 44 from front to axle, 10 from bottom.
3. Diameter = 3mm.



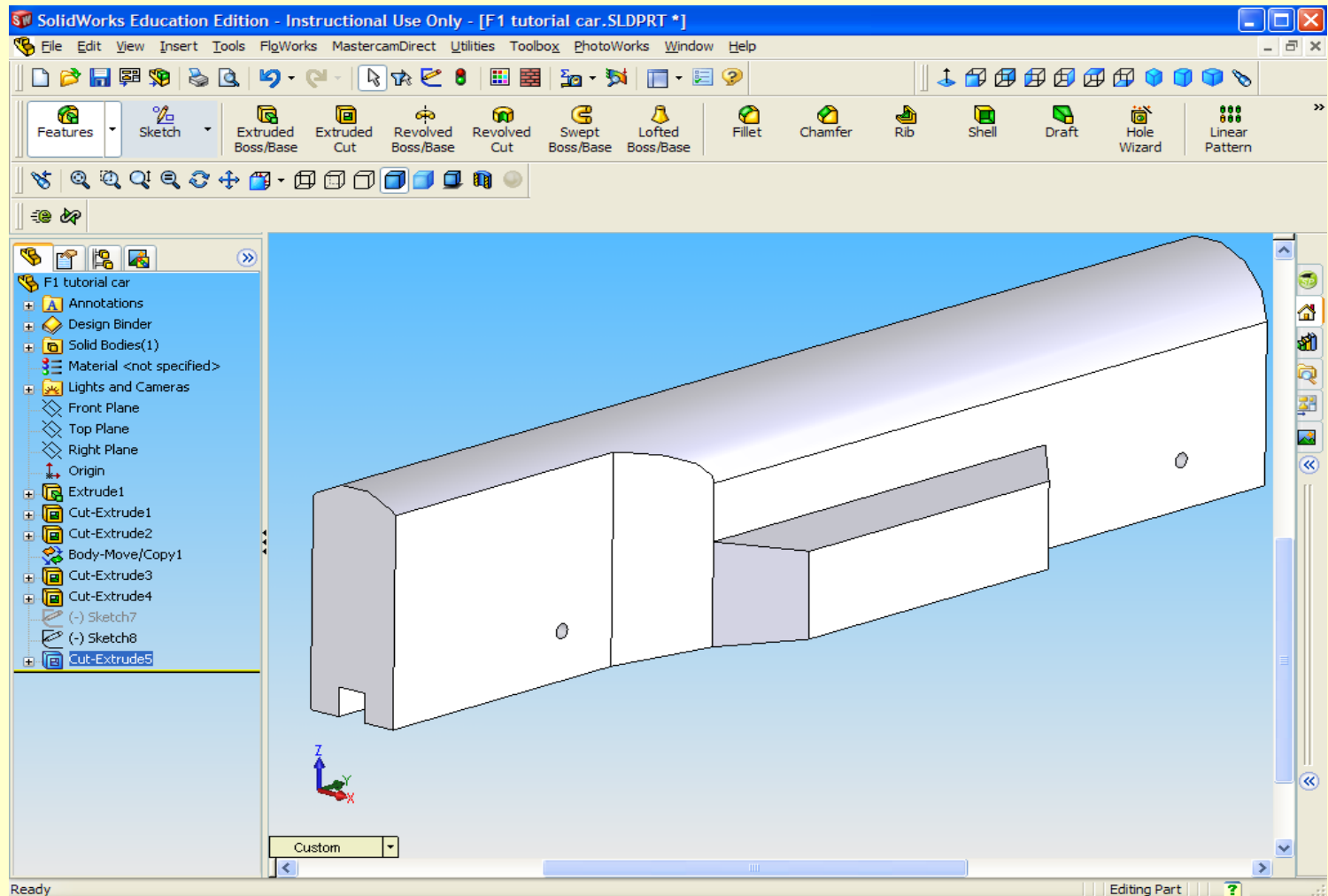
1. Switch to a perspective view and click “Exit Sketch.”



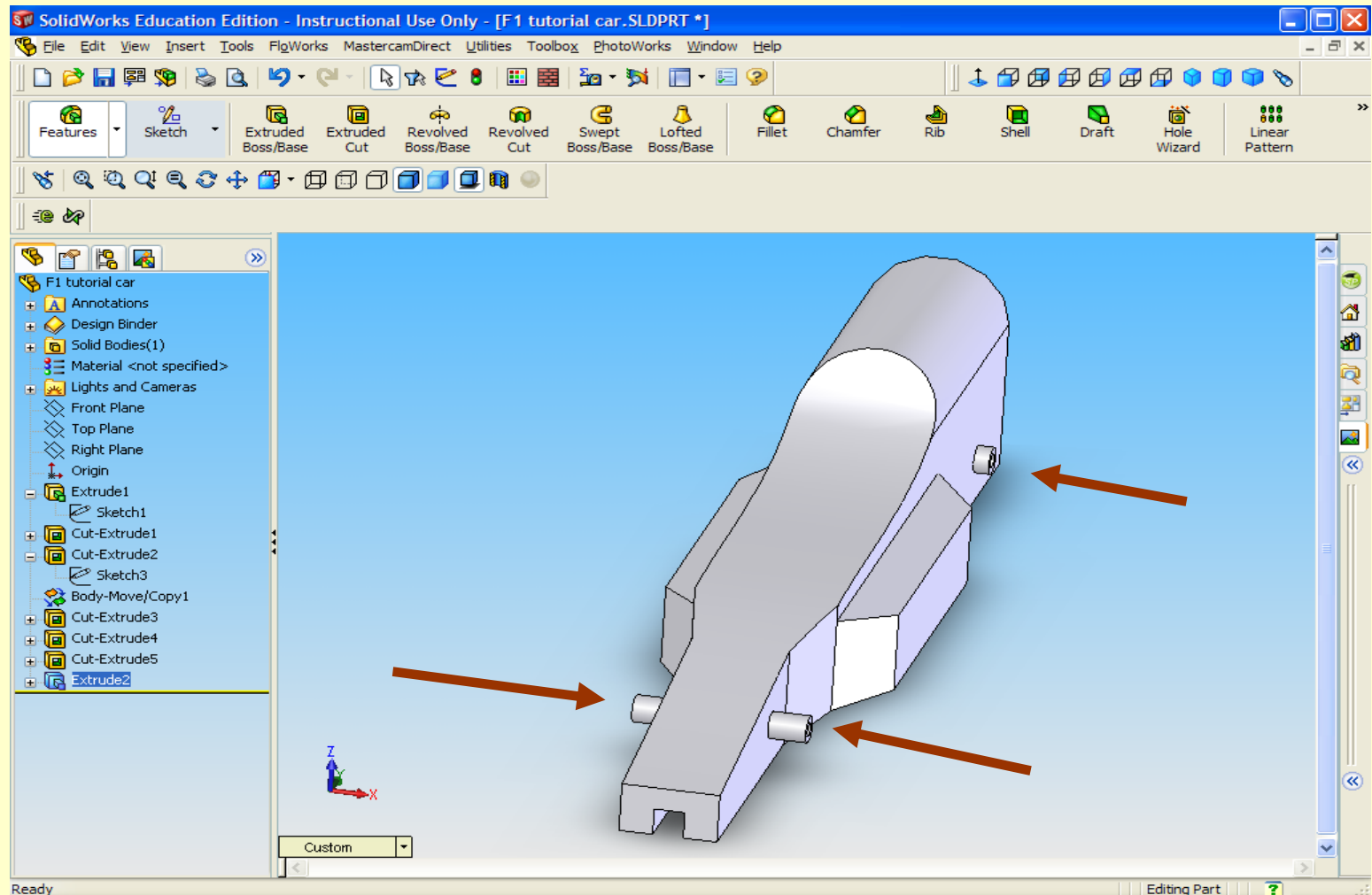
1. Select “Through All” from the Direction 1 dropdown.
2. Click Direction 2 and select “Through All” there as well.
3. Then click the green check.



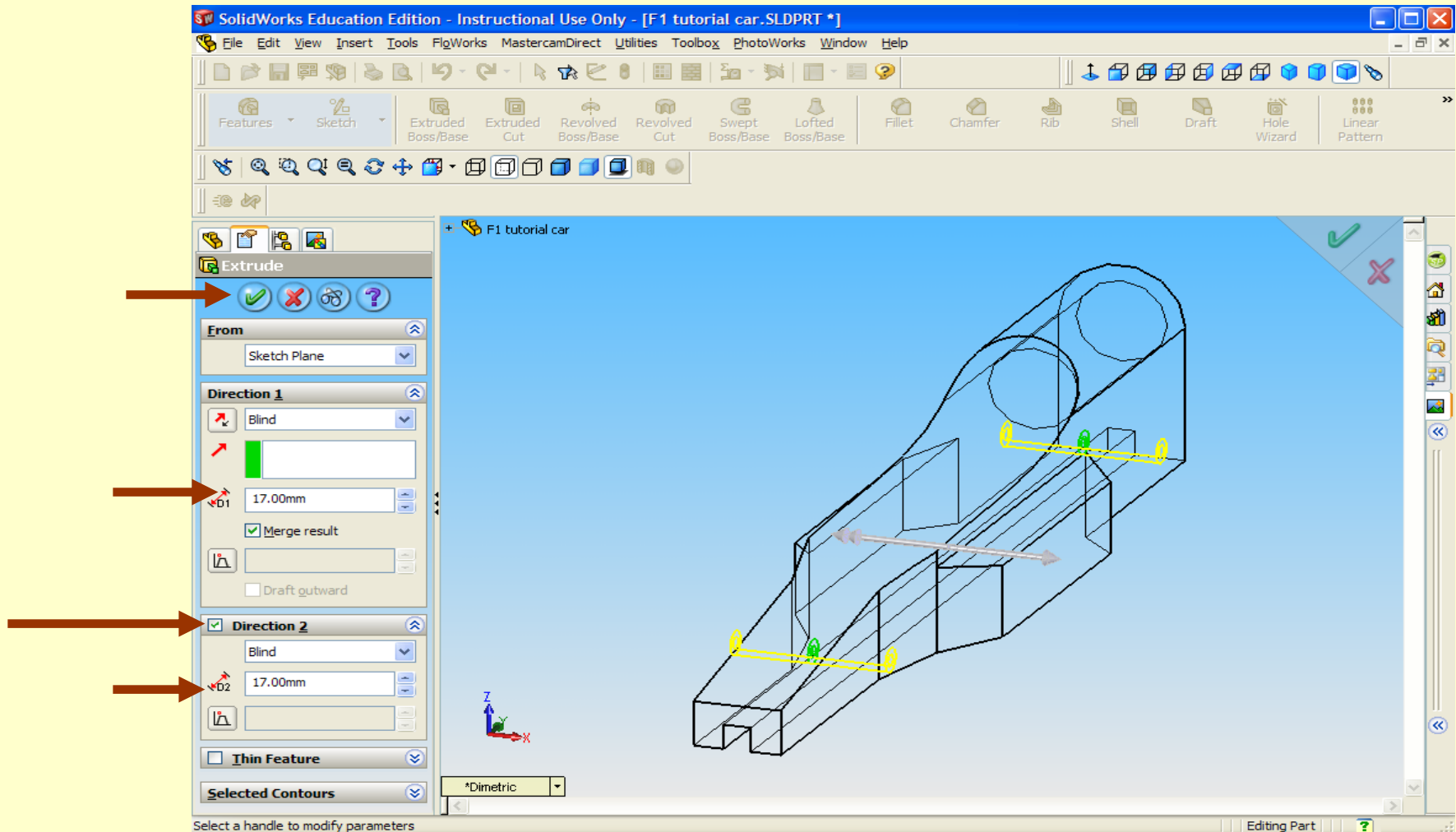
1. This just creates holes for the axles. Continue to slide #43.
2. If you want standoffs...see instructions on the next 2 slides.



...Such as this. You must perform an Extrude Boss/Base rather than the Extrude Cut in slide 32. Also then you must draw a 6mm diameter circle around each 3mm hole-circle. Then give a dimension in slide 40 around 17mm rather than Through All.

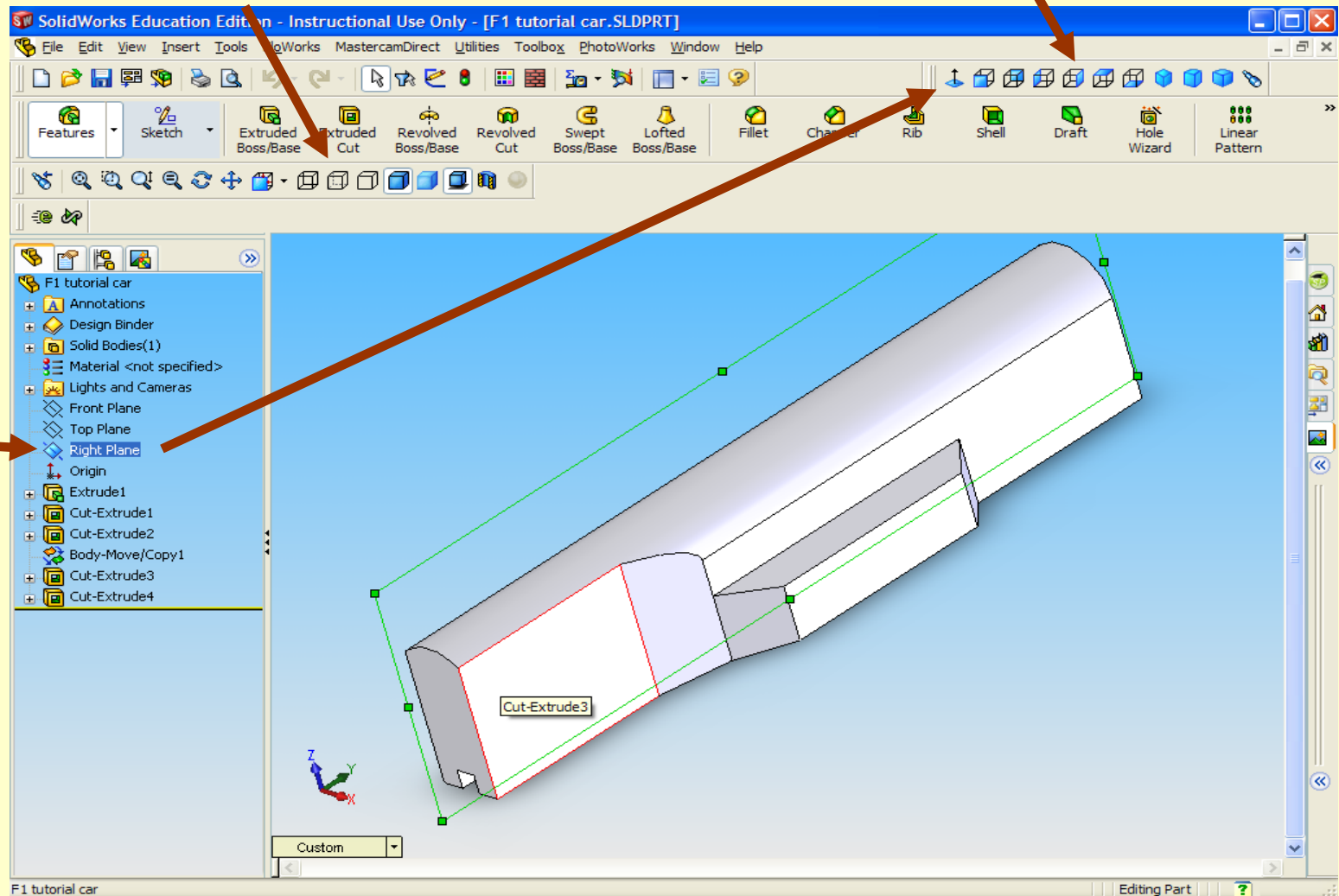


1. Select Direction 2, and input 17mm for both D1 and D2.
2. Click the Green Check.

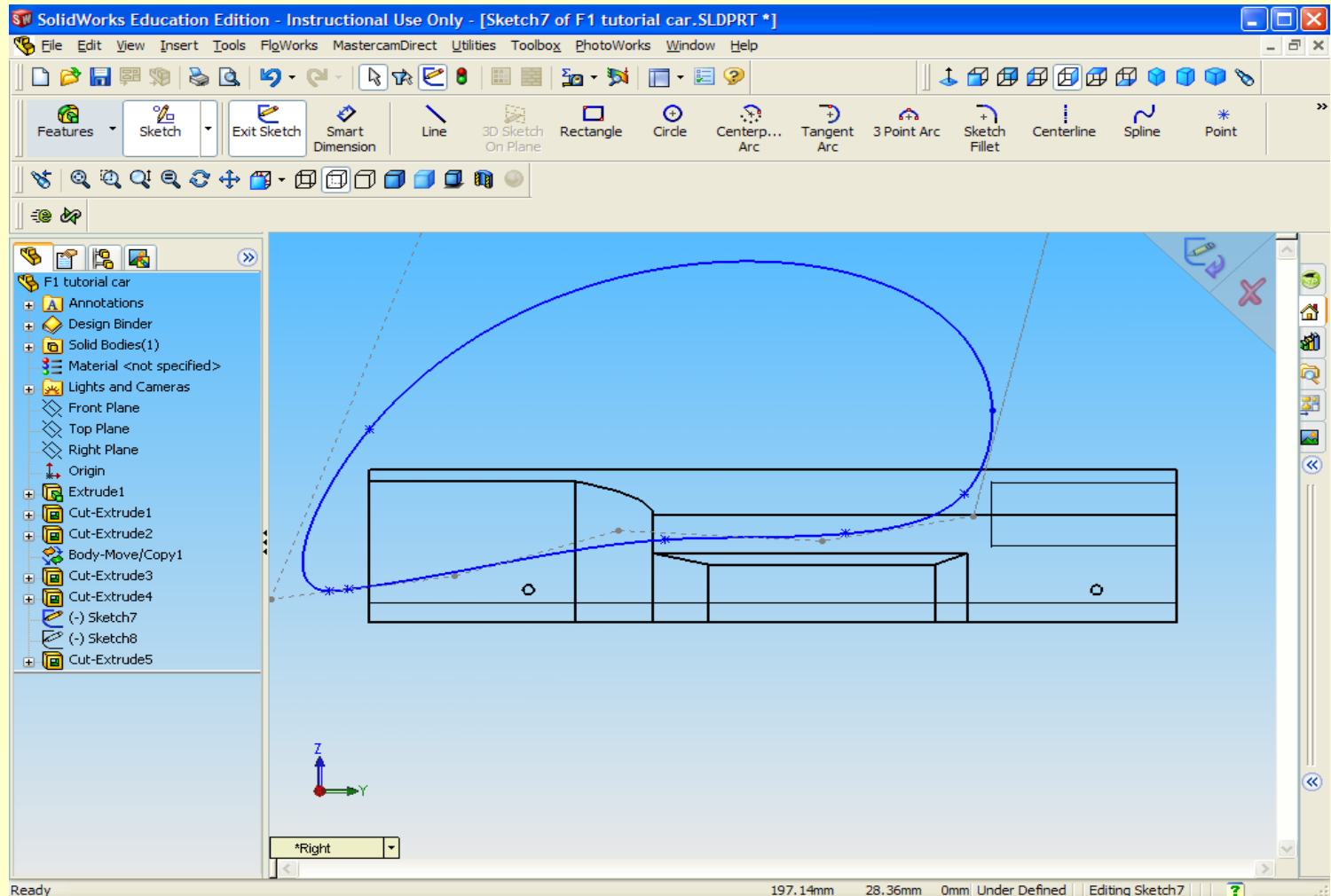


Without standoffs for axles...

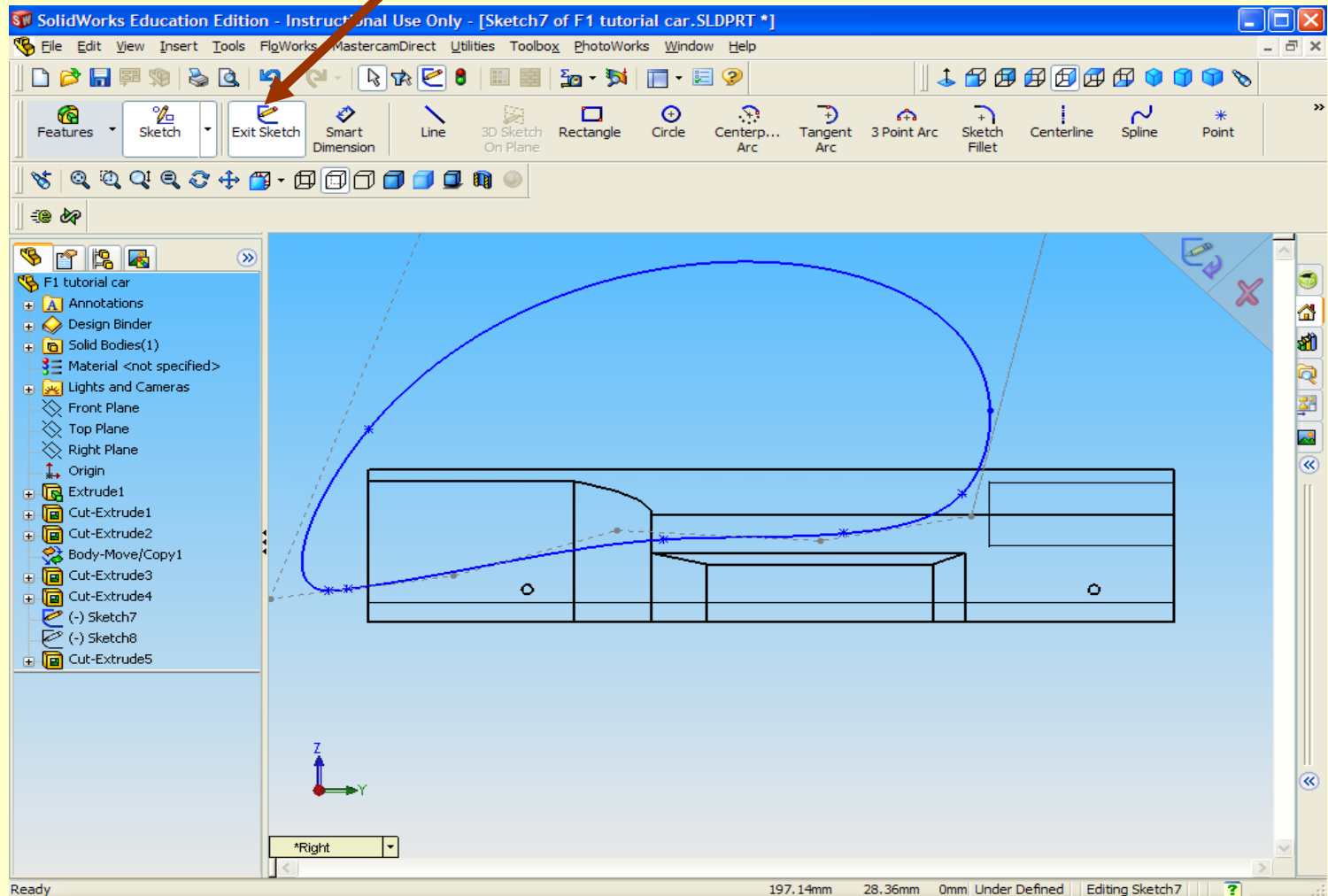
- Click on “Right Plane” then “Normal To.” Also then click on “Right View.”
- Click “Hidden Lines Visible.”



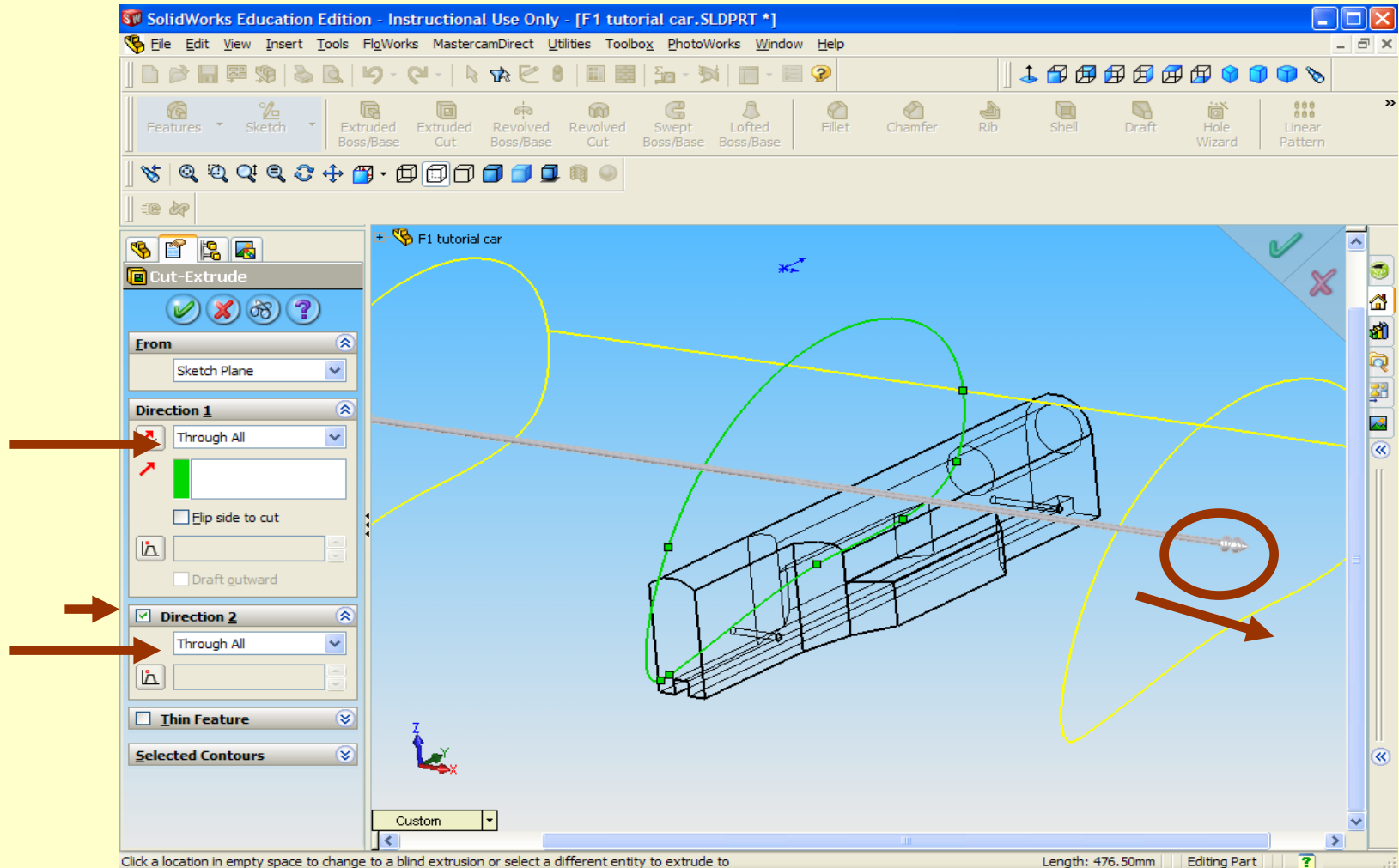
1. Click “Extruded Cut”
2. Use “Spline” or other sketch tools to draw an enclosed “cookie cutter” shape to cut away material from the profile. Do **not** cut off material below the axle holes.



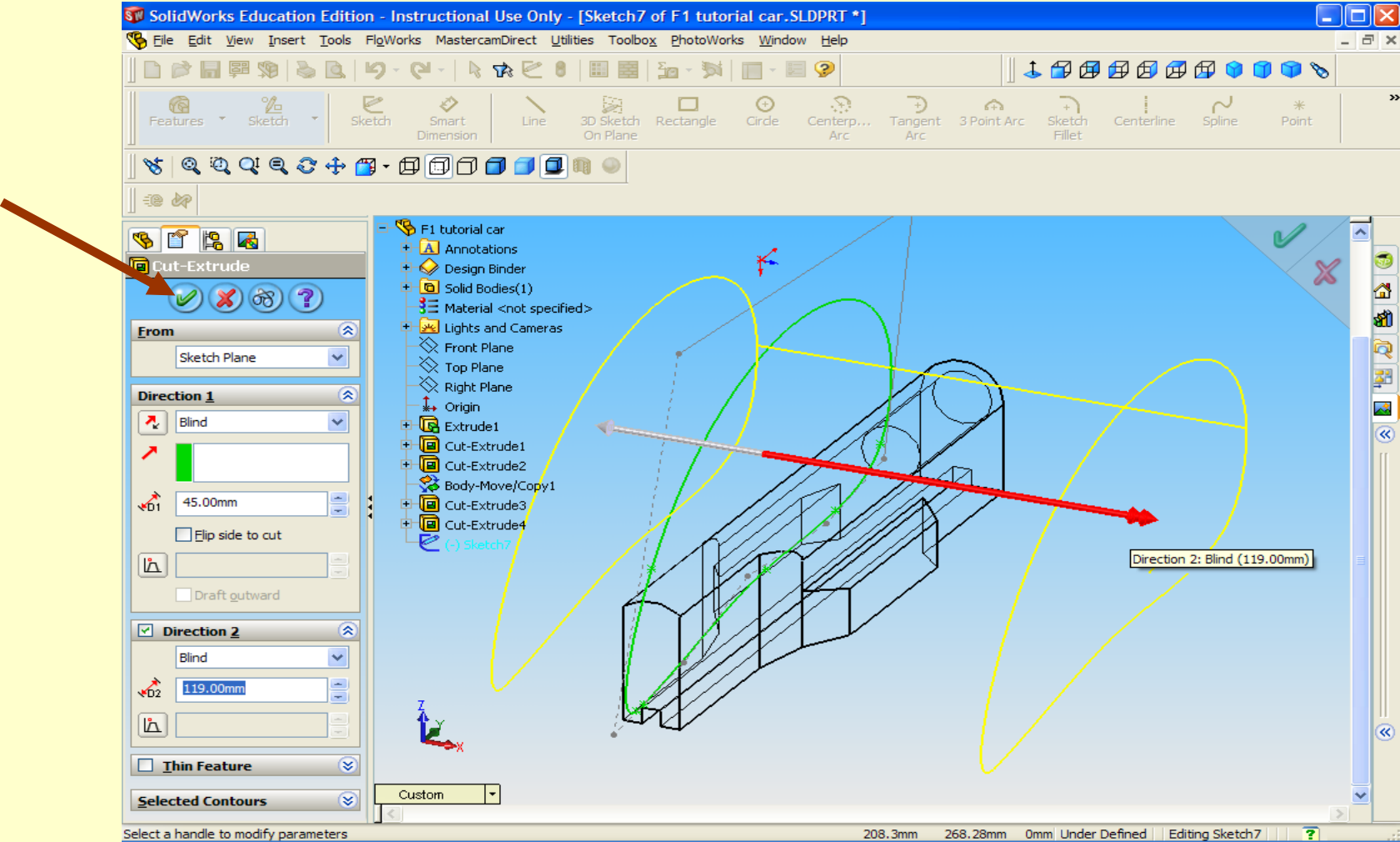
1. Click the Green Check mark and then Exit Sketch



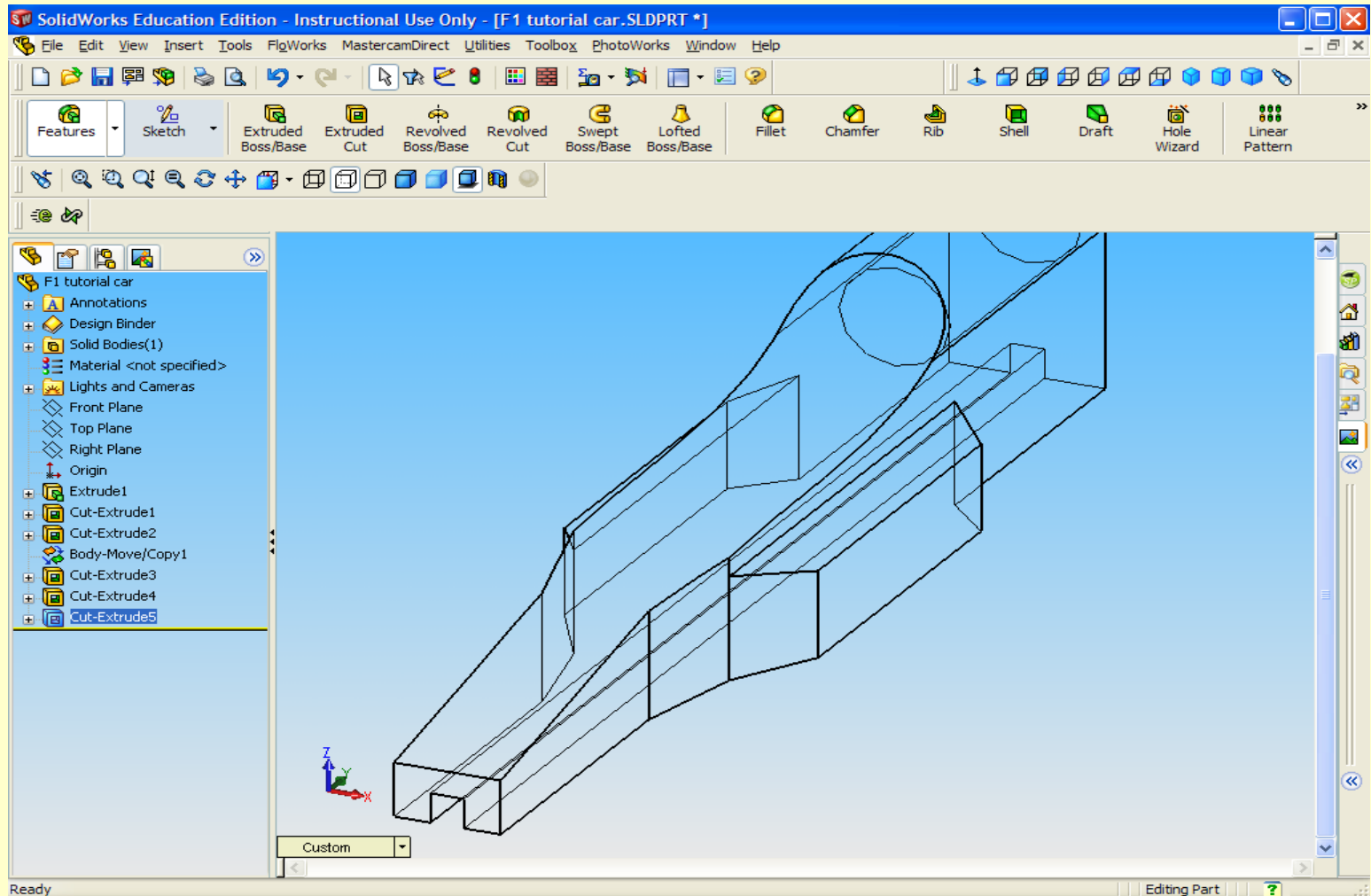
1. Hold down your mouse wheel to rotate your view.
2. Check Direction 2
3. Select Through All for both directions or click and drag the gray arrow past the block.



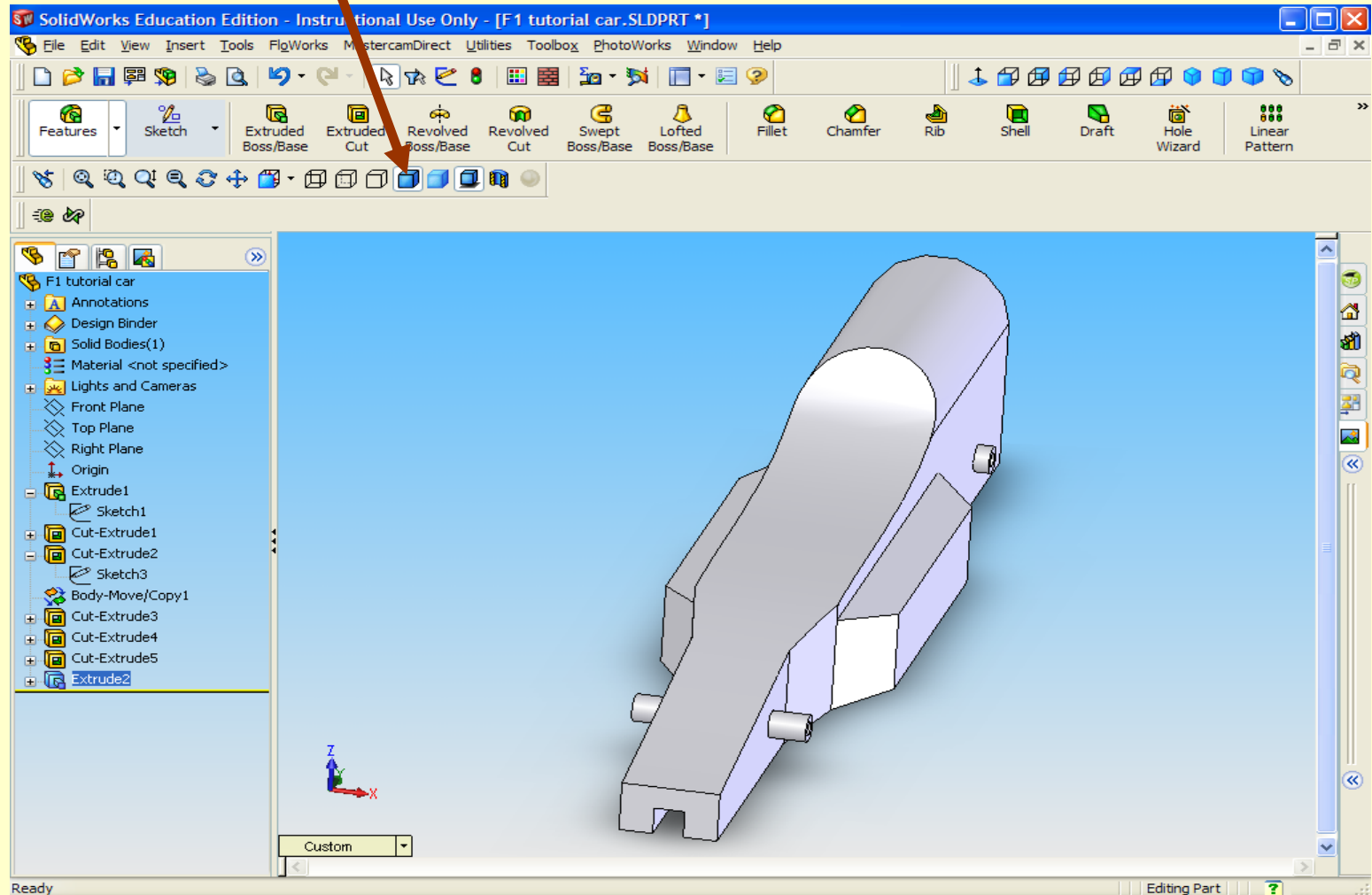
1. Once you've done either way click the Green Check.



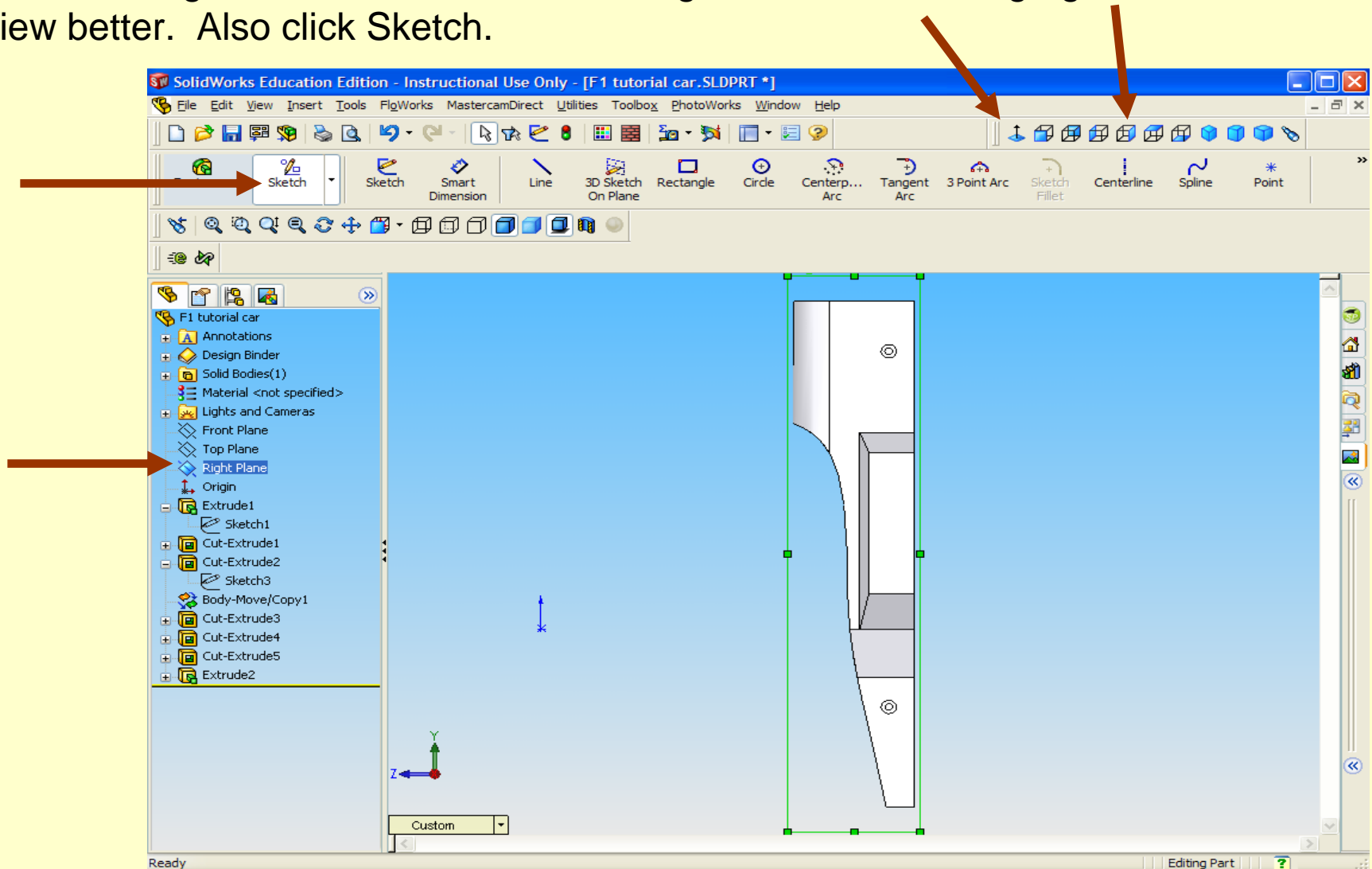
1. The main body is roughed out.
2. Please save your work... File> Save As



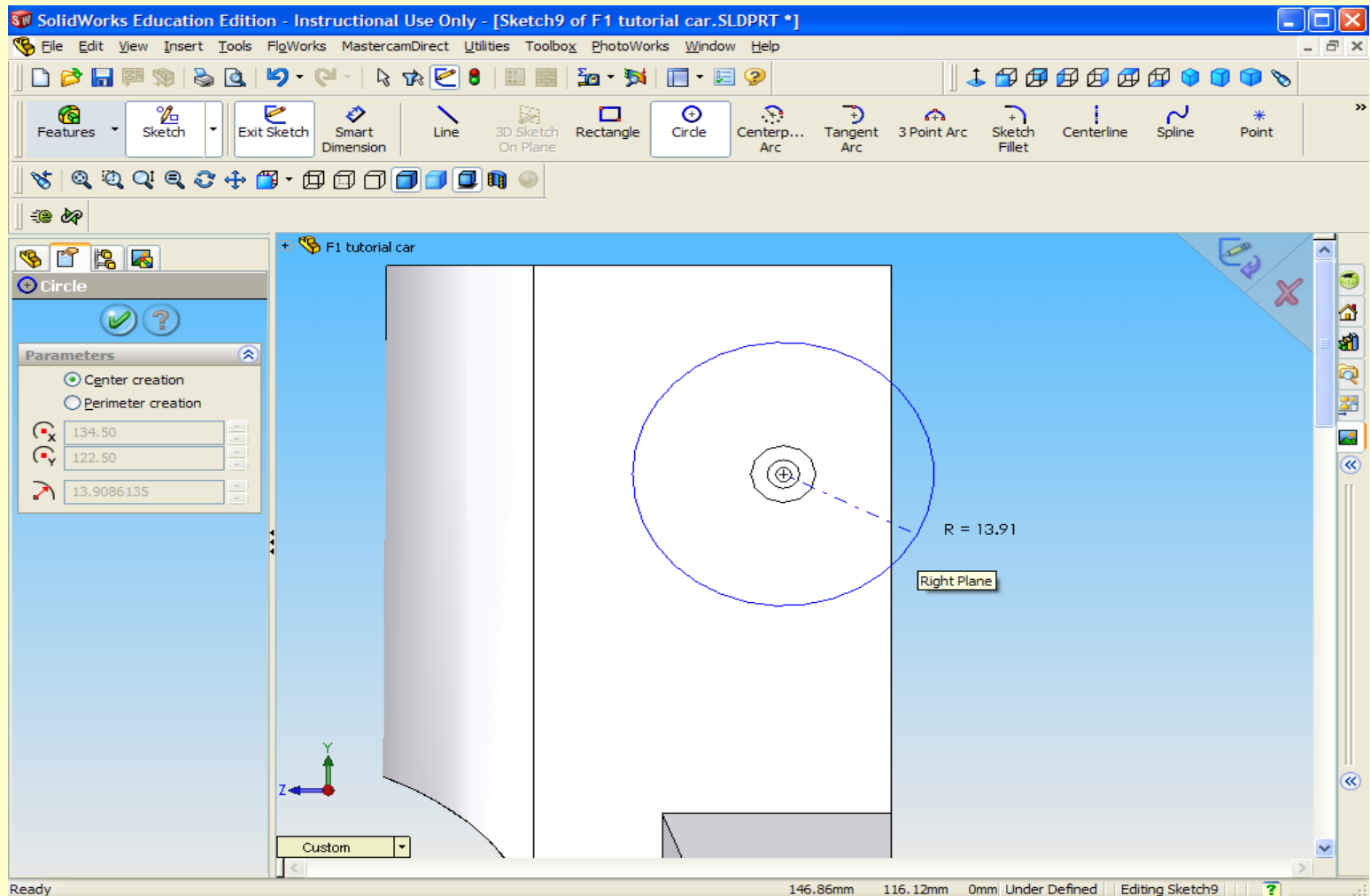
1. You may click on shaded with edges.



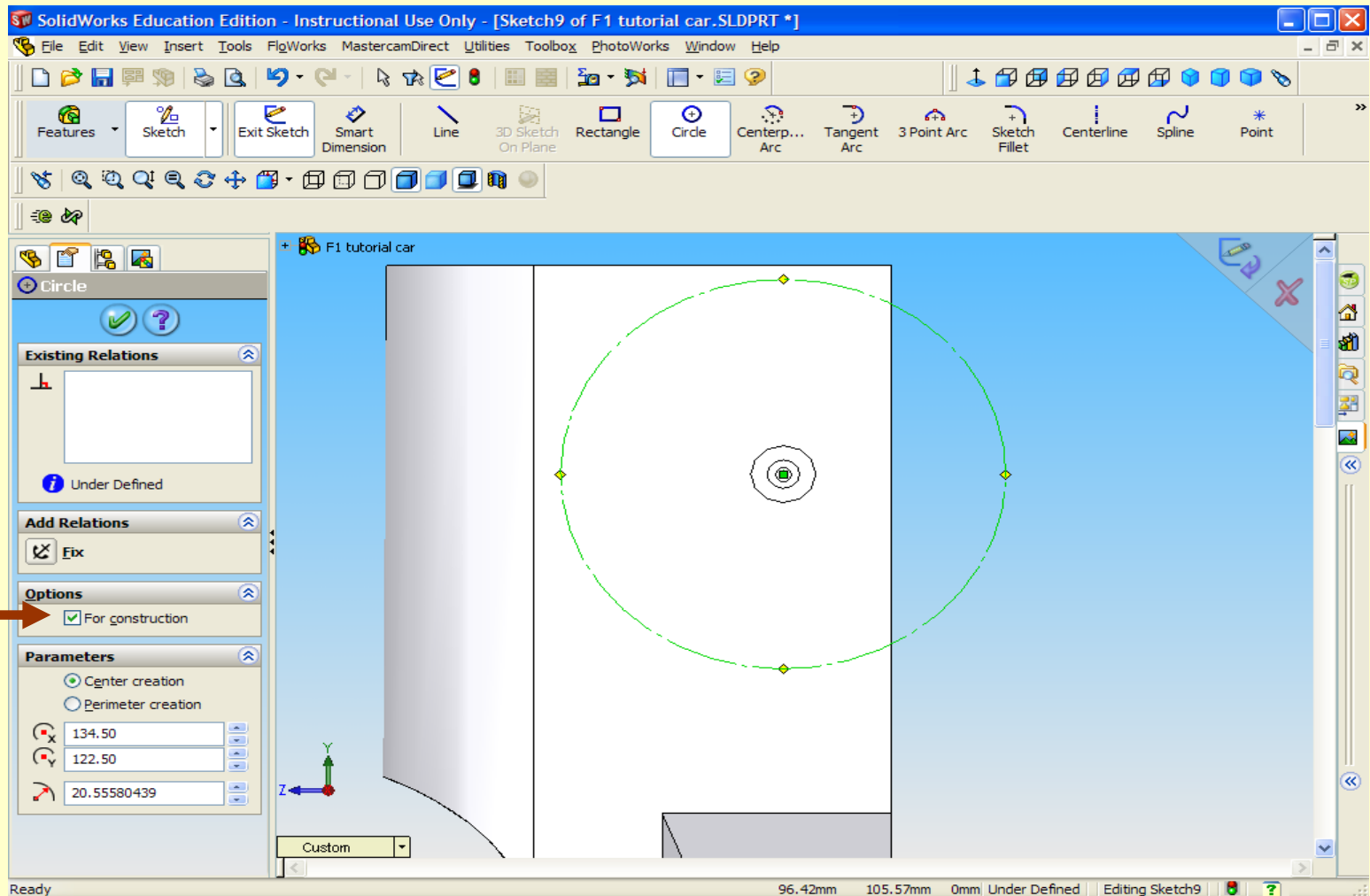
1. Now let's create some reference geometry for our later machining needs.
2. Select the "Right Plane" and "Normal To" again. Then selecting right view will orient your view better. Also click Sketch.



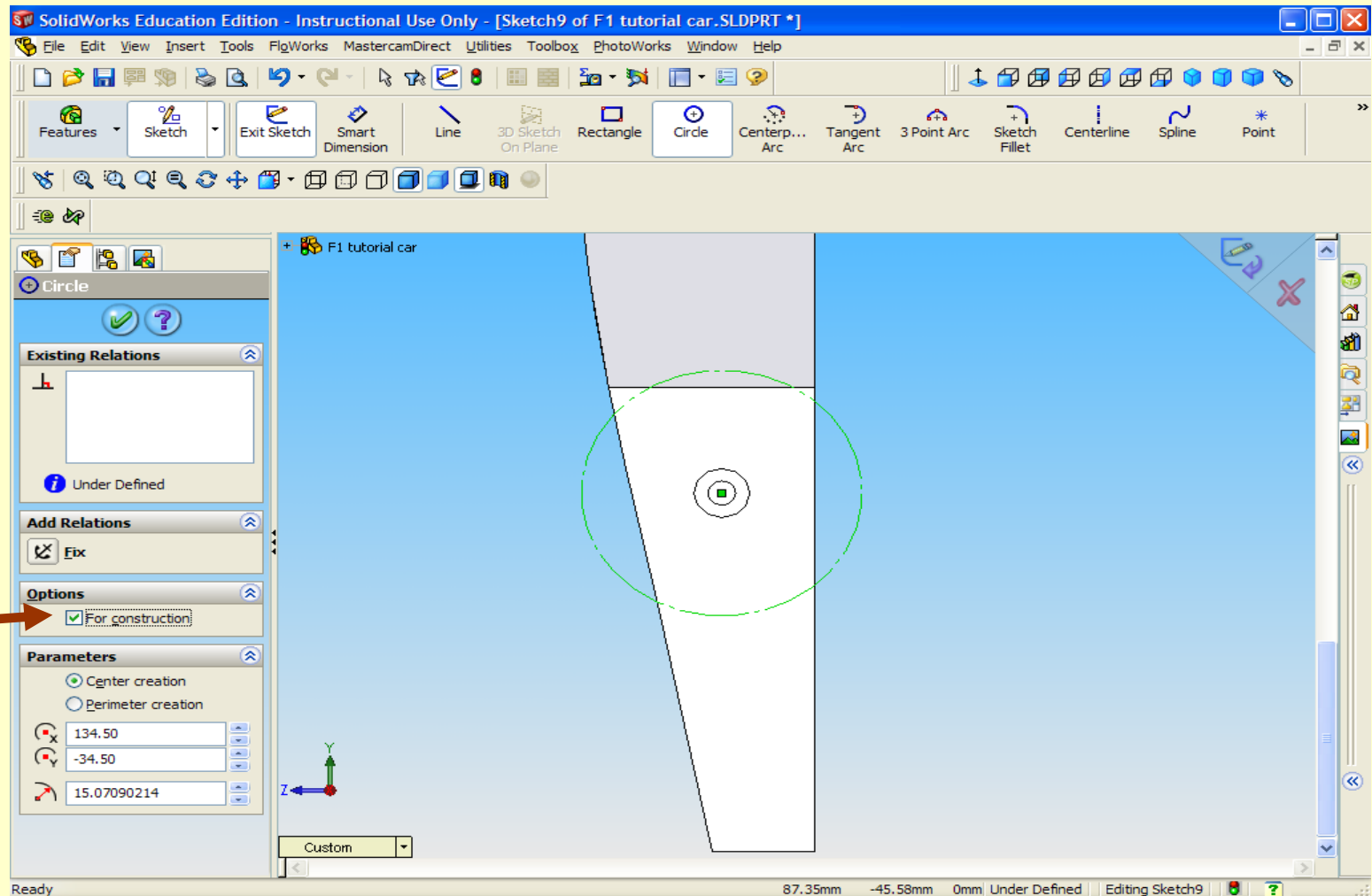
1. Zoom into the back end.
2. Use Circle to create a circle centered on the axle holes.



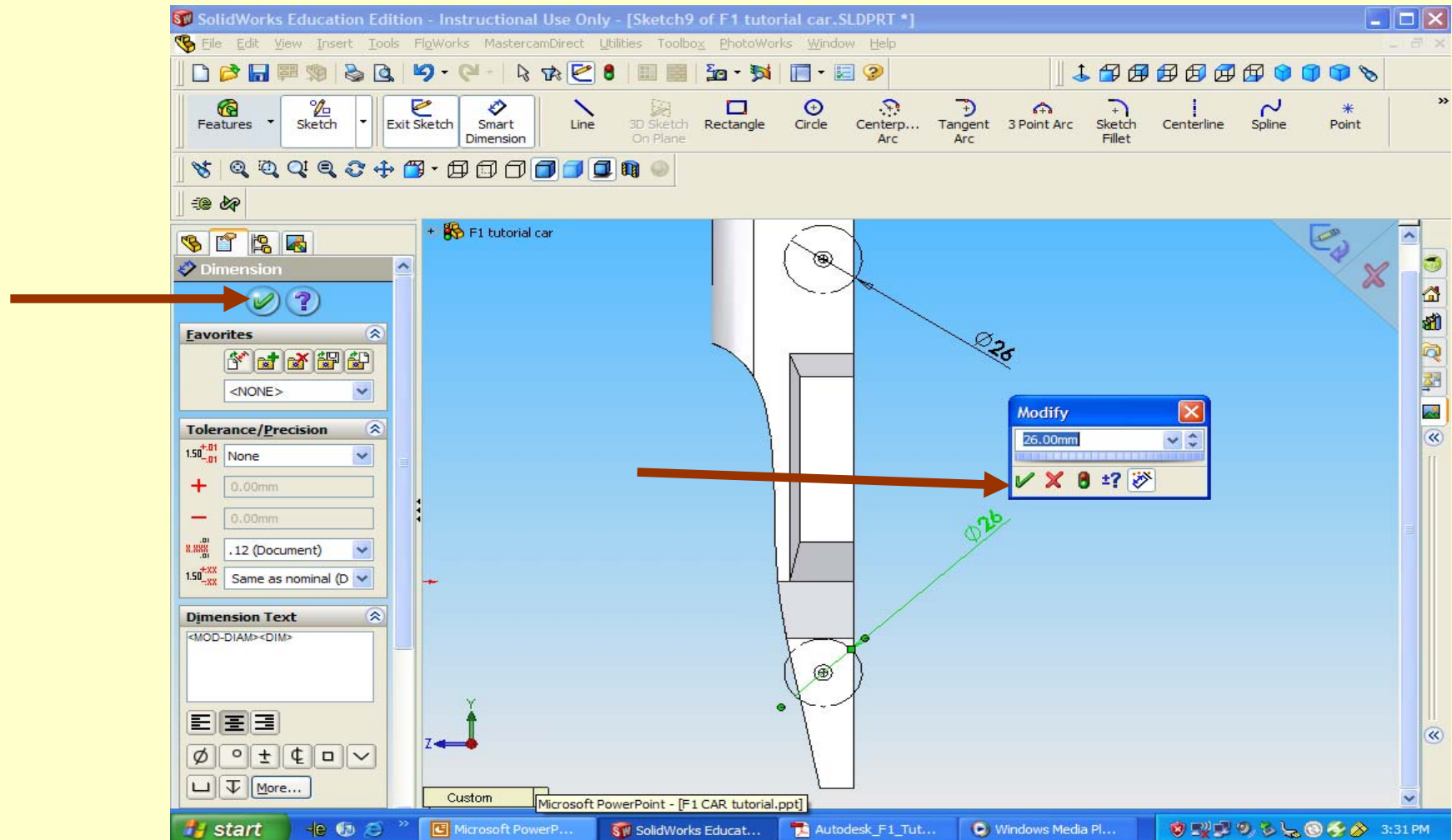
1. After clicking to place the circle, check For Construction.
2. Your line becomes dashed.



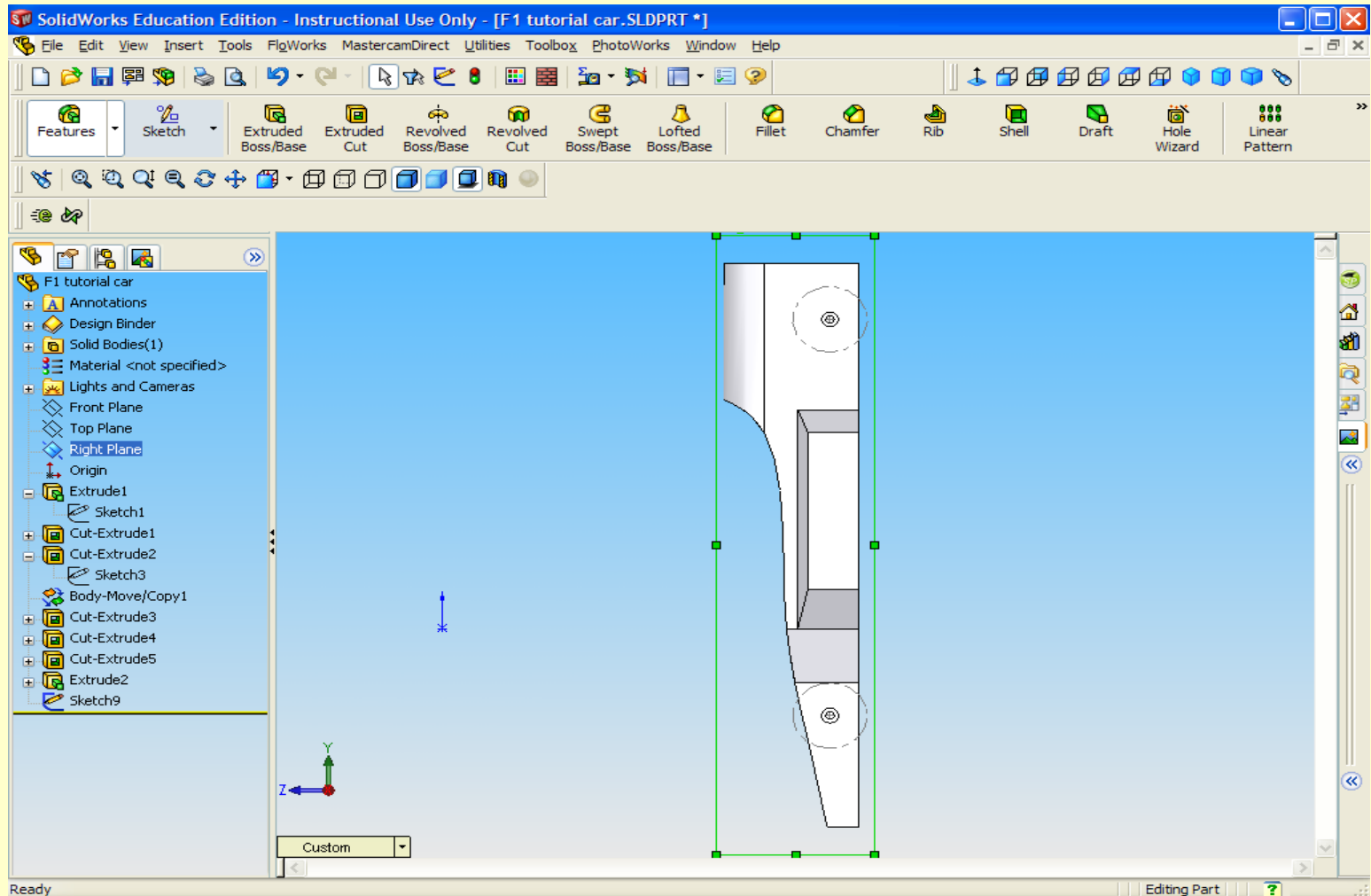
1. Repeat and place a construction circle centered on the front axle hole.



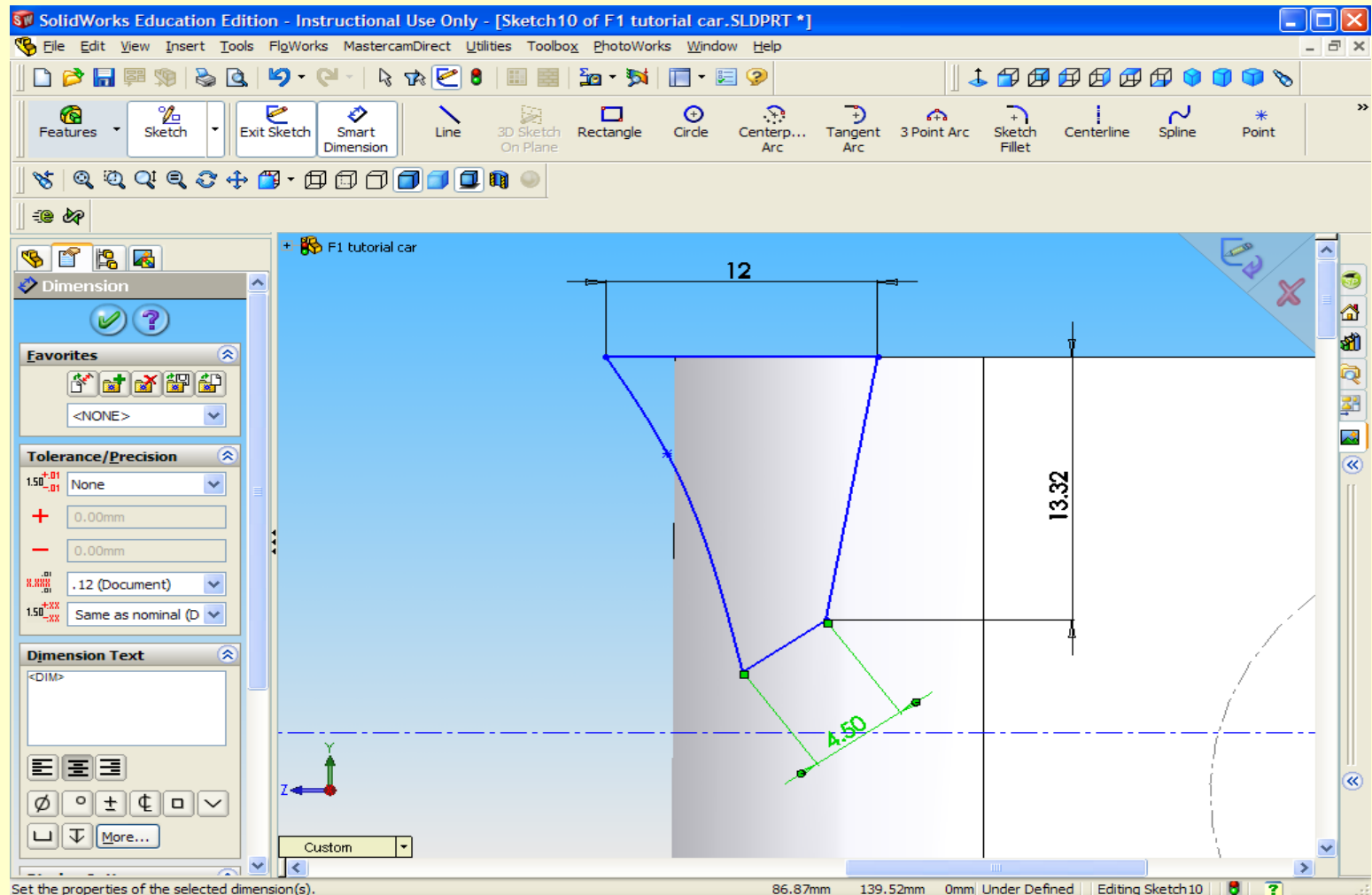
1. Click Smart Dimensions
2. Double click on each circle and dim each one to be 26.
3. Click the green check here and here. Then click Exit Sketch.



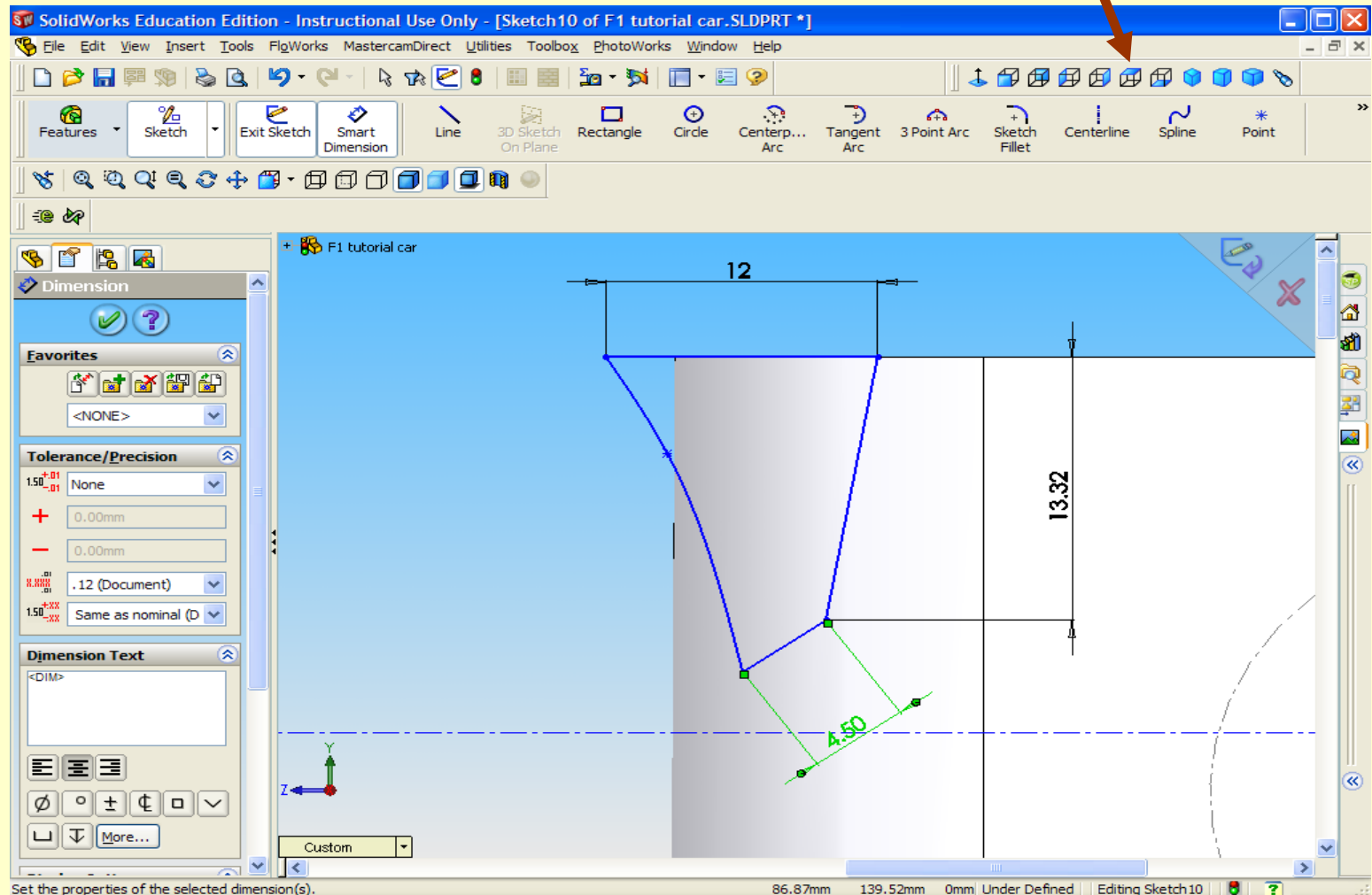
1. Right Plane, Normal To again. Clicking right view will orient the car better.
2. Click Features, then Extruded Boss/ Base.



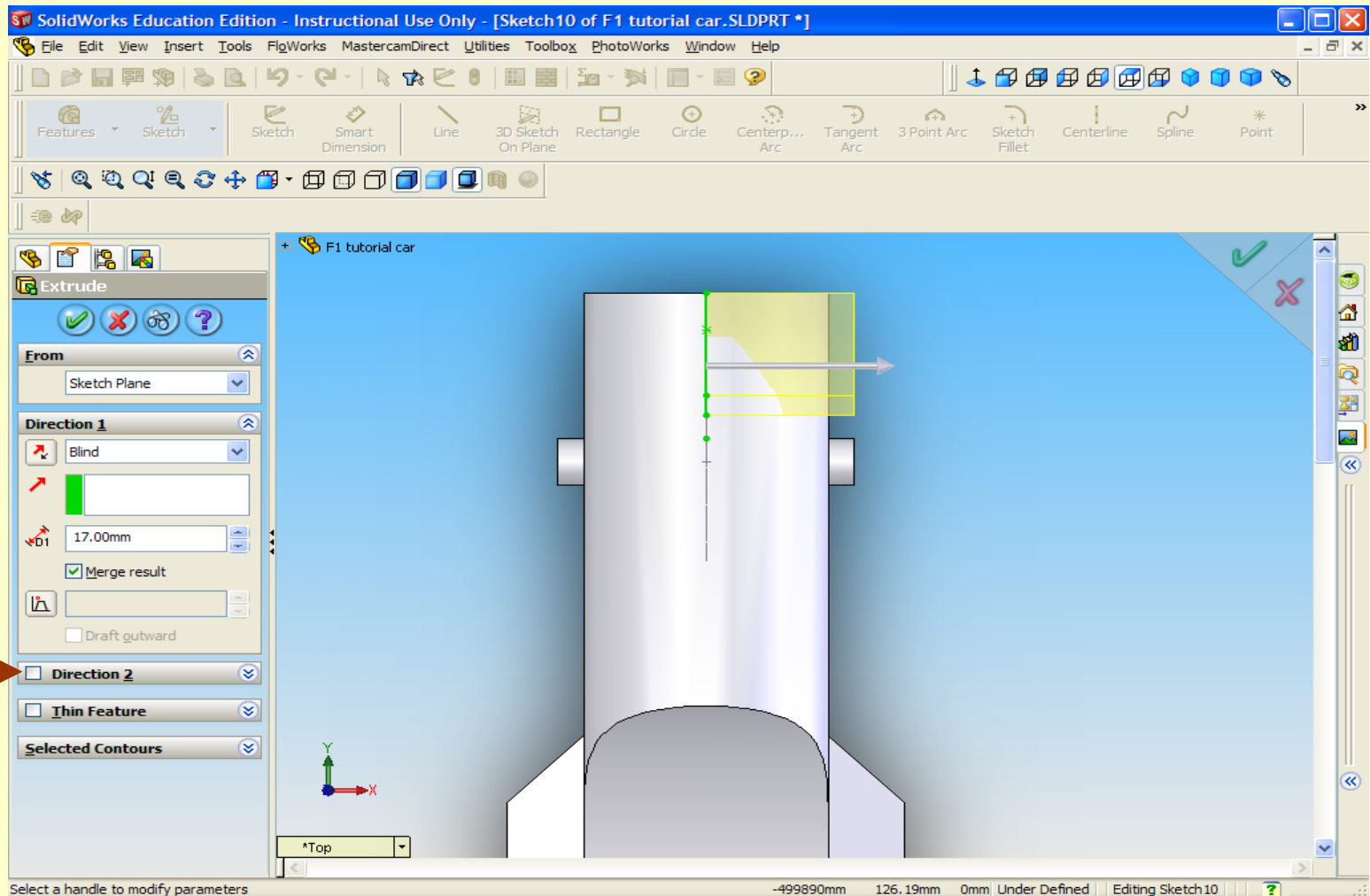
1. Using the drawing tools, draw a wedge space between the reference line and the back edge of the car.
2. Use Smart Dimension to dimension 2 of the line segments.



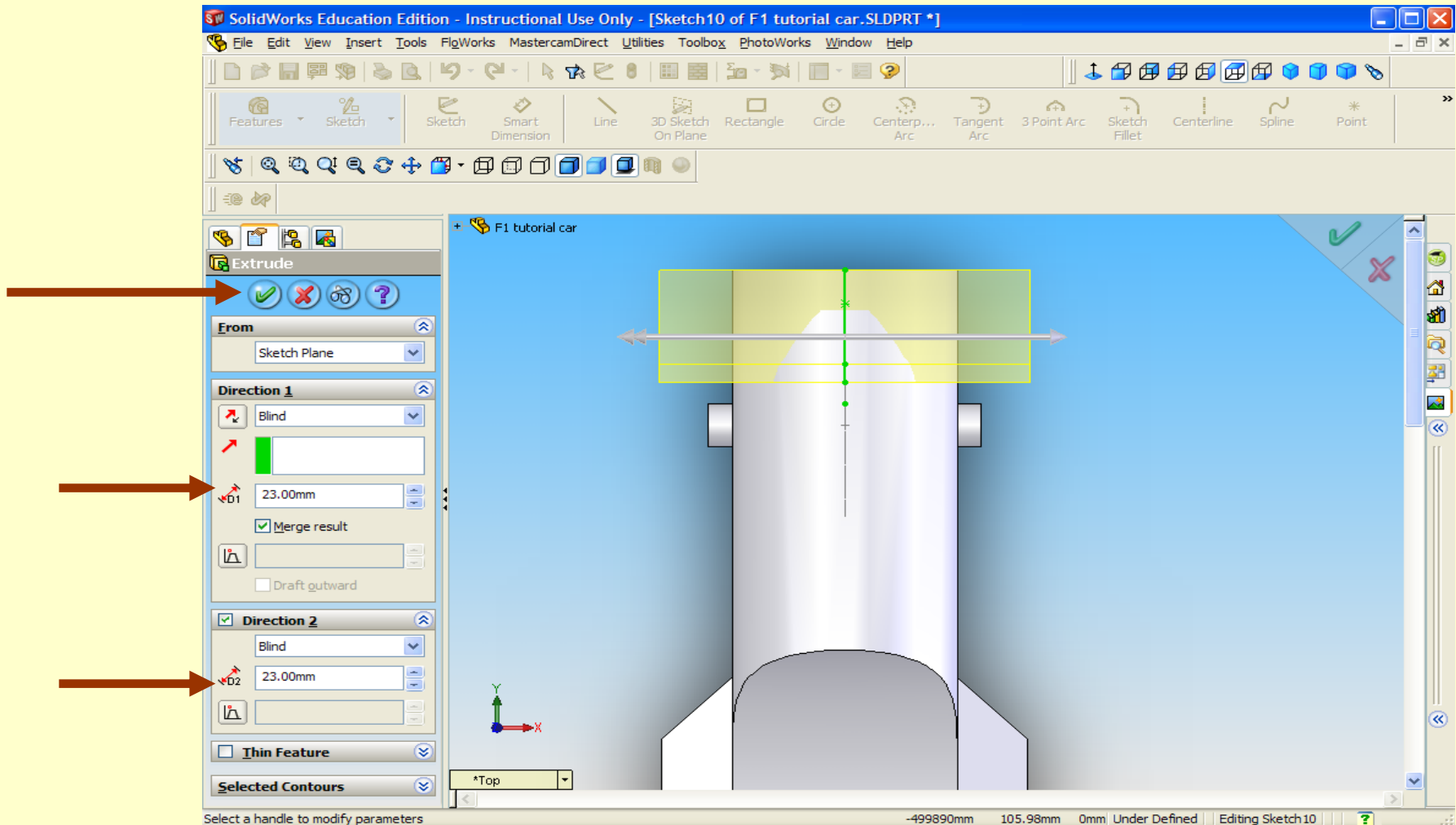
1. Click the green check and Exit Sketch.
2. Then select the Top View.



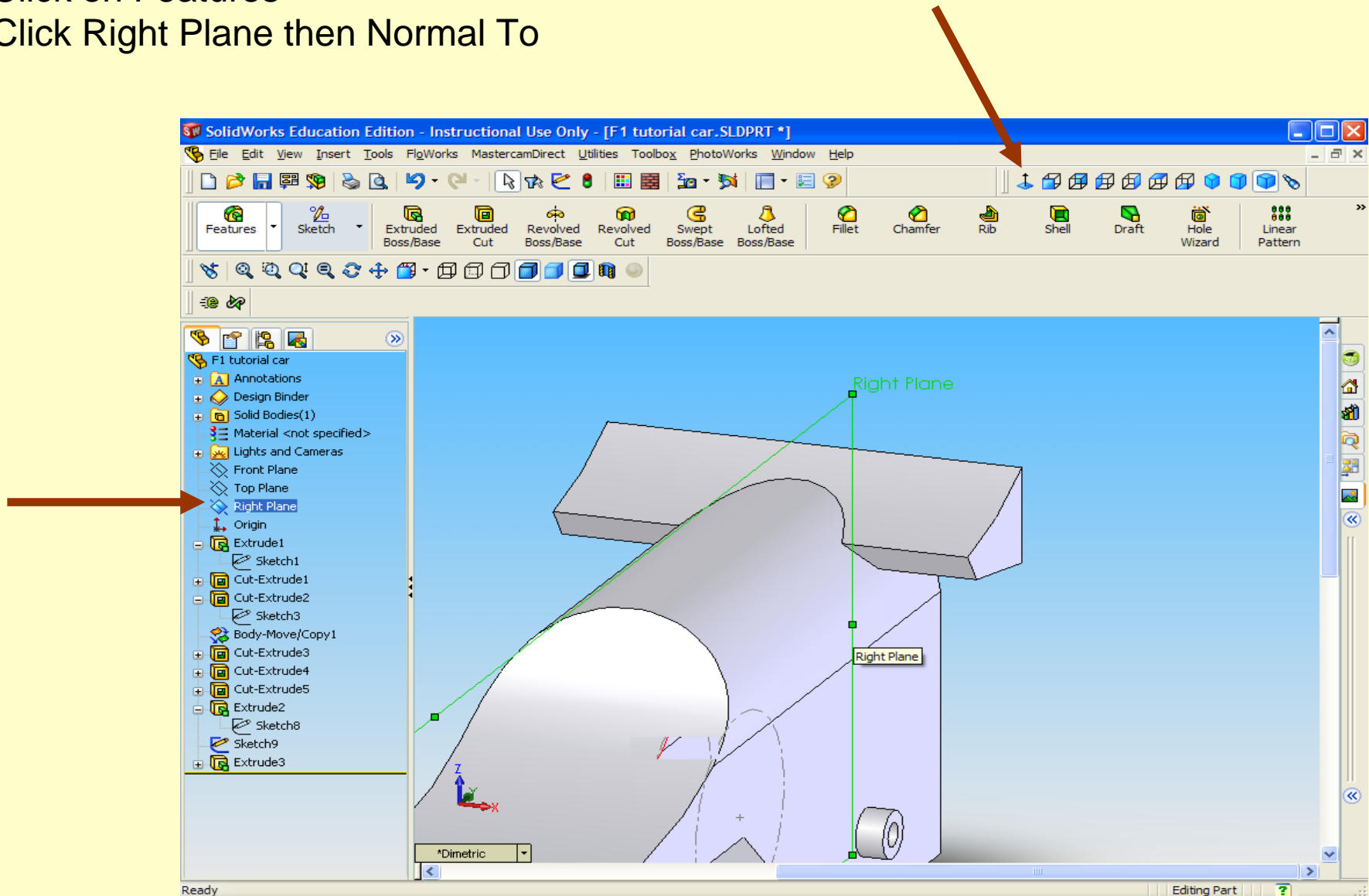
1. Select Direction 2 again.



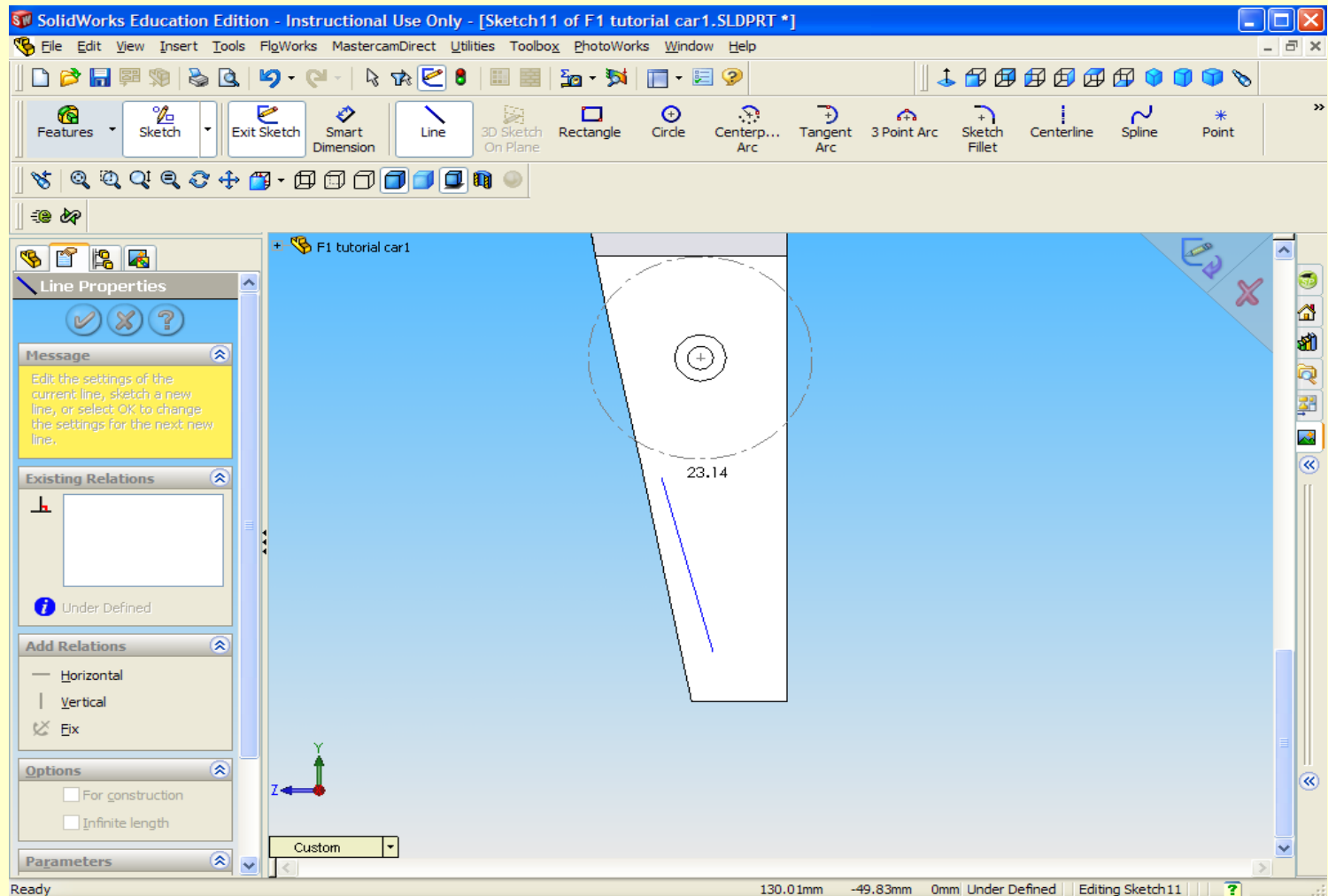
1. Type in 23 mm for D1 and D2.
2. Click the green check.



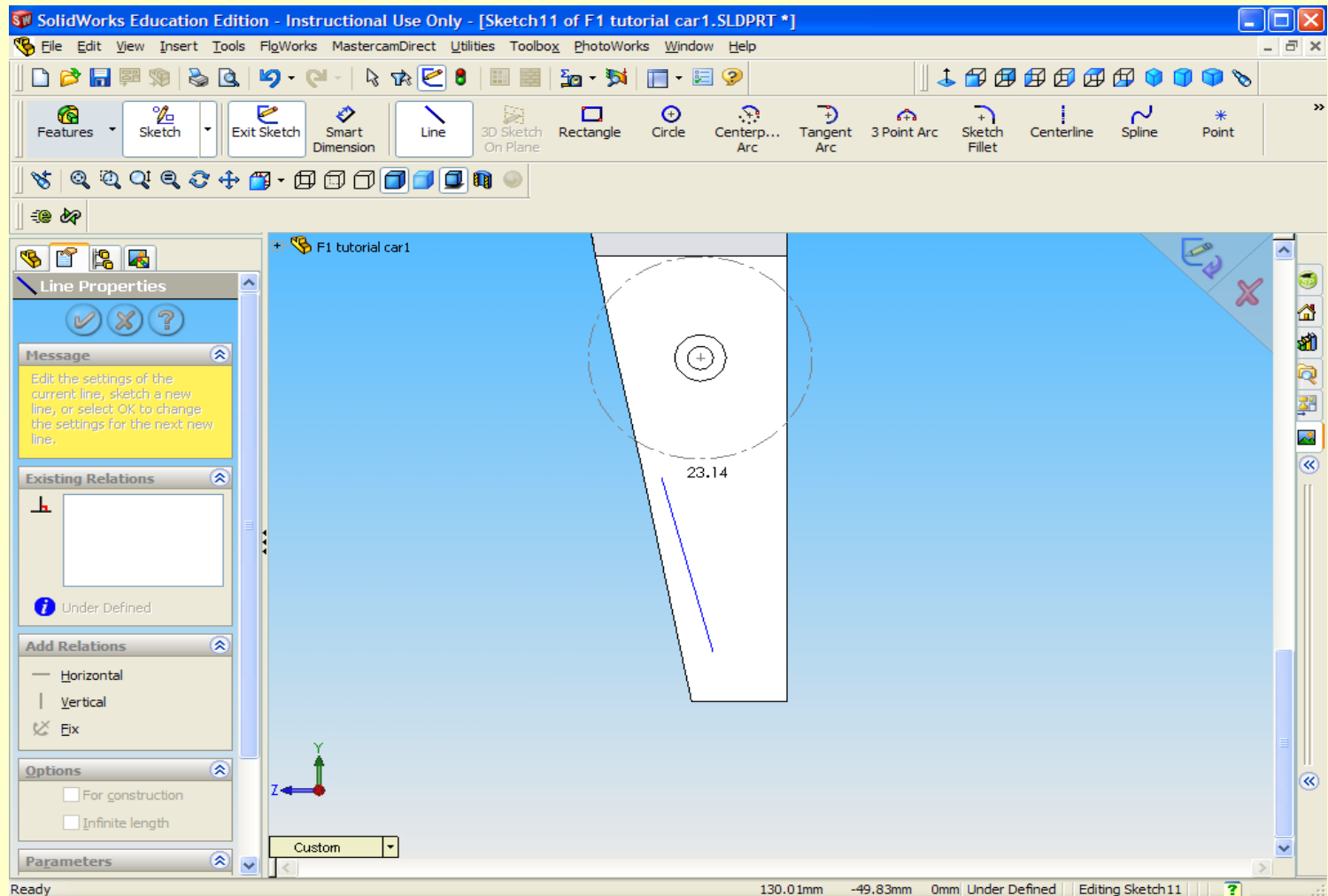
1. Click on Features
2. Click Right Plane then Normal To



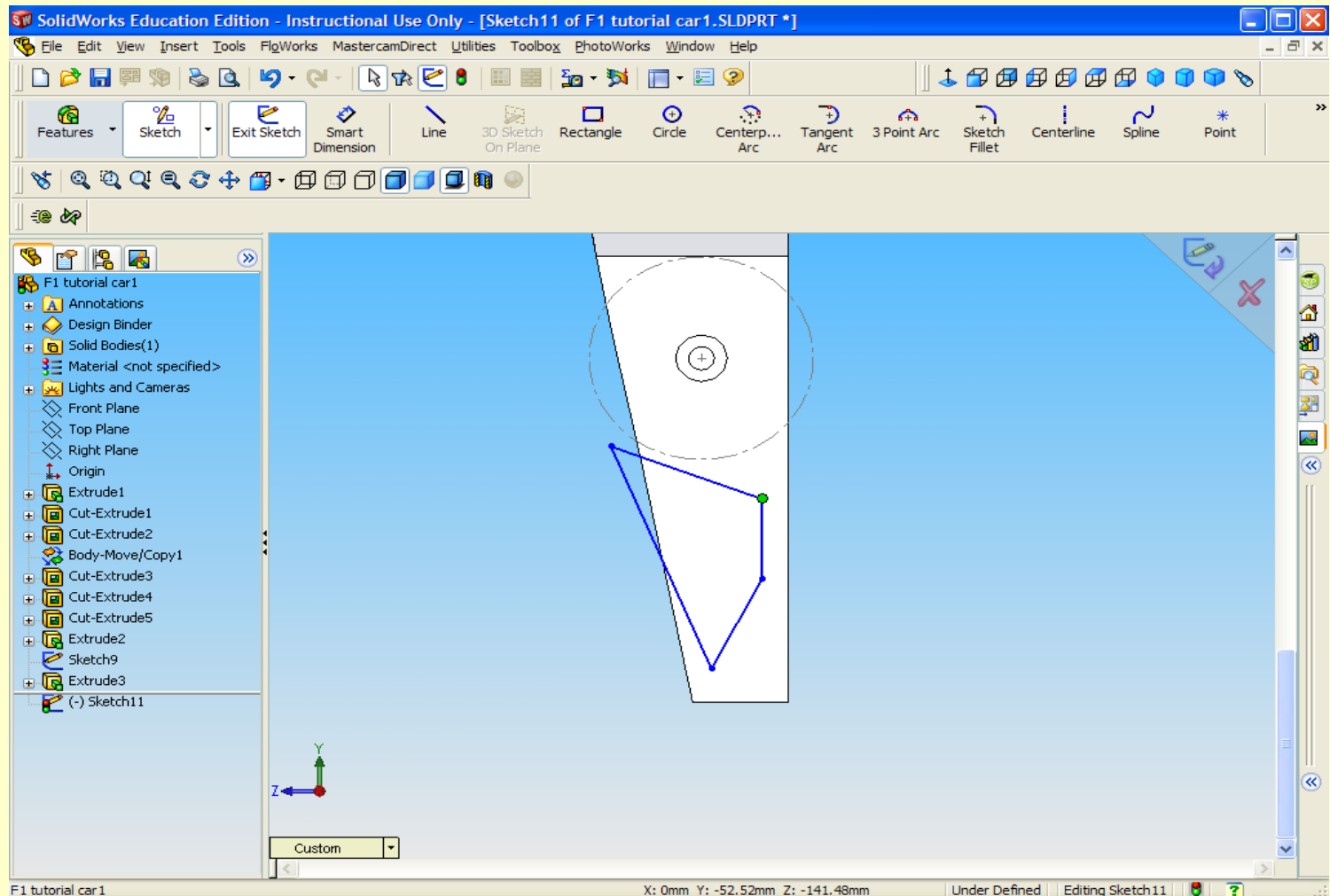
1. Click on Extruded Boss/ Base.
2. Using the mouse wheel, zoom into the front of the car.



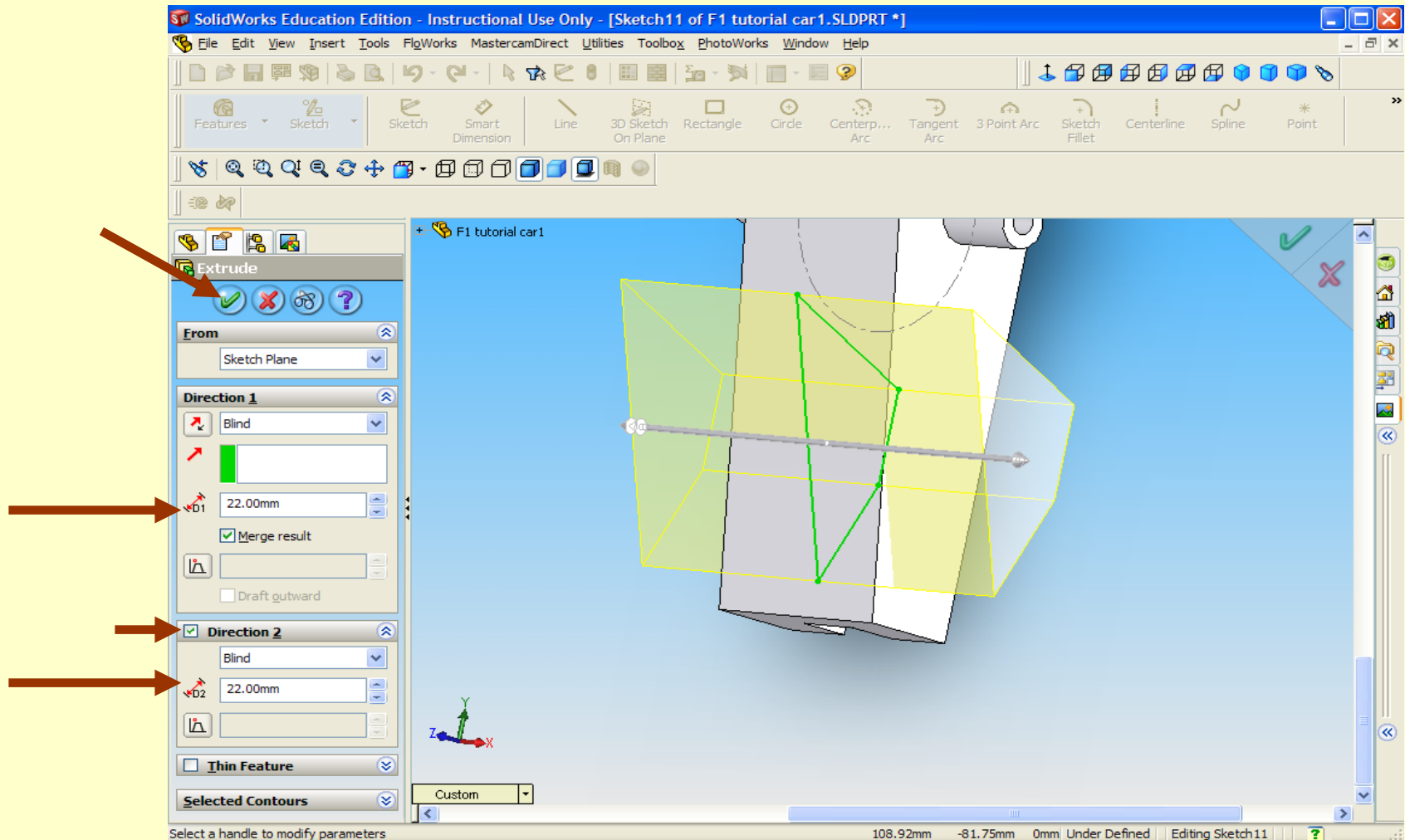
1. Use the sketch tools to make a wedge to be extruded.



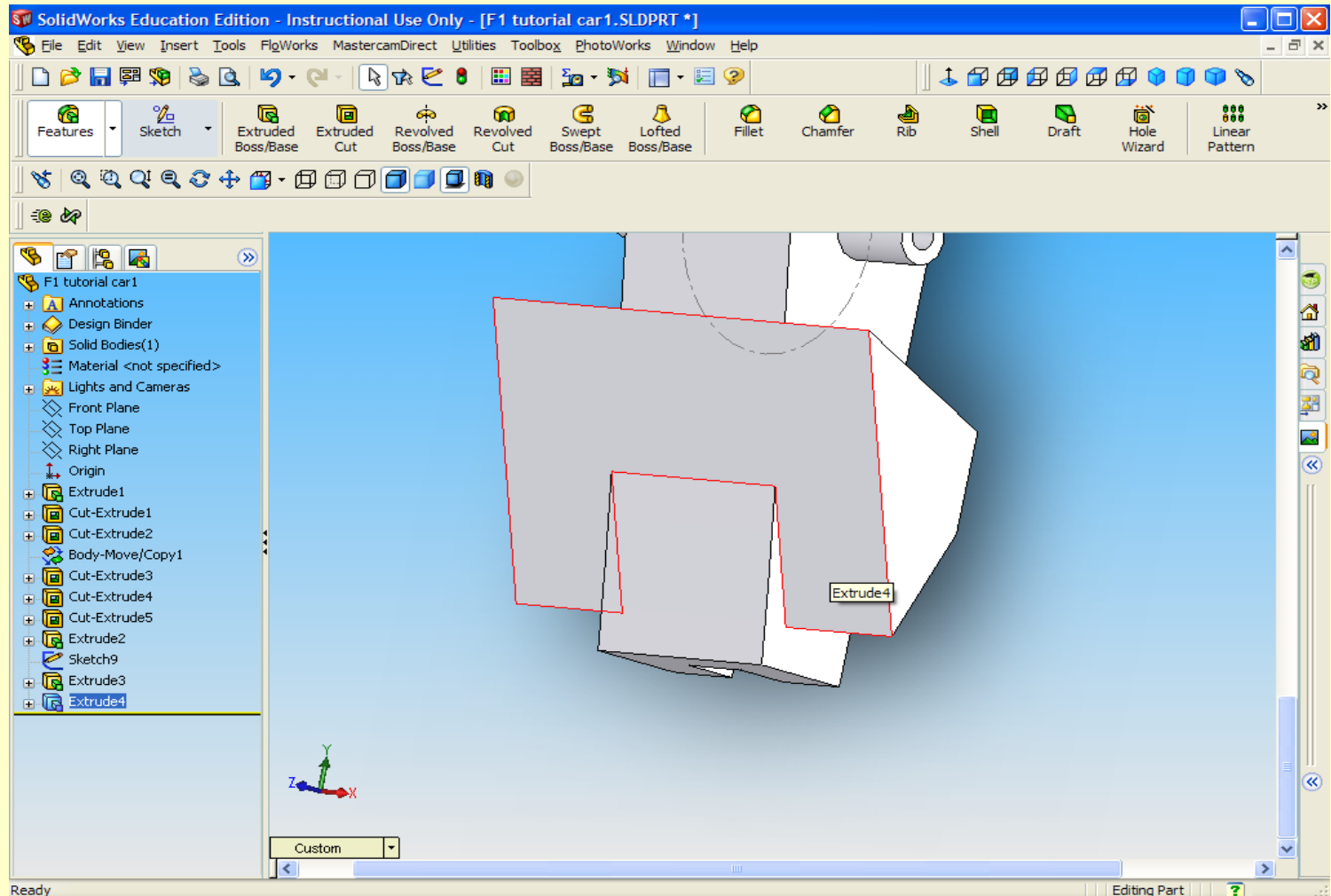
1. Exit Sketch when finished.
2. Then rotate your view by holding the mouse wheel to see the extrusion.



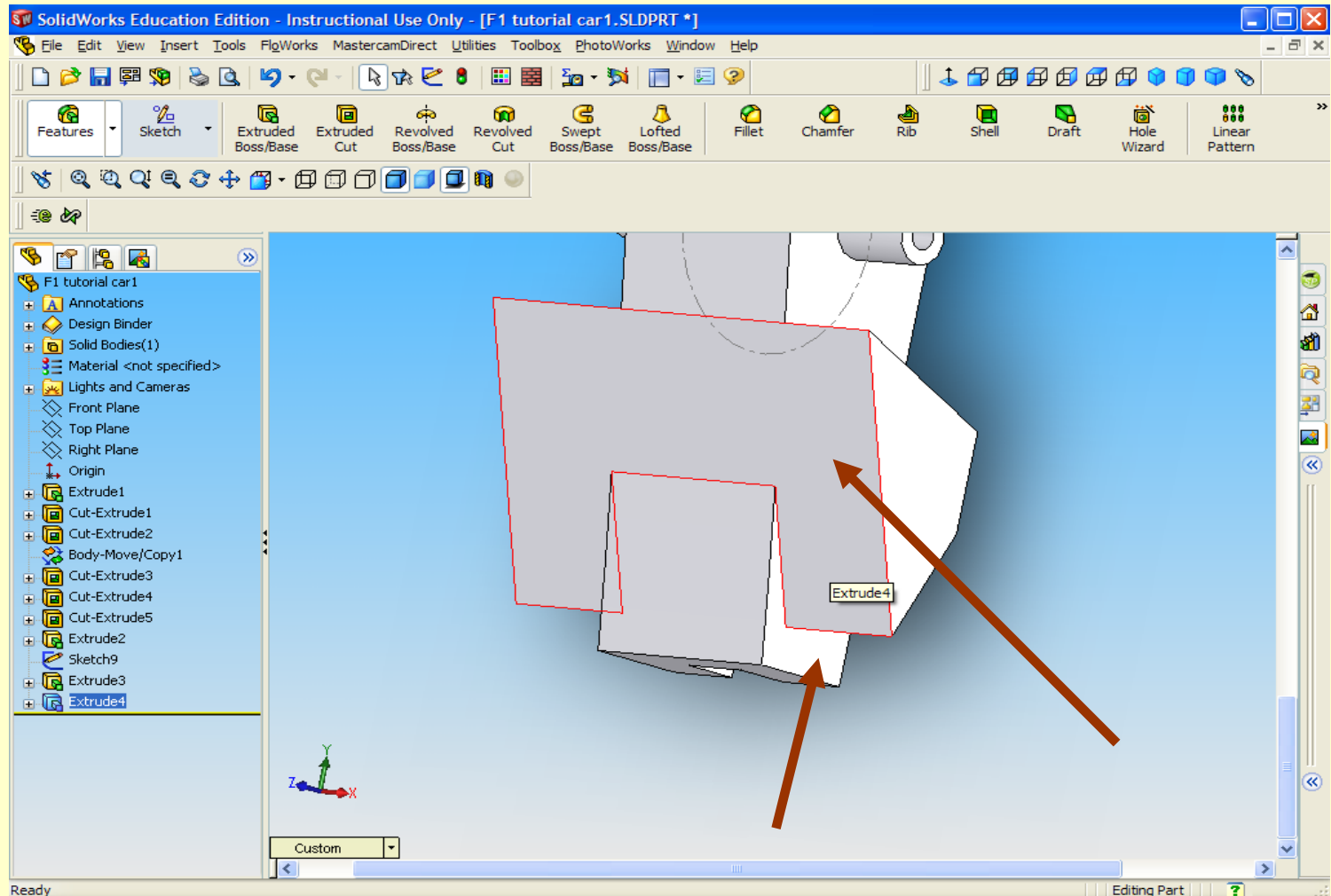
1. Select Direction 2 and input 22 for D1 and D2.
2. Click the green check.



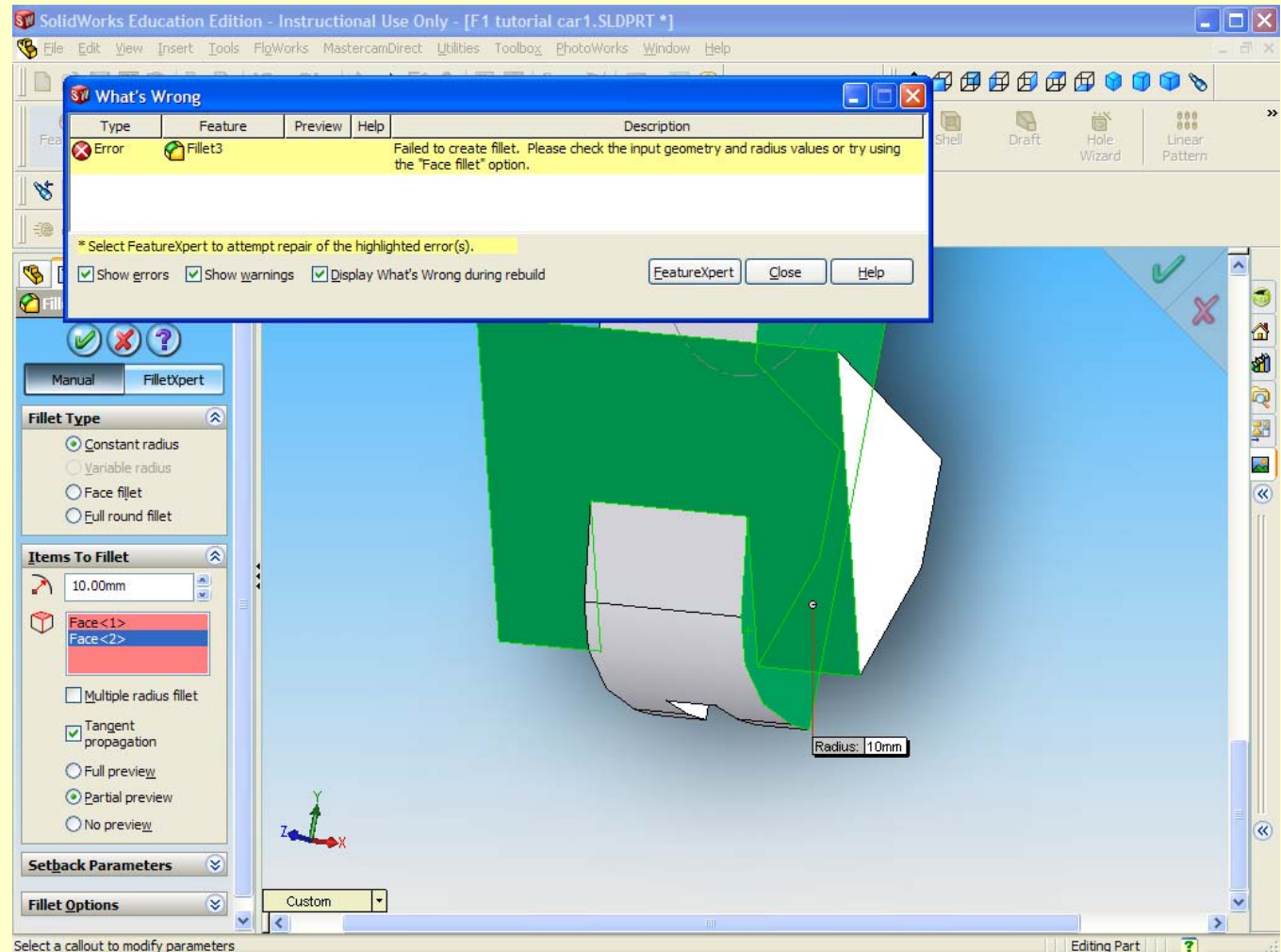
1. Now we're ready to fillet our sharp edges.
2. It is often better to apply individual fillets, or symmetrical ones. Then escape and make another set rather than put all fillets in one operation.



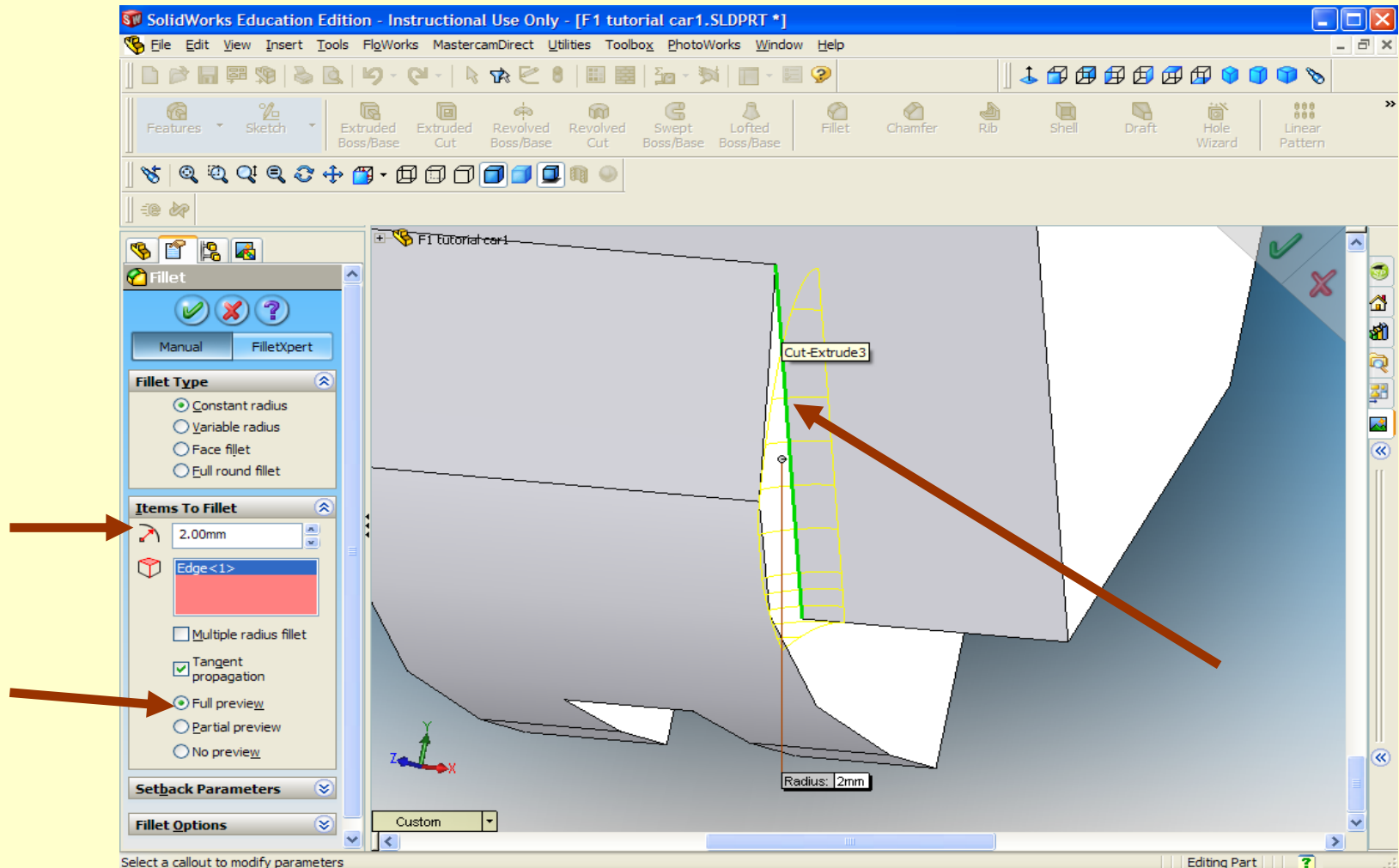
1. Select FILLET from the feature toolbar.
2. Then Click on this face and this face.
3. Click the green check mark that will appear in the task pane.



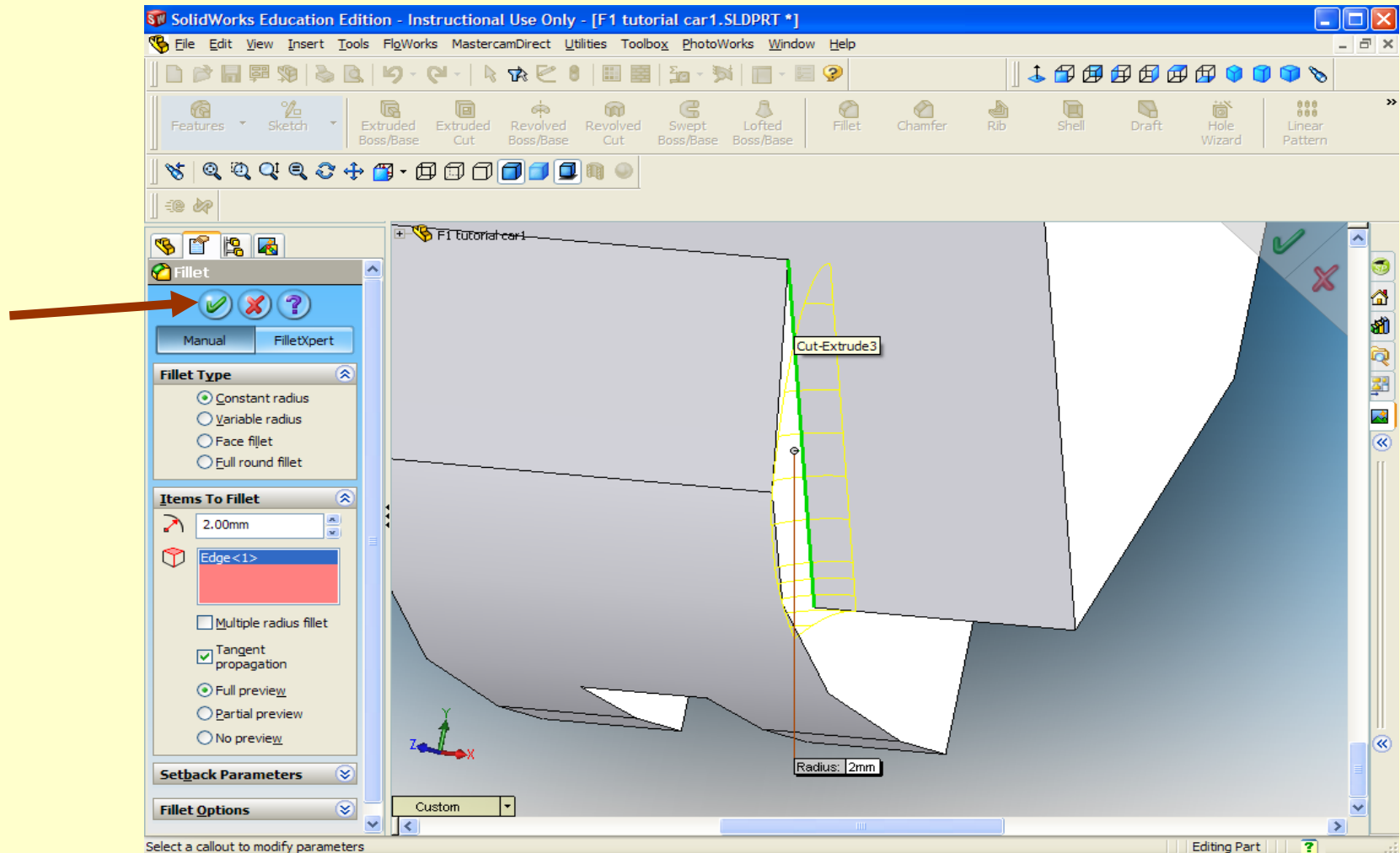
1. Because of the complexity of certain surfaces, or their relation to each other, Solidworks may not be able create it and will show this error window.
2. Close it and try filleting the edge/ line between the surfaces



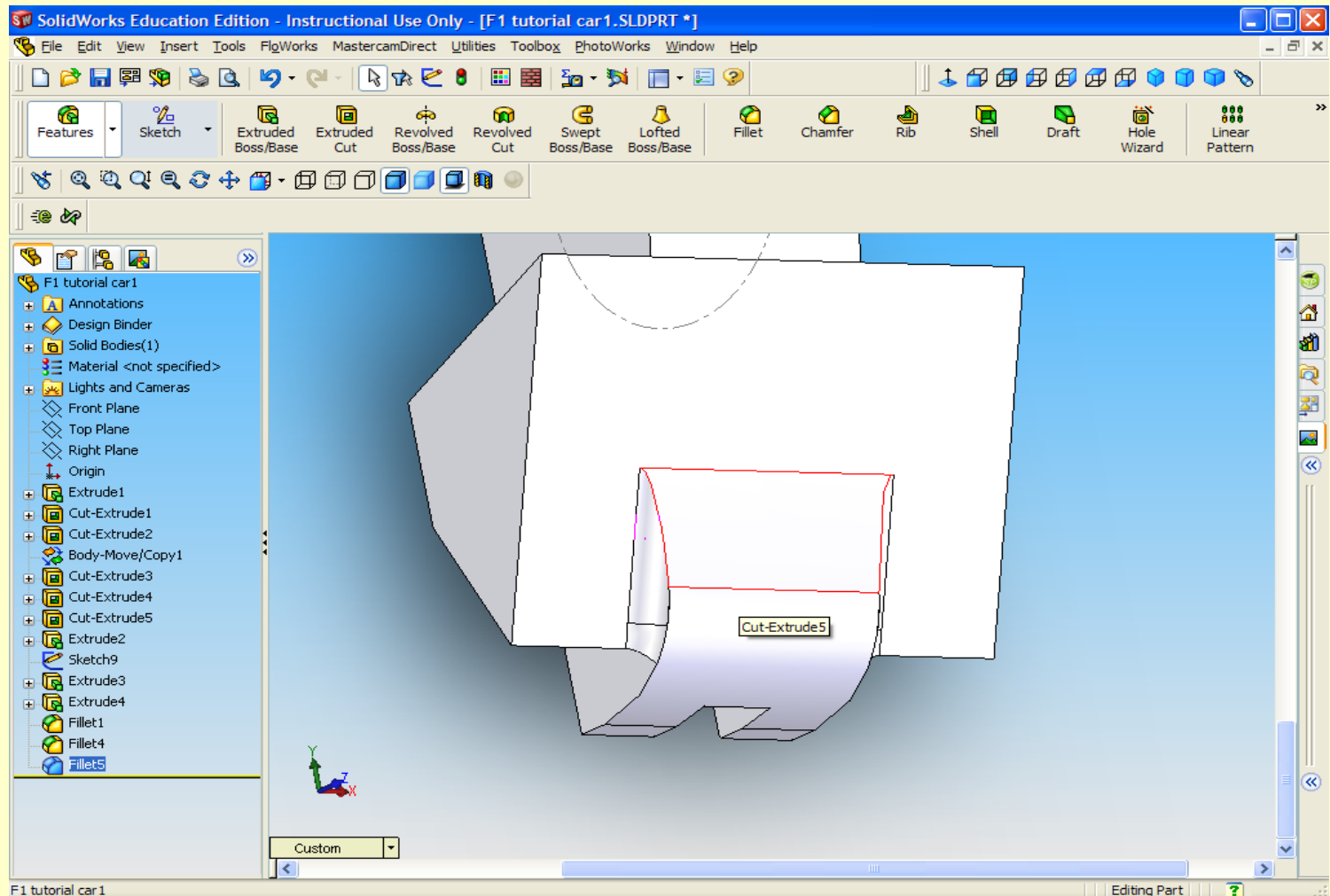
1. Click on the corner edge.
2. Be sure that FULL PREVIEW is checked.
3. Type in a smaller number for the radius until a yellow preview fillet appears.



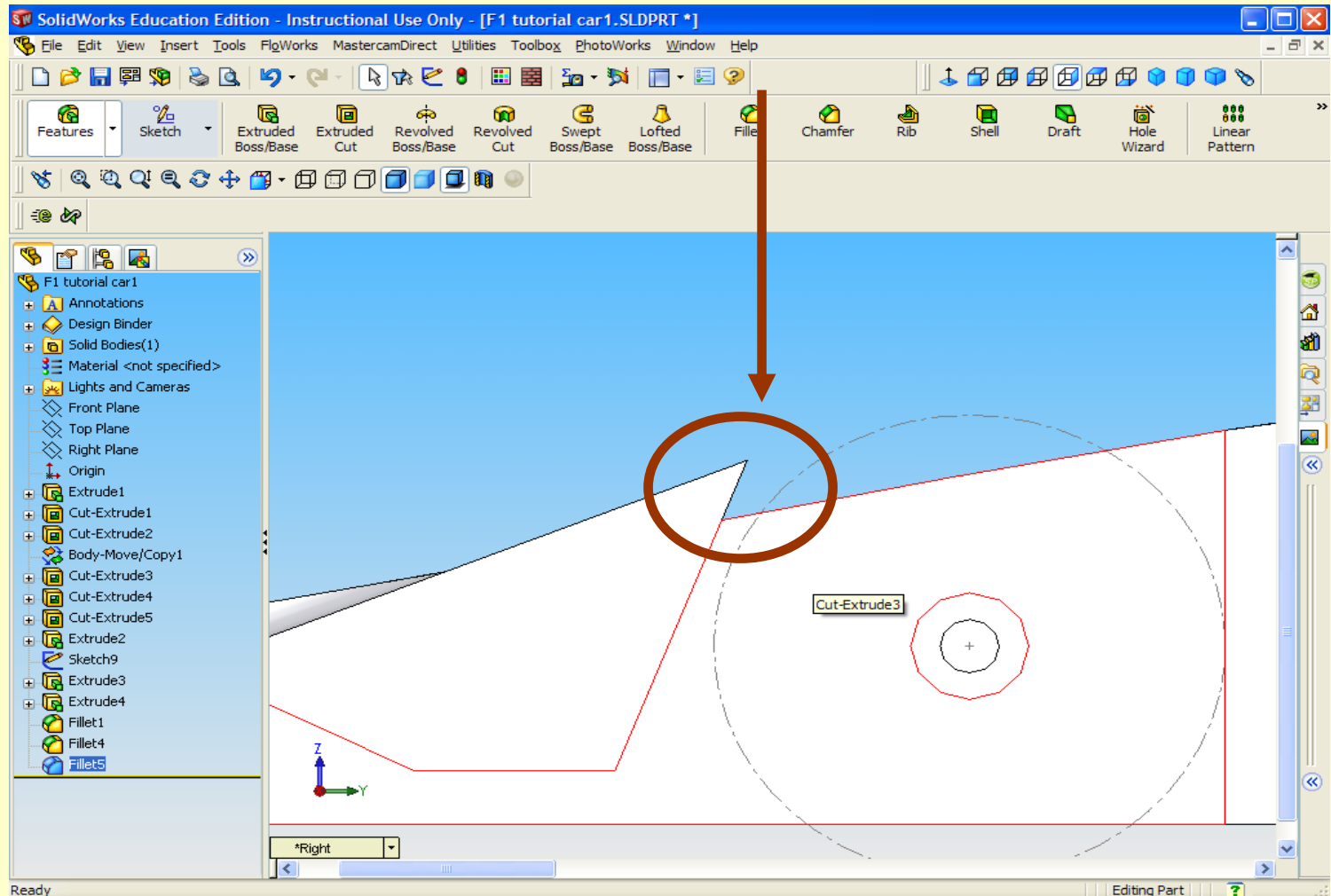
1. Click on the green check.



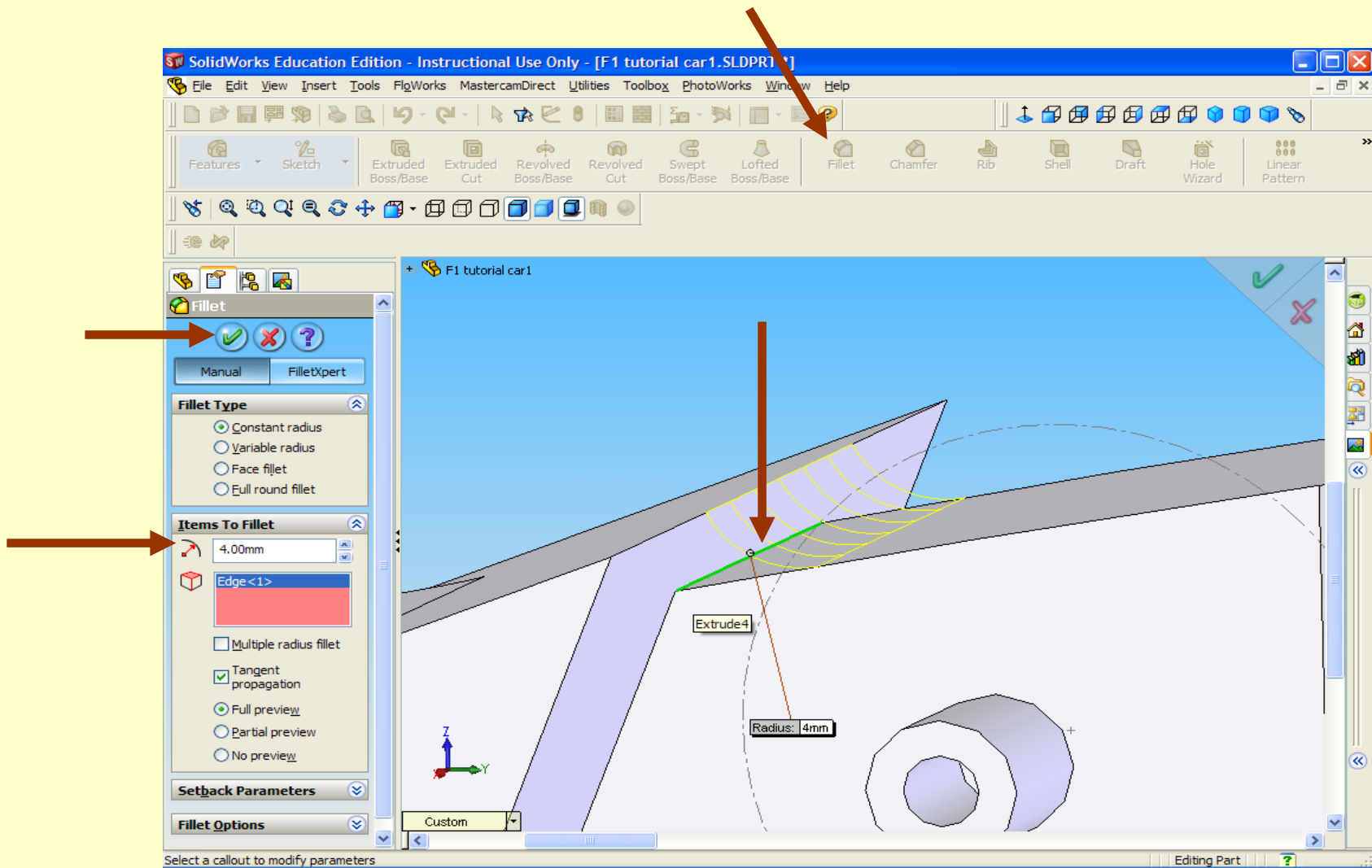
1. Rotate your view, and click Fillet then the opposite corner edge.
2. The settings should popup by default.
3. Click the green check.



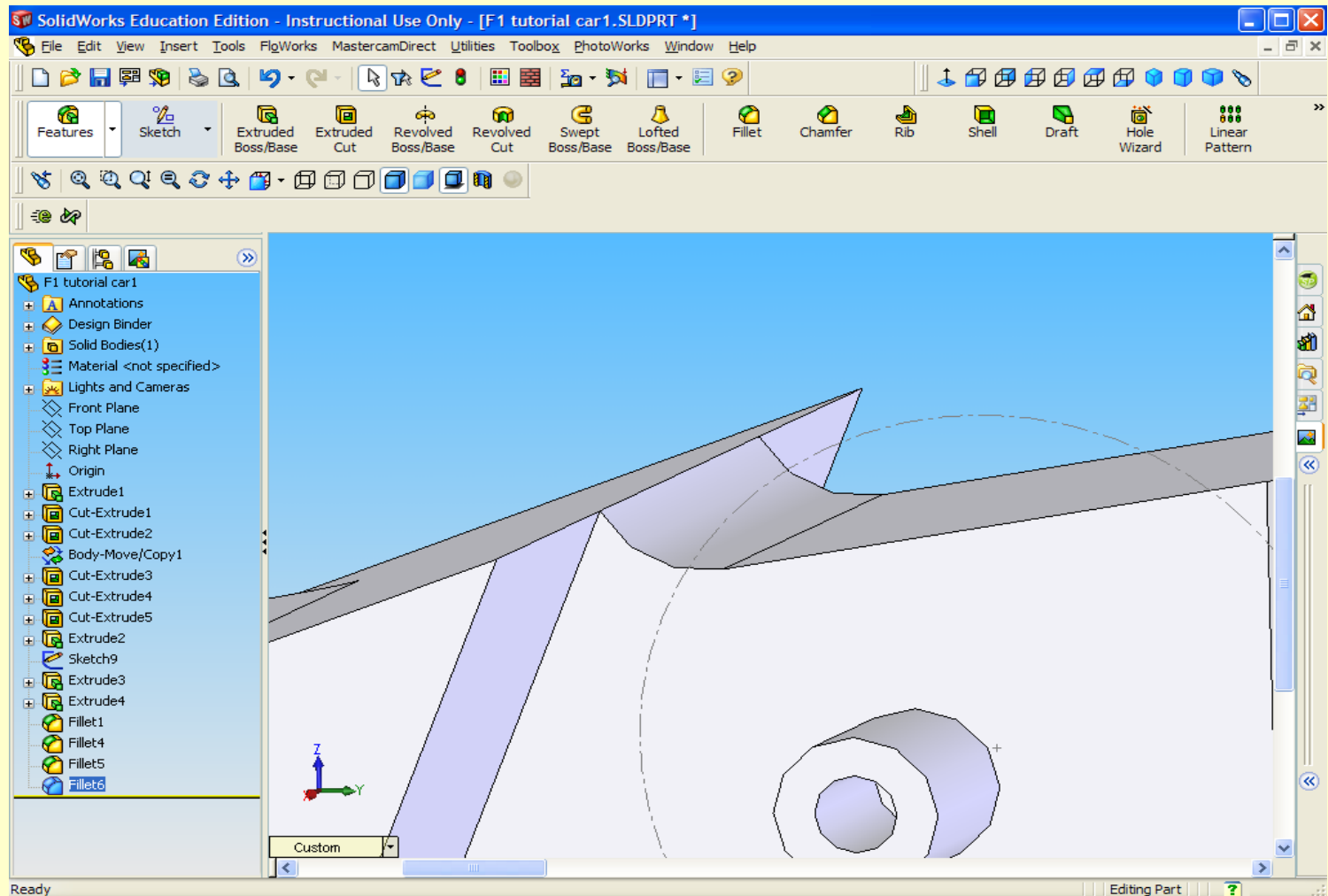
1. Since the blank will be cut from the top and bottom, “UNDERCUTS” like this will not be machined properly. So please apply large fillets to areas like this.



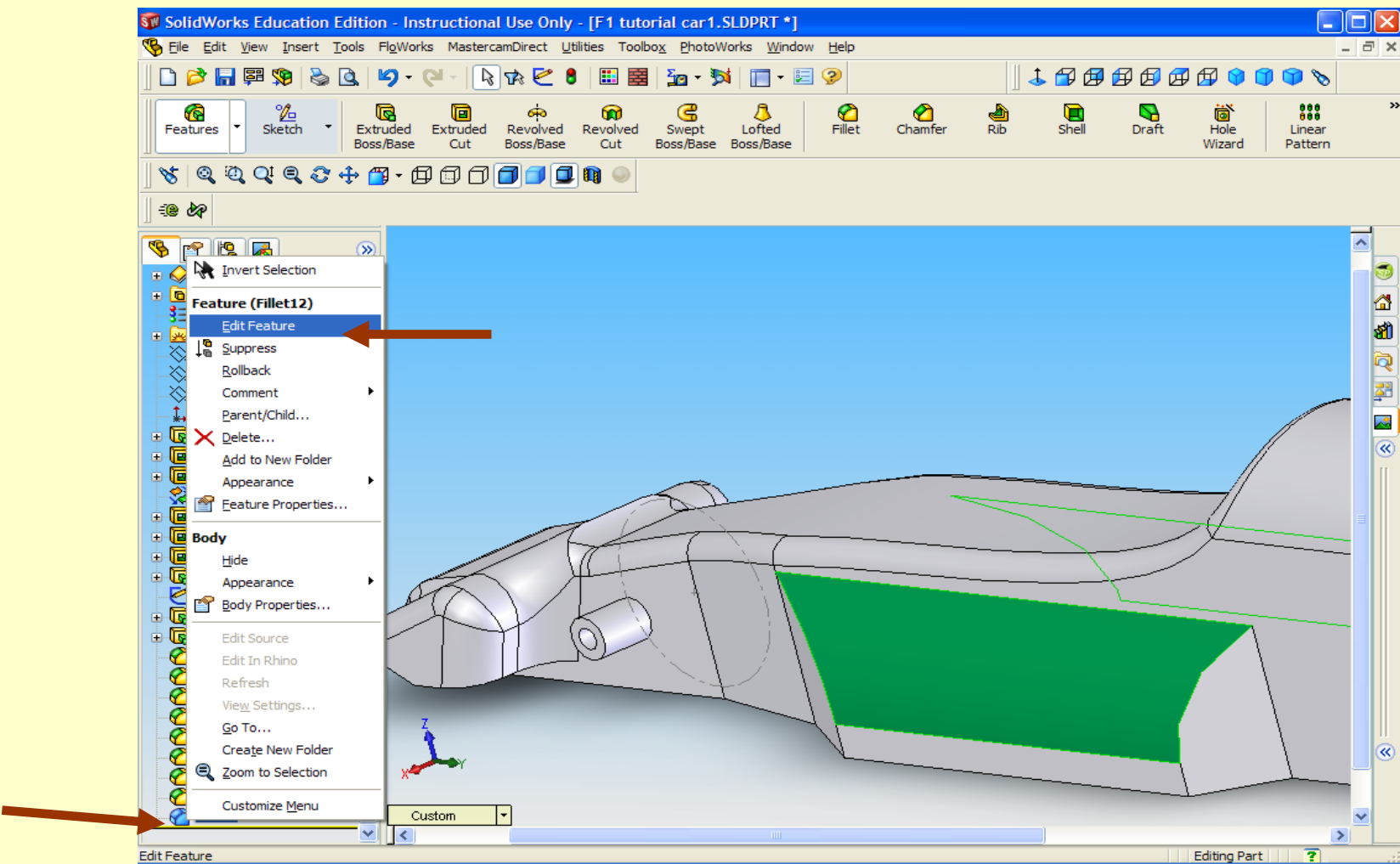
1. Click Fillet, select the edge, fill in a radius, click the green check.



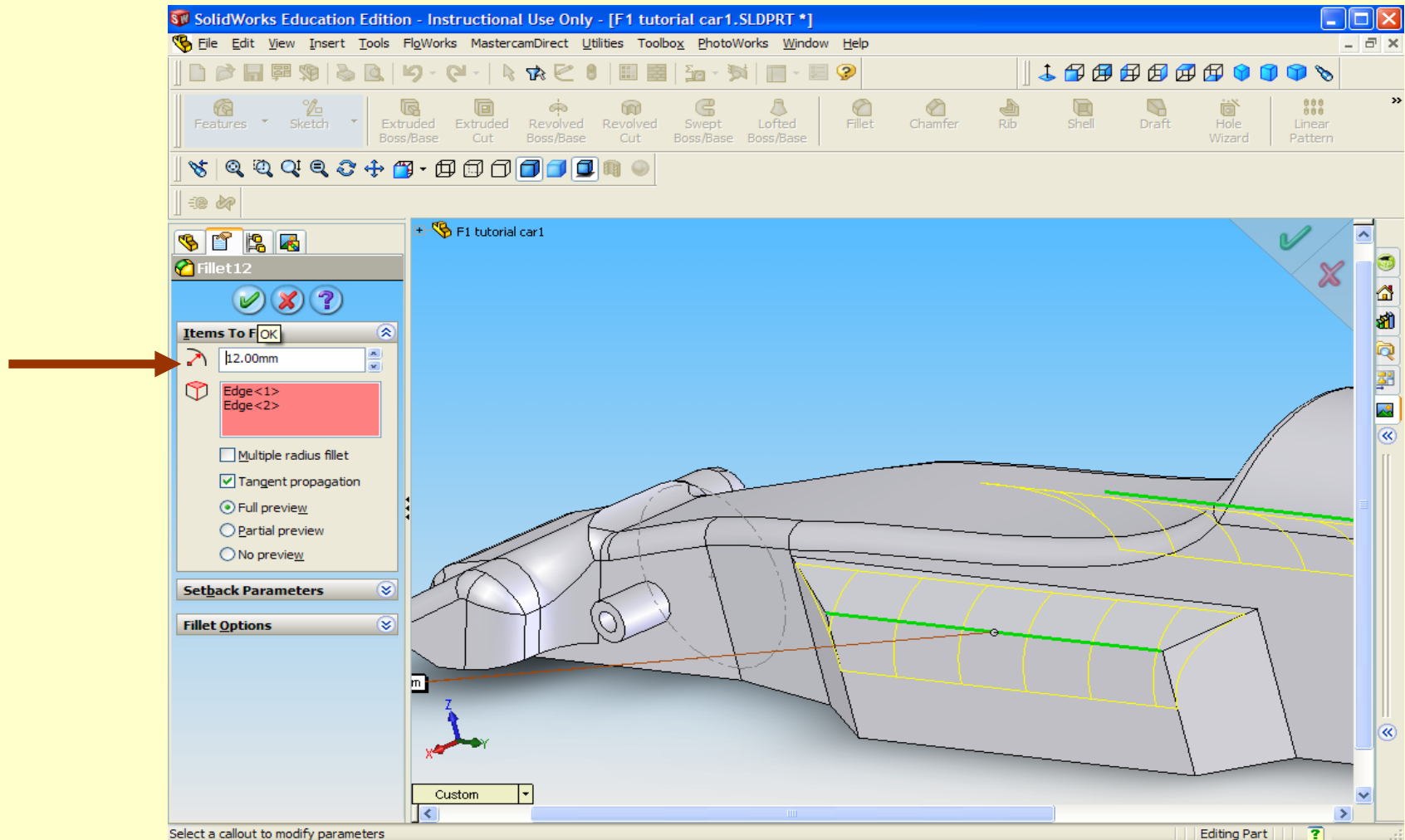
1. Continue to fillet all other edges of the car body.



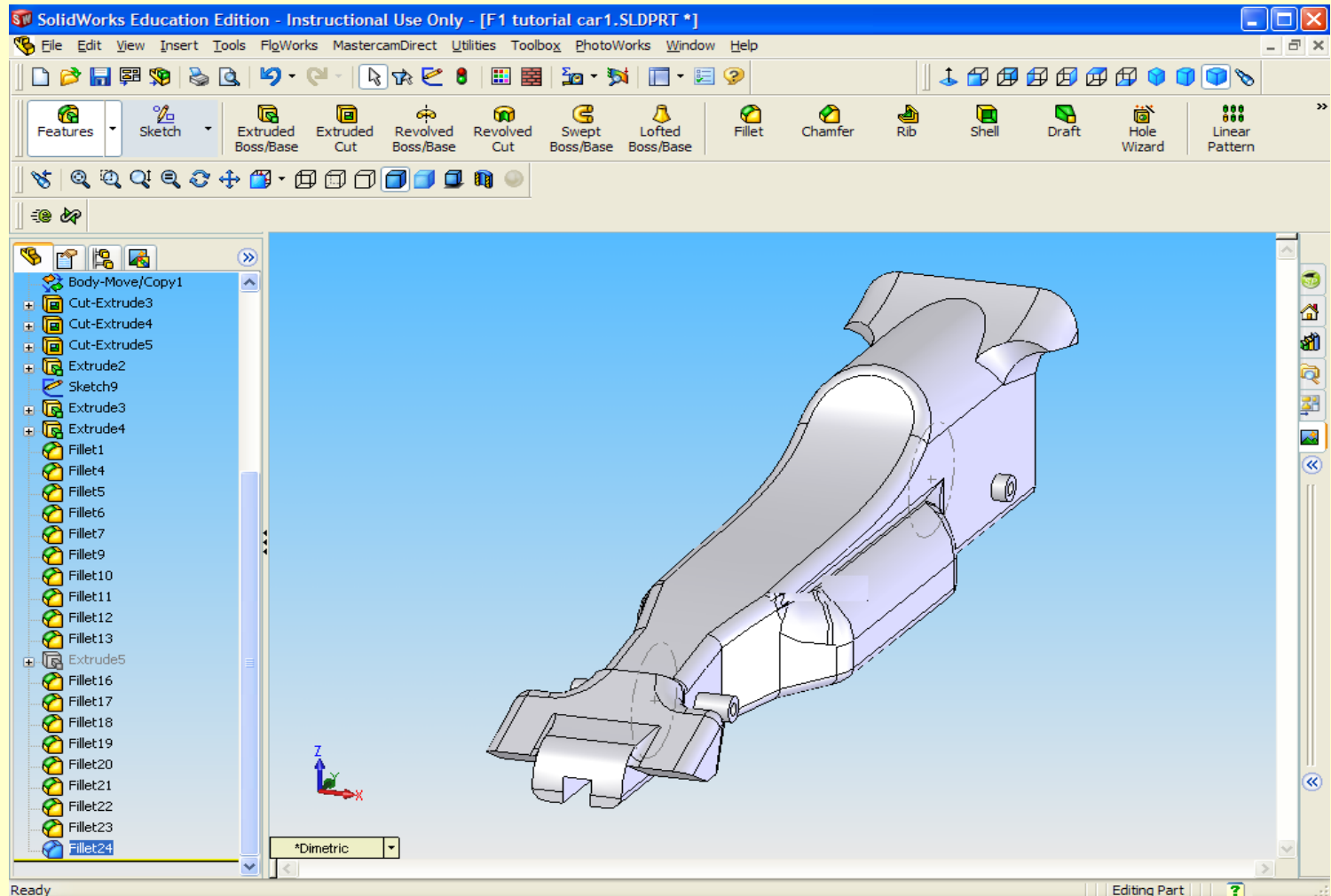
1. If you applied a Fillet that you don't like, you can right click on it in the task pane, Then select Edit Feature.



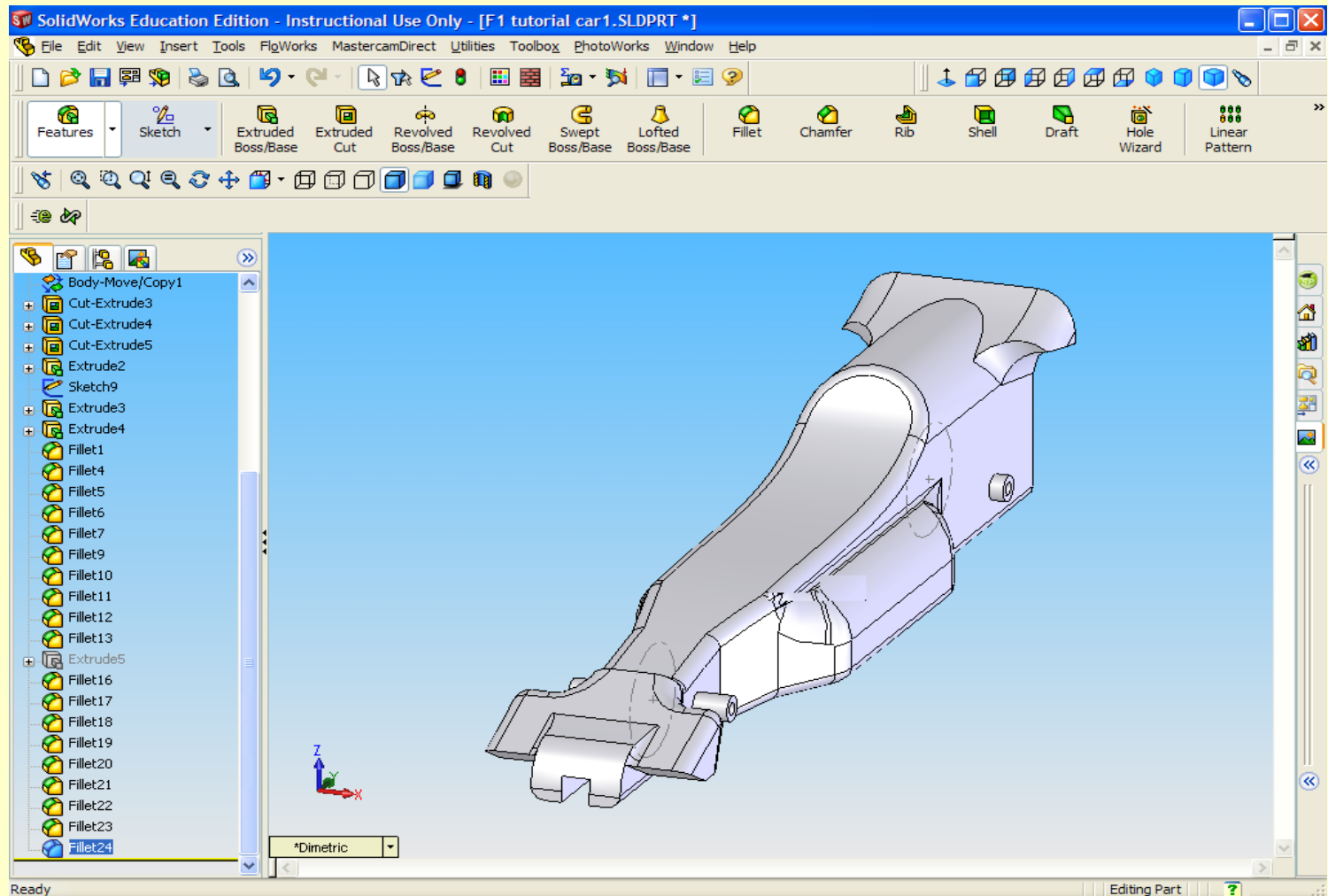
1. Simply change the radius and watch the yellow previews then click green check.



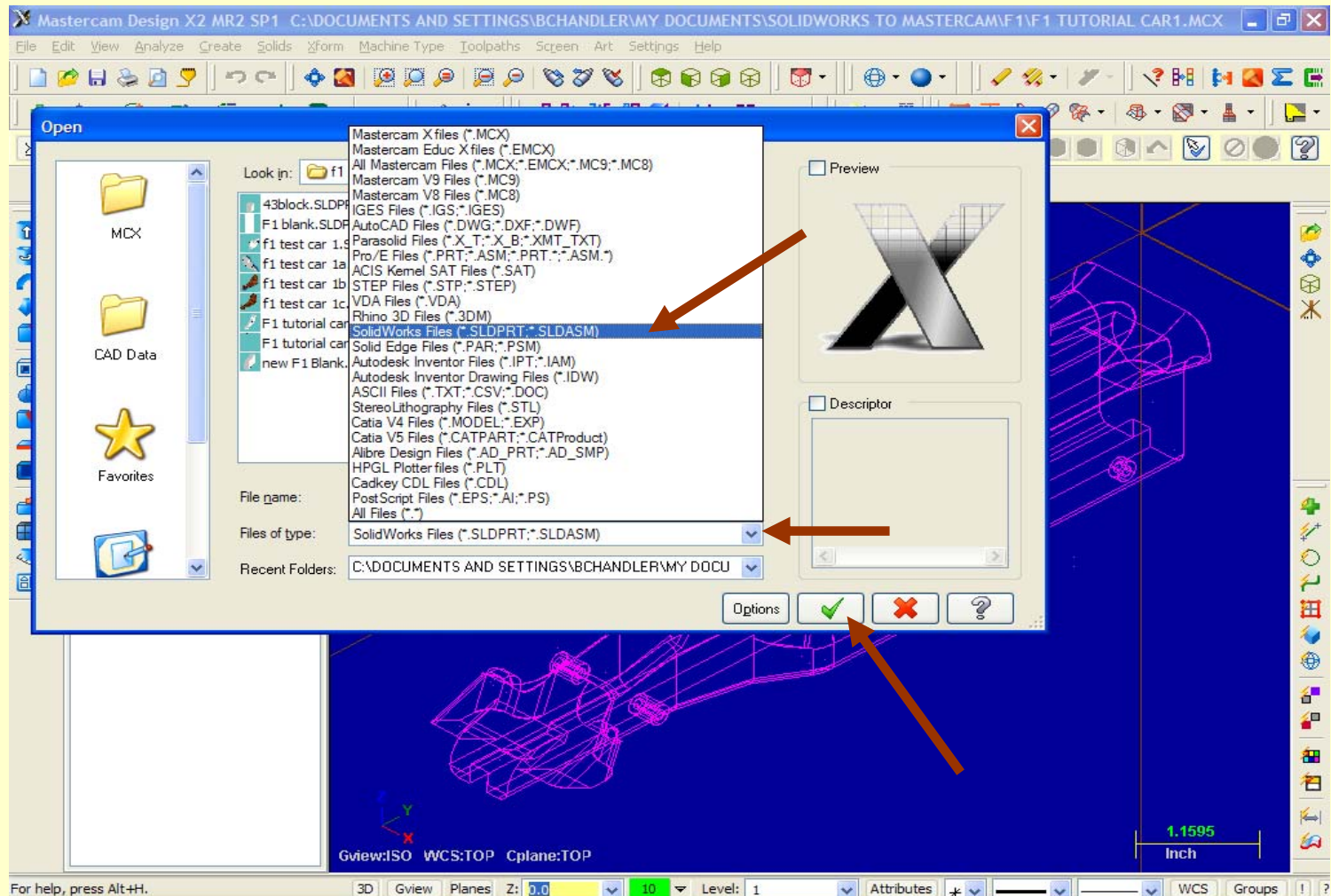
1. This example used over 20 fillets.
2. Fillet tool, click on two symmetrical edges, type a radius that shows up in yellow preview, then click green check mark to reply, and repeat.



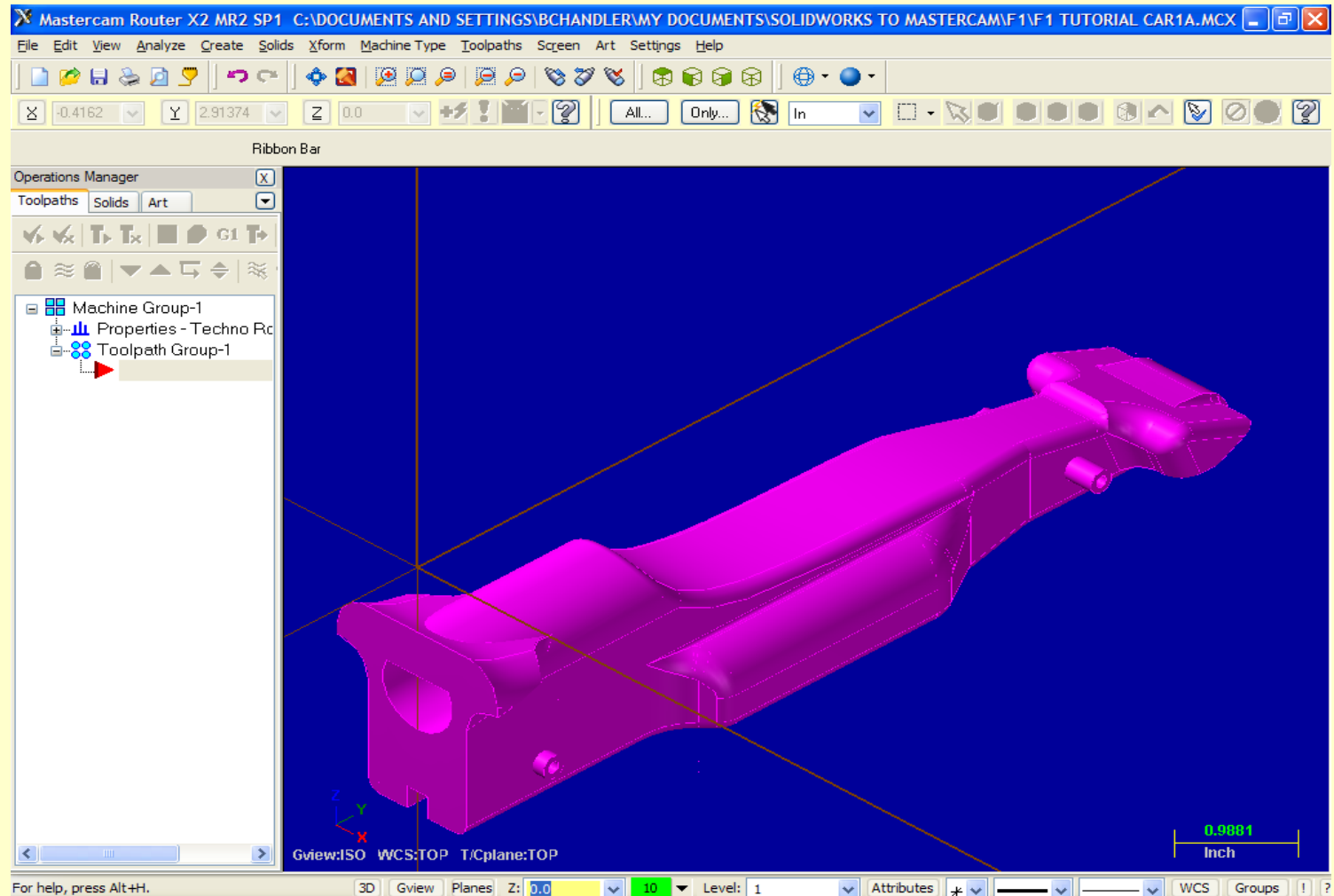
1. Save your F1 car design



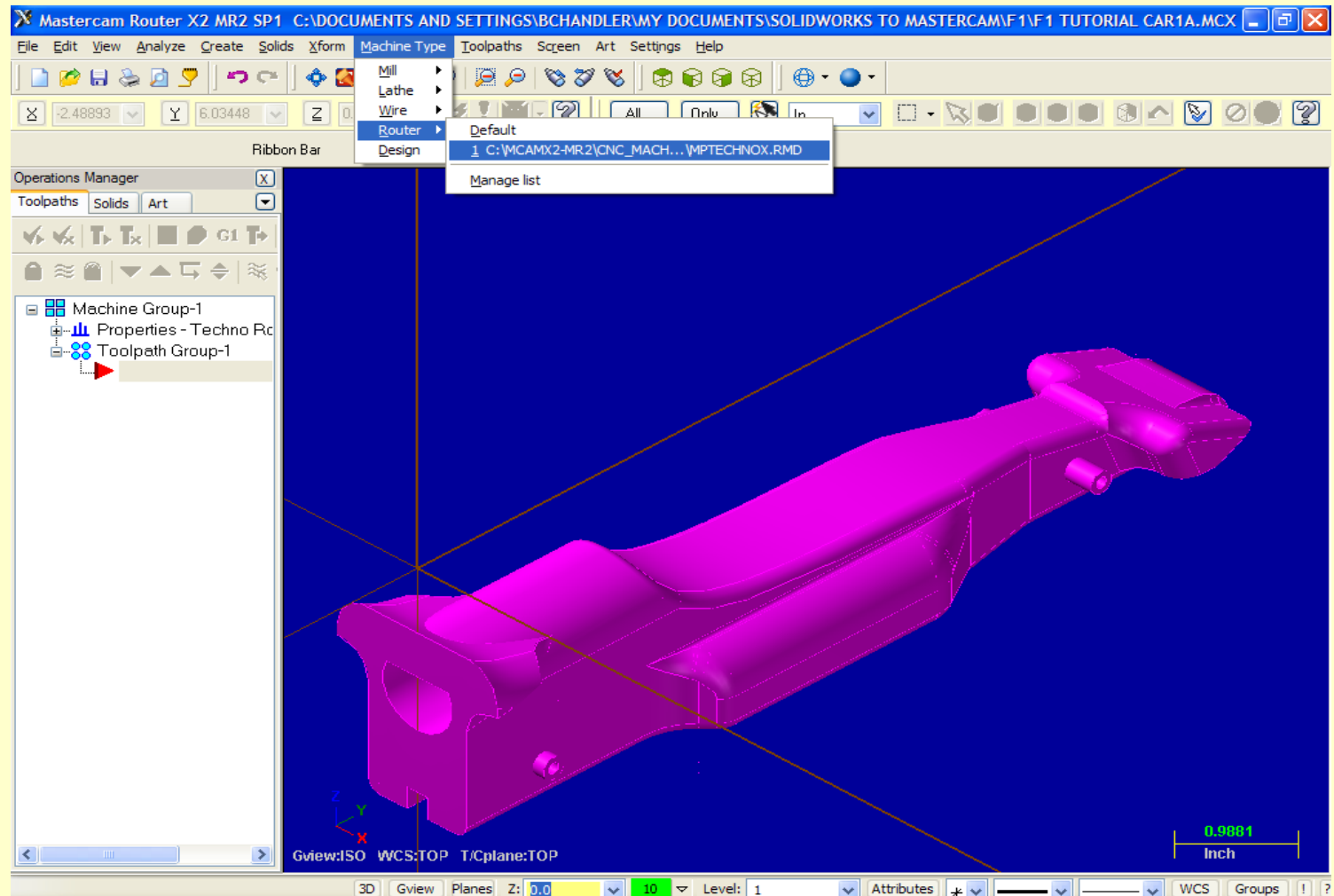
1. Open Mastercam
2. Select File> Open> then select Solidworks Files from the files of type drop down.
3. Find your car design and click the green check to open it.



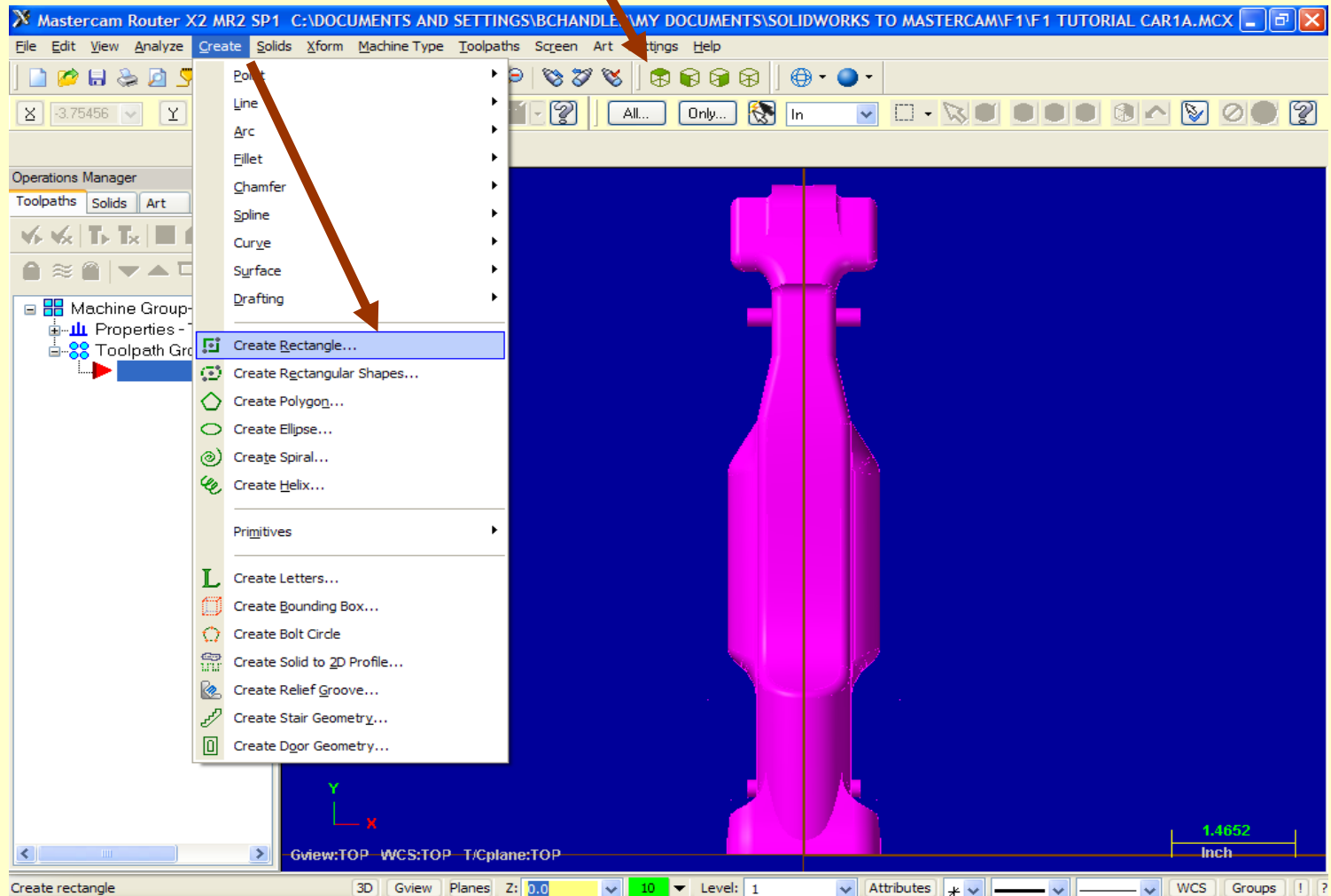
1. Press F9 on the keyboard for the red crosshairs which show 0,0,0 coordinates.



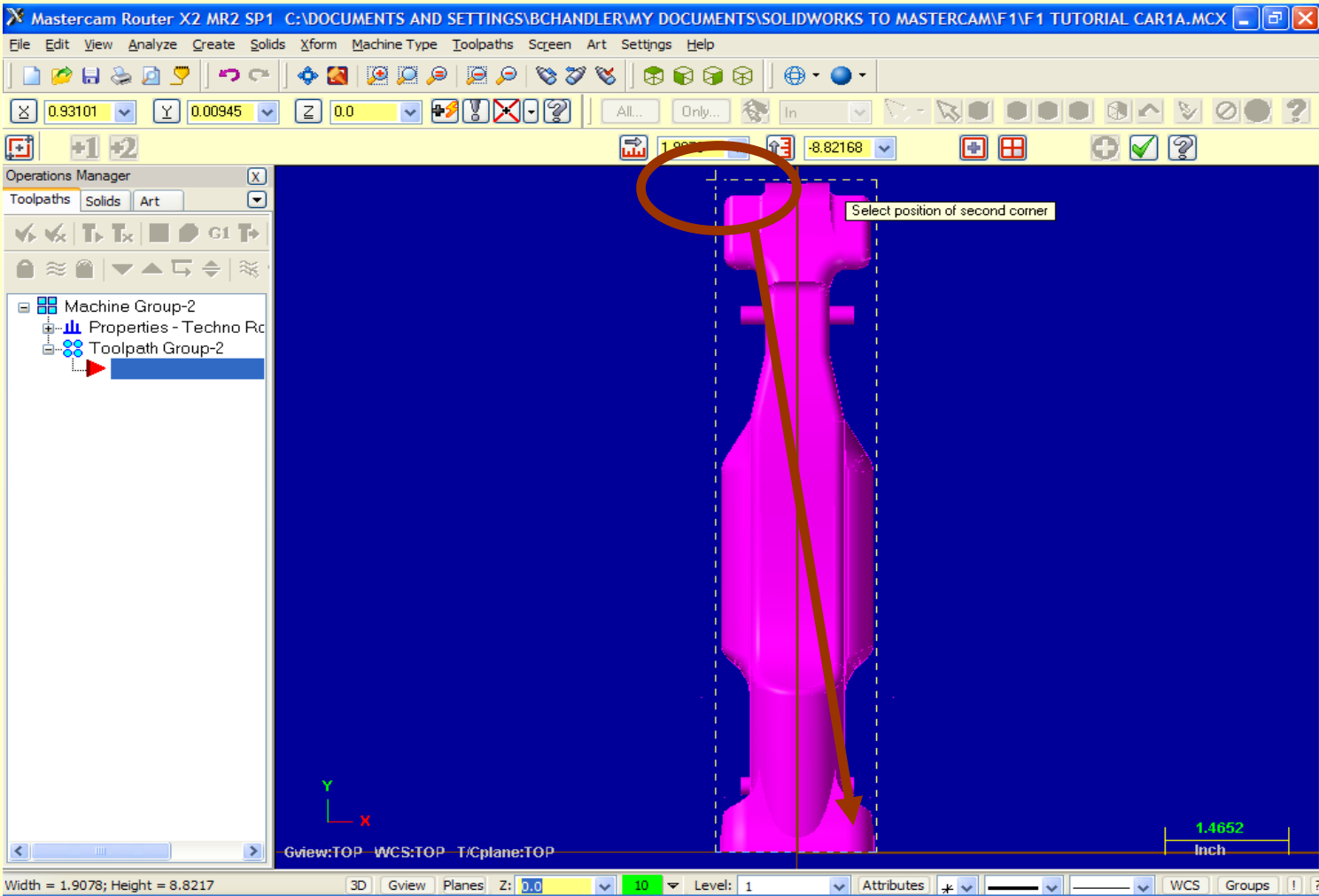
1. Select Machine Type, then choose the CNC machine designated by your instructor...
From the Mill or Router category.



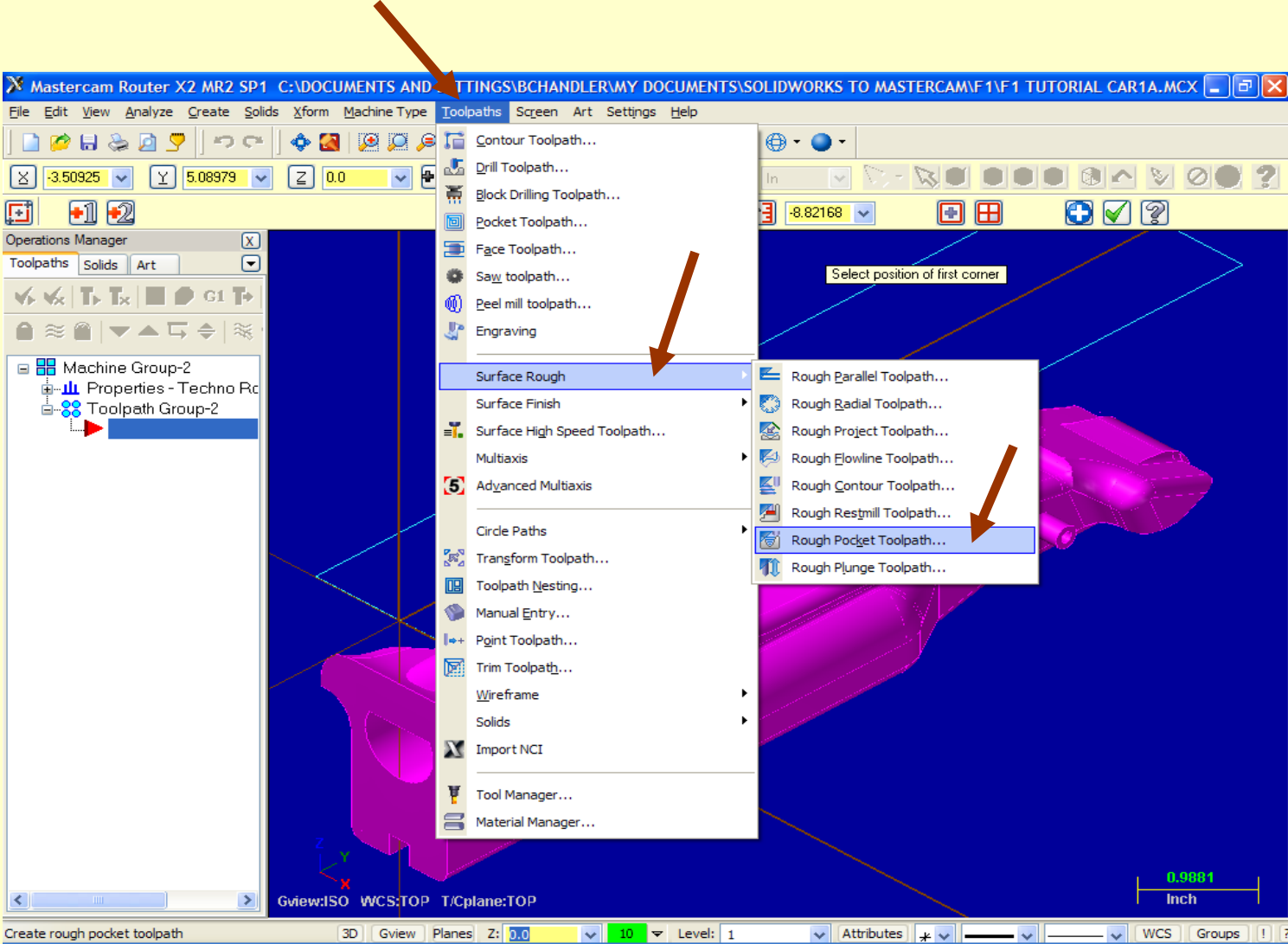
1. Switch to a top view.
2. Select Create > Create Rectangle.



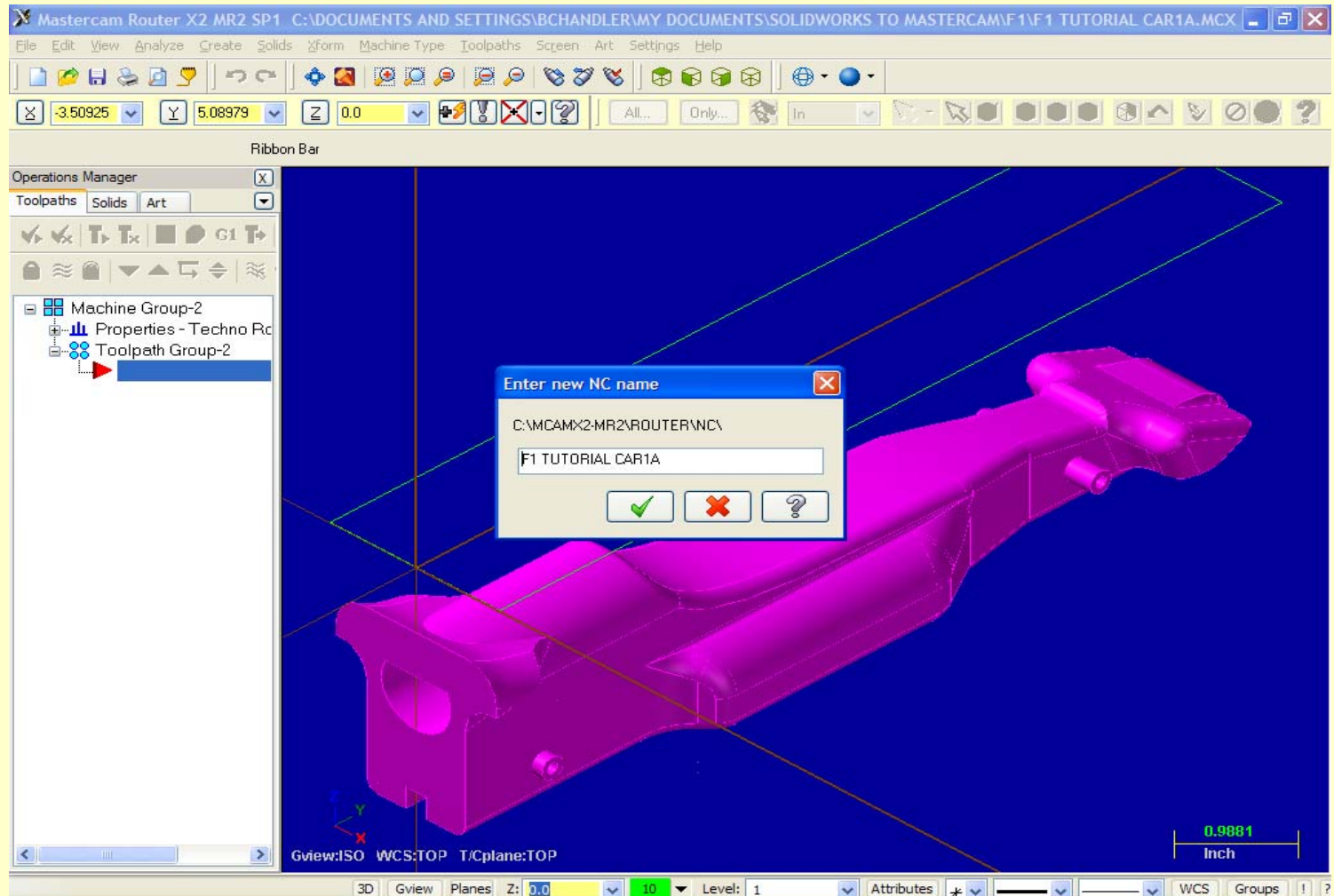
1. Click just off to the side of the top left edge of the car...and drag the rectangle Around the entire body.



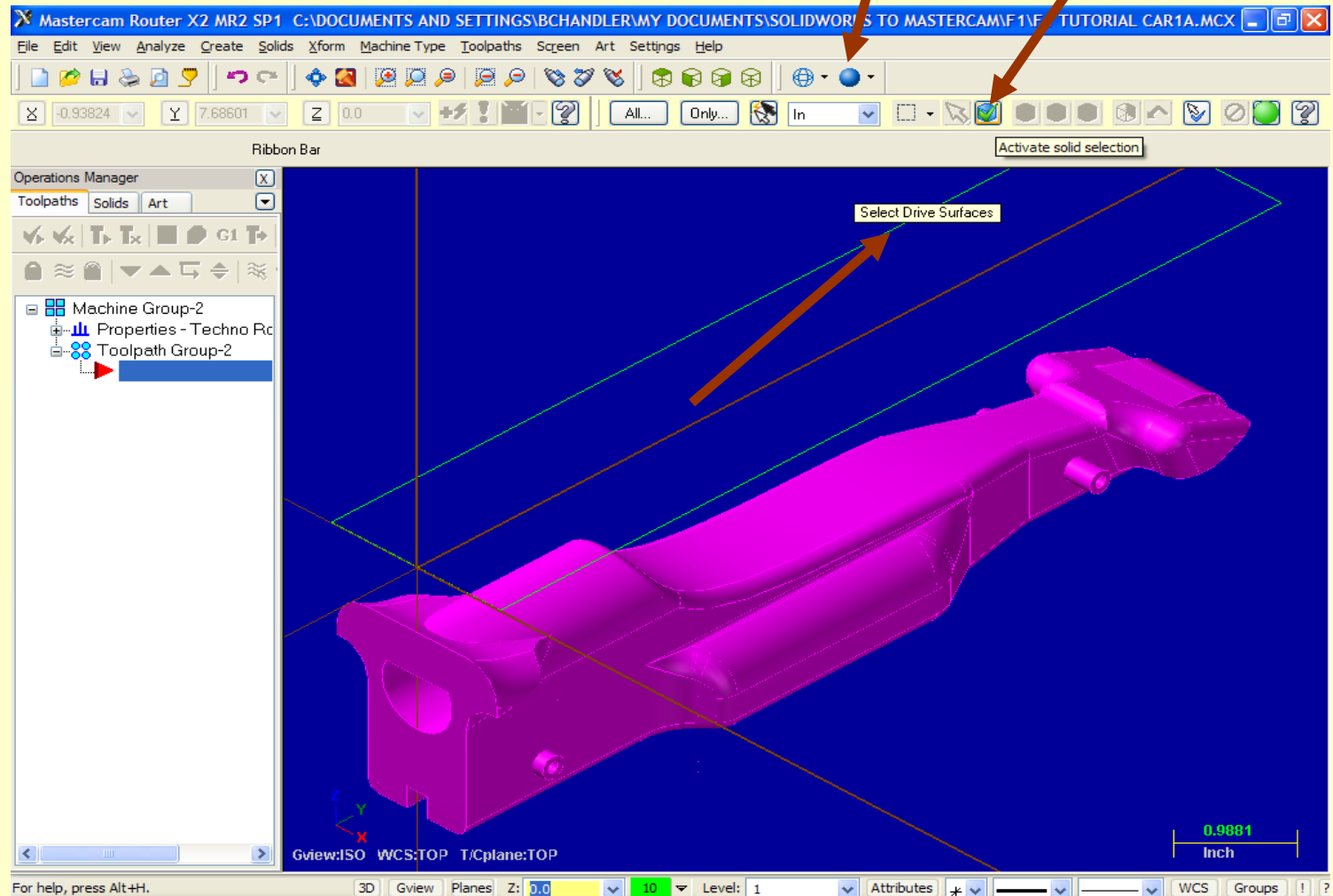
1. Select Toolpaths > Surface Rough > Rough Pocket Toolpath



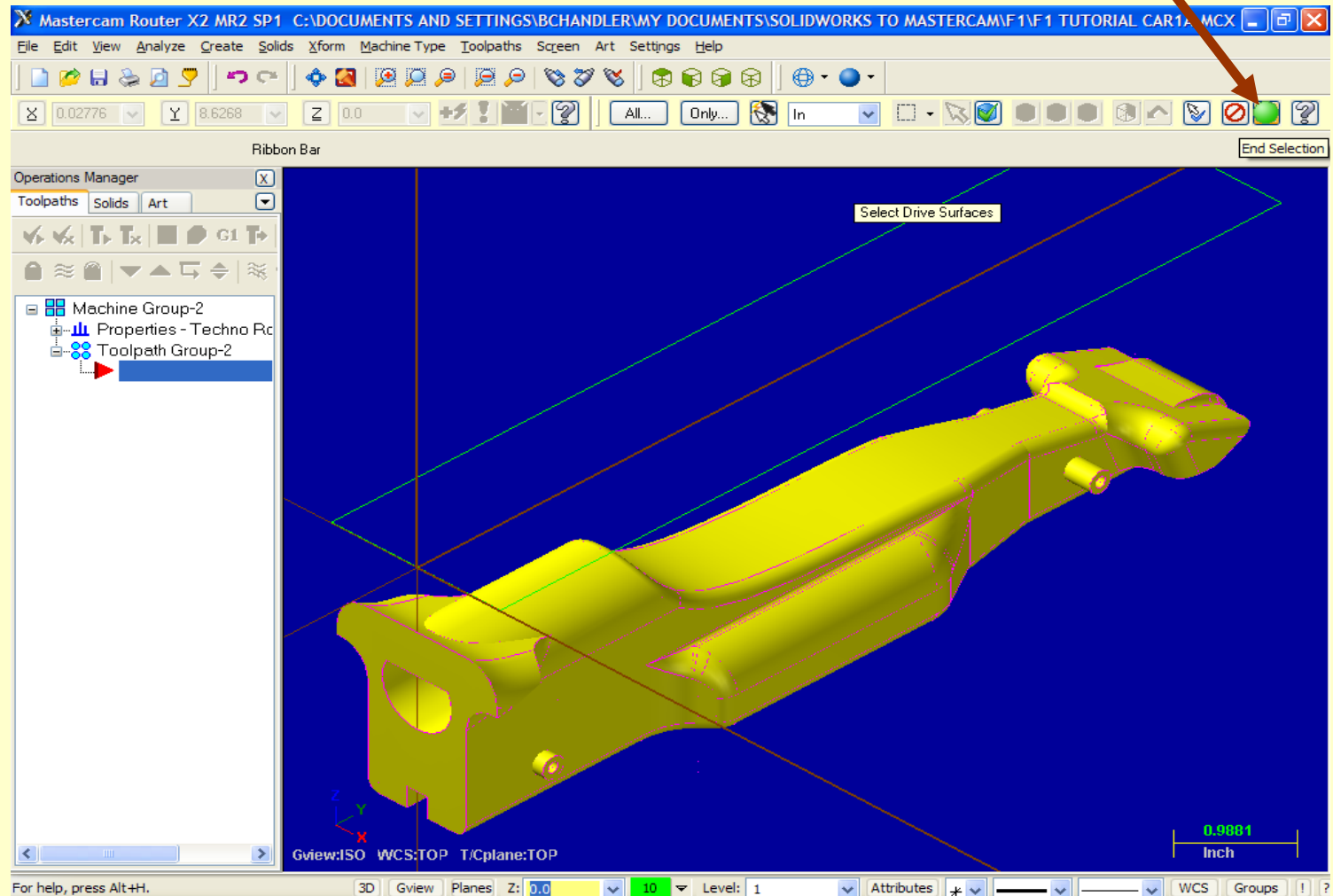
1. Just click the green check in the default naming window. You will save and name your work later.



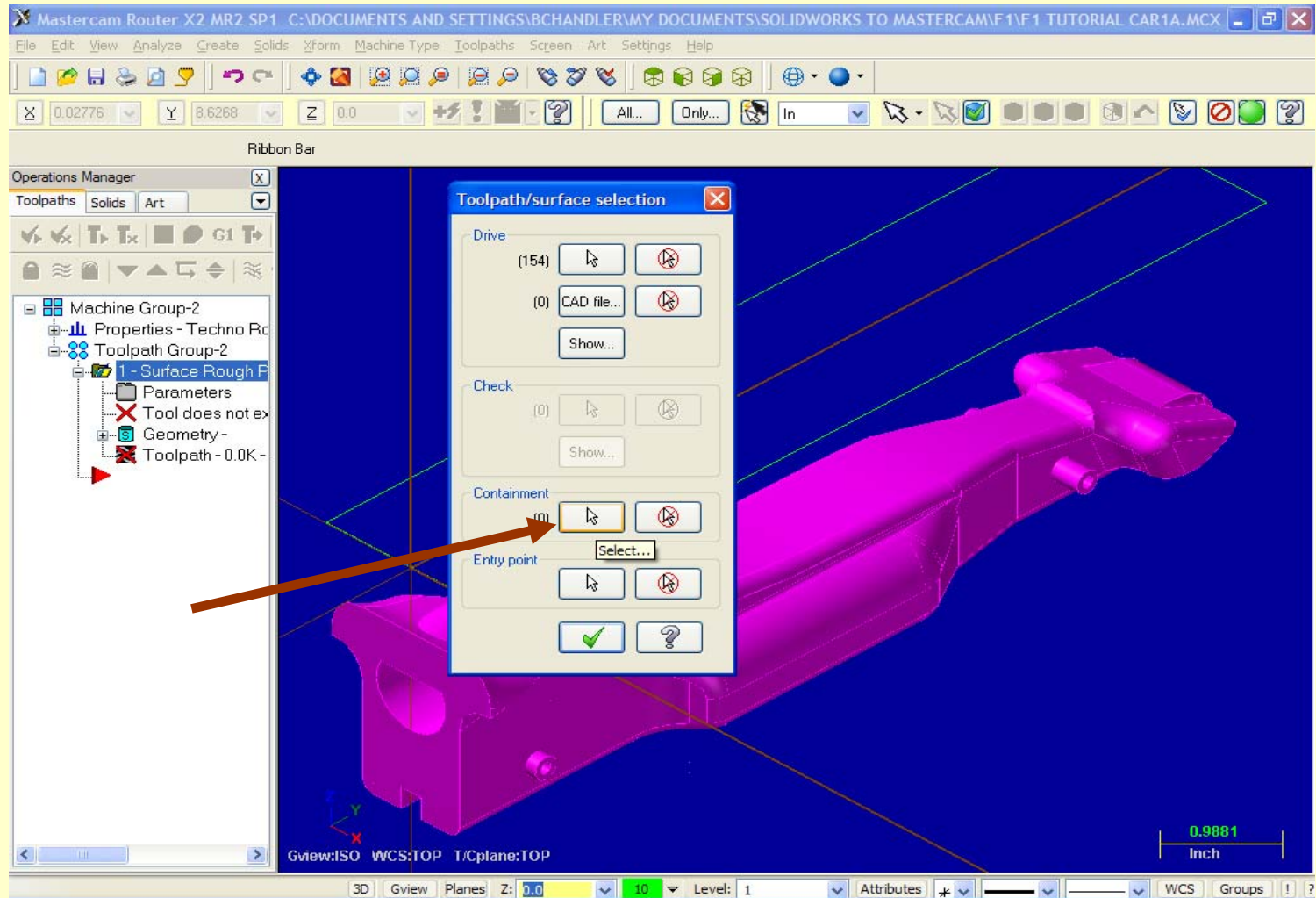
1. Select the Shaded icon to see a solid form of your car.
2. A small prompt window will say to select the drive surface.
3. Click the Activate solid selection icon.



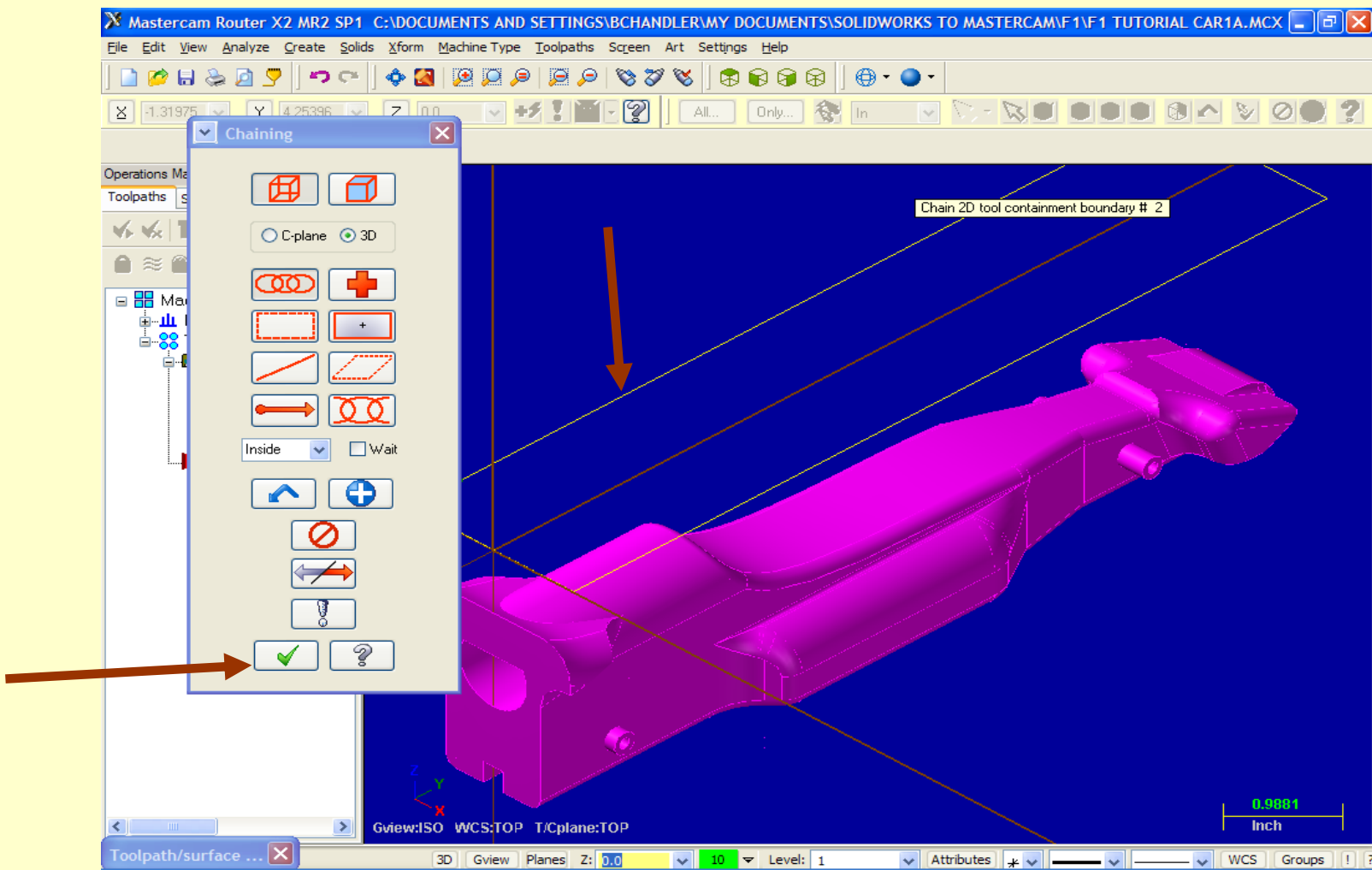
1. All edges should highlight yellow.
2. Now select the green go button to finish.



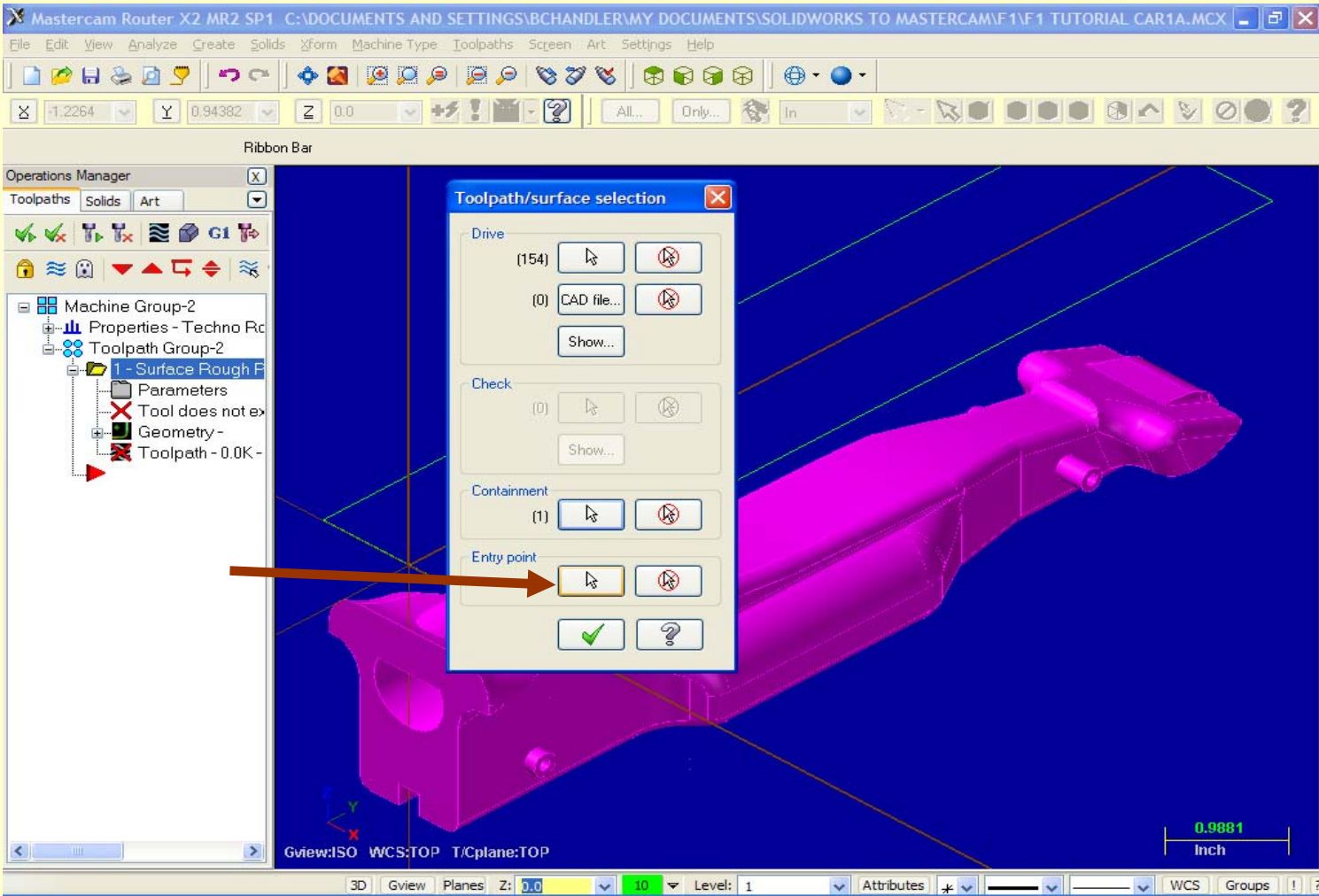
1. The confirmation window appears. Select the pointer under Containment.



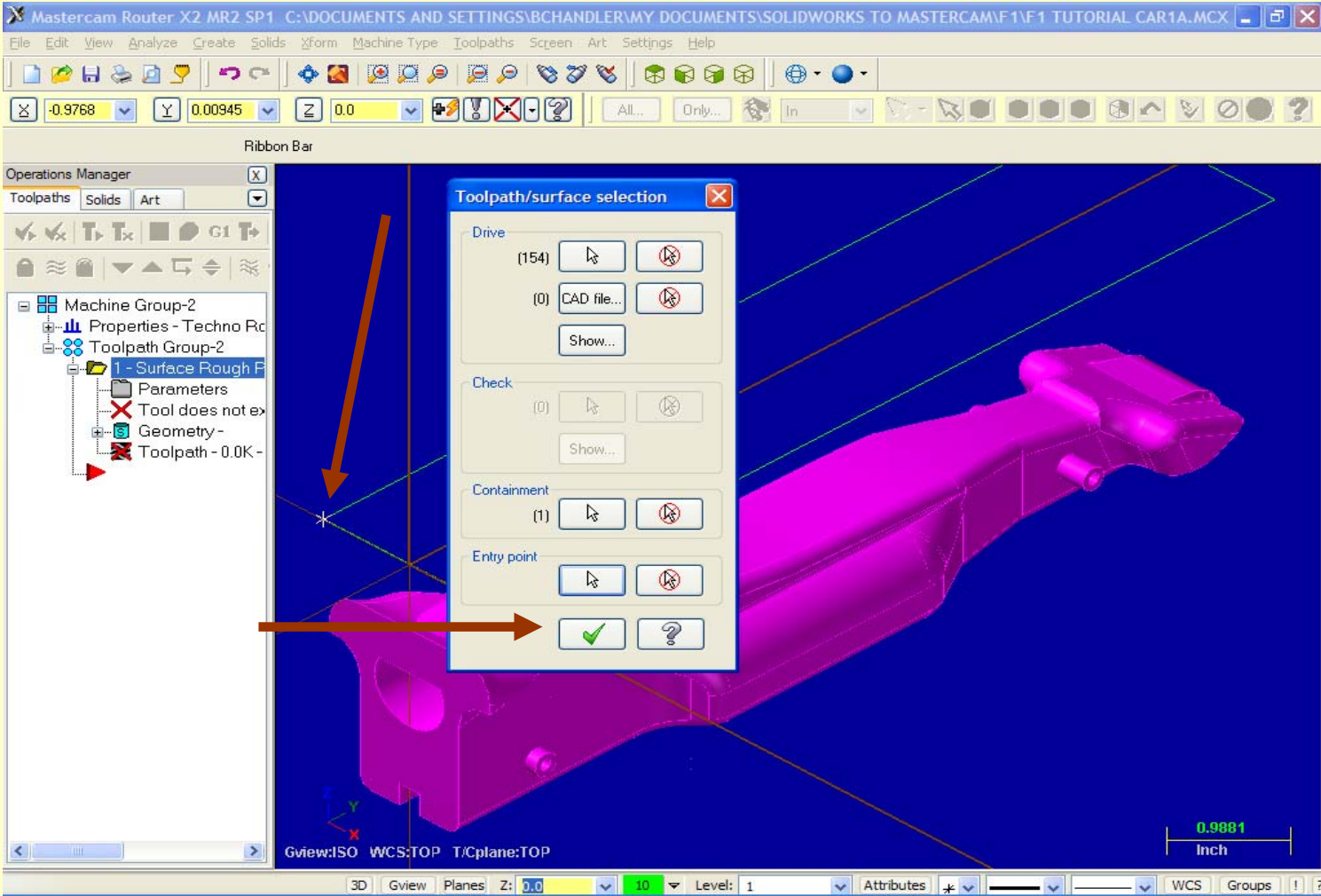
1. Click on the rectangle you created earlier. Then click the green check mark in this window. The rectangle should highlight with an arrow visible in the path.



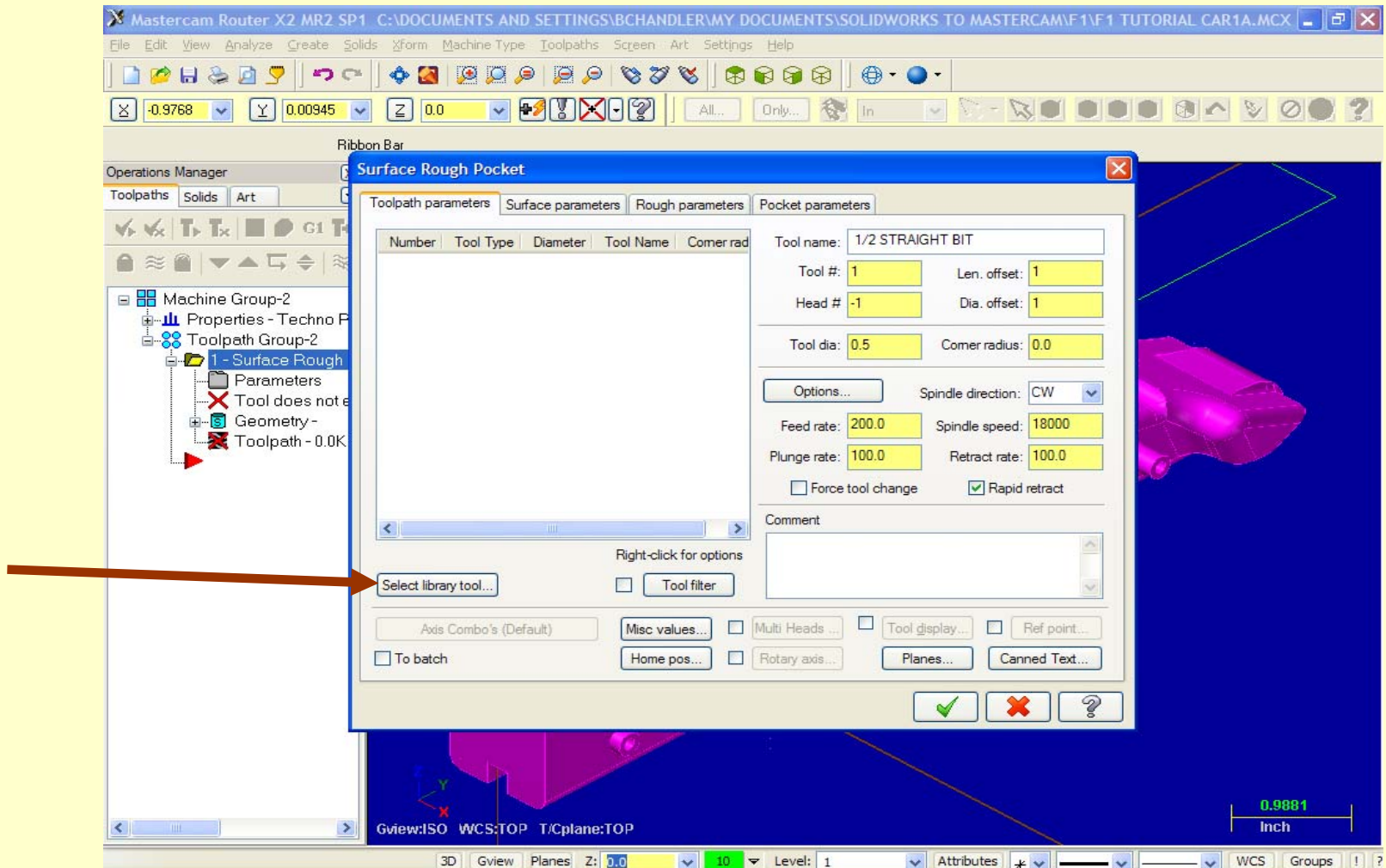
1. The toolpath selection window appears again...this time click the arrow for Entry Point.



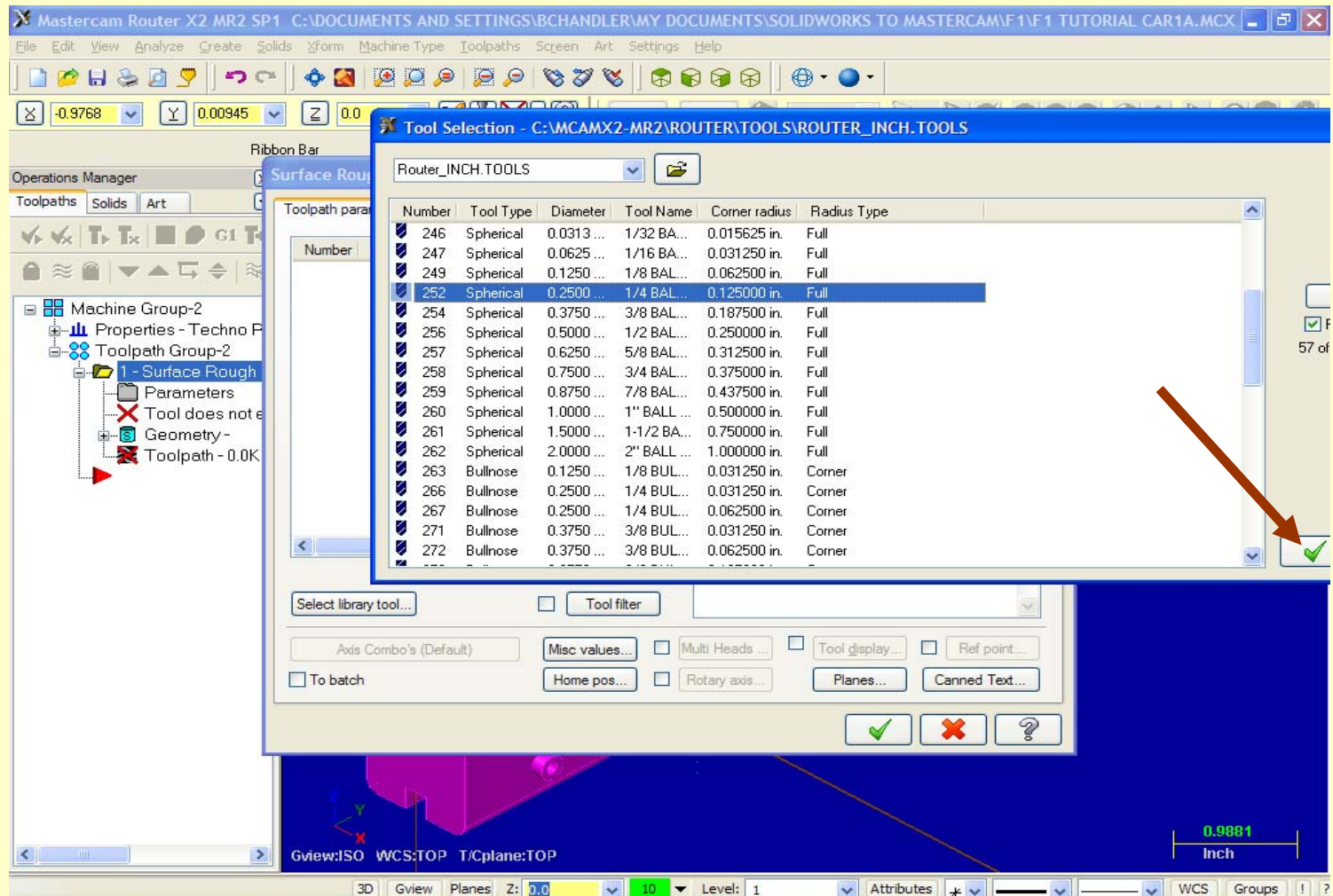
1. Click on the bottom left corner of your rectangle then the green check.



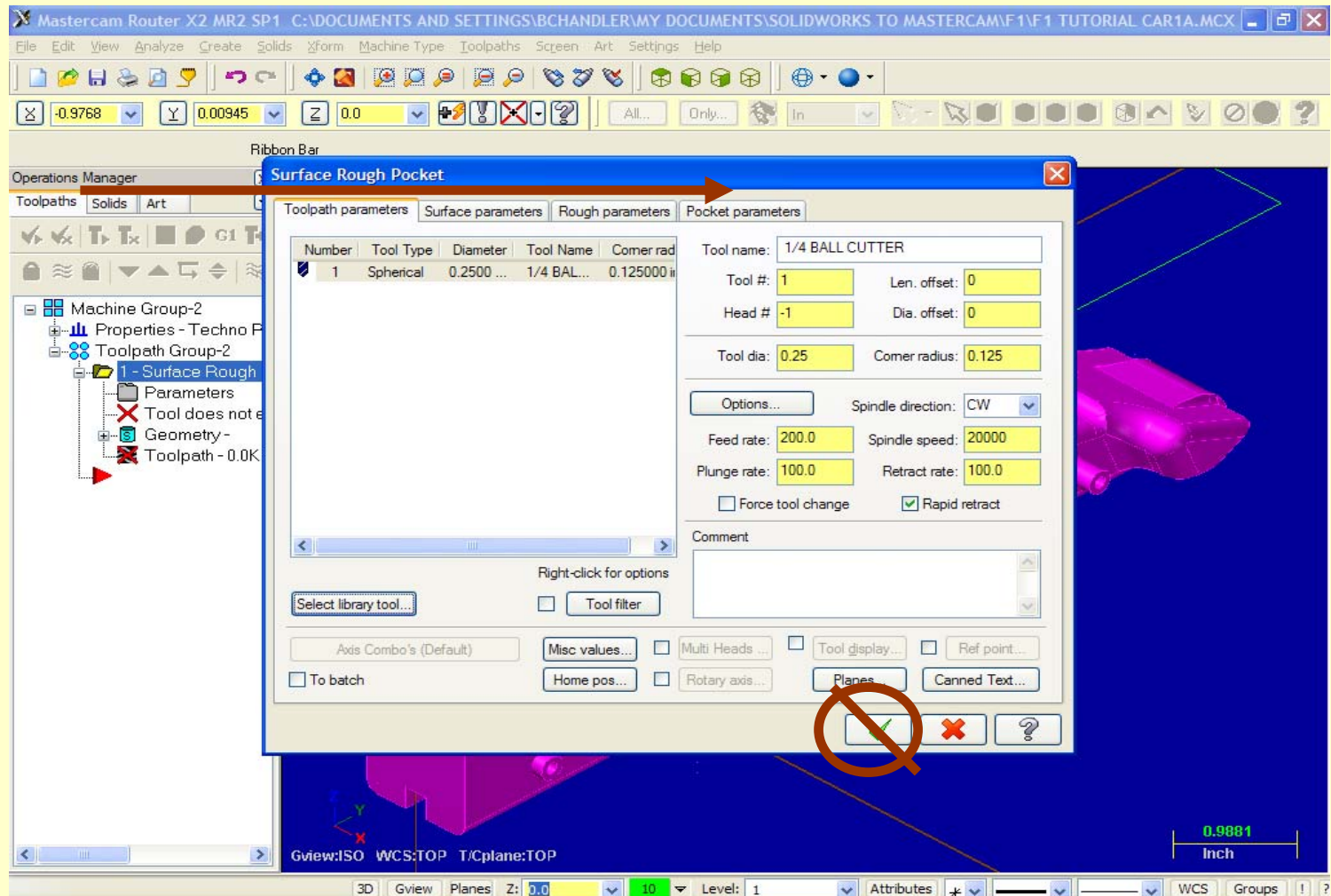
1. The Main Toolpath Parameters Screen appears.
2. Click on **Select Library Tool**



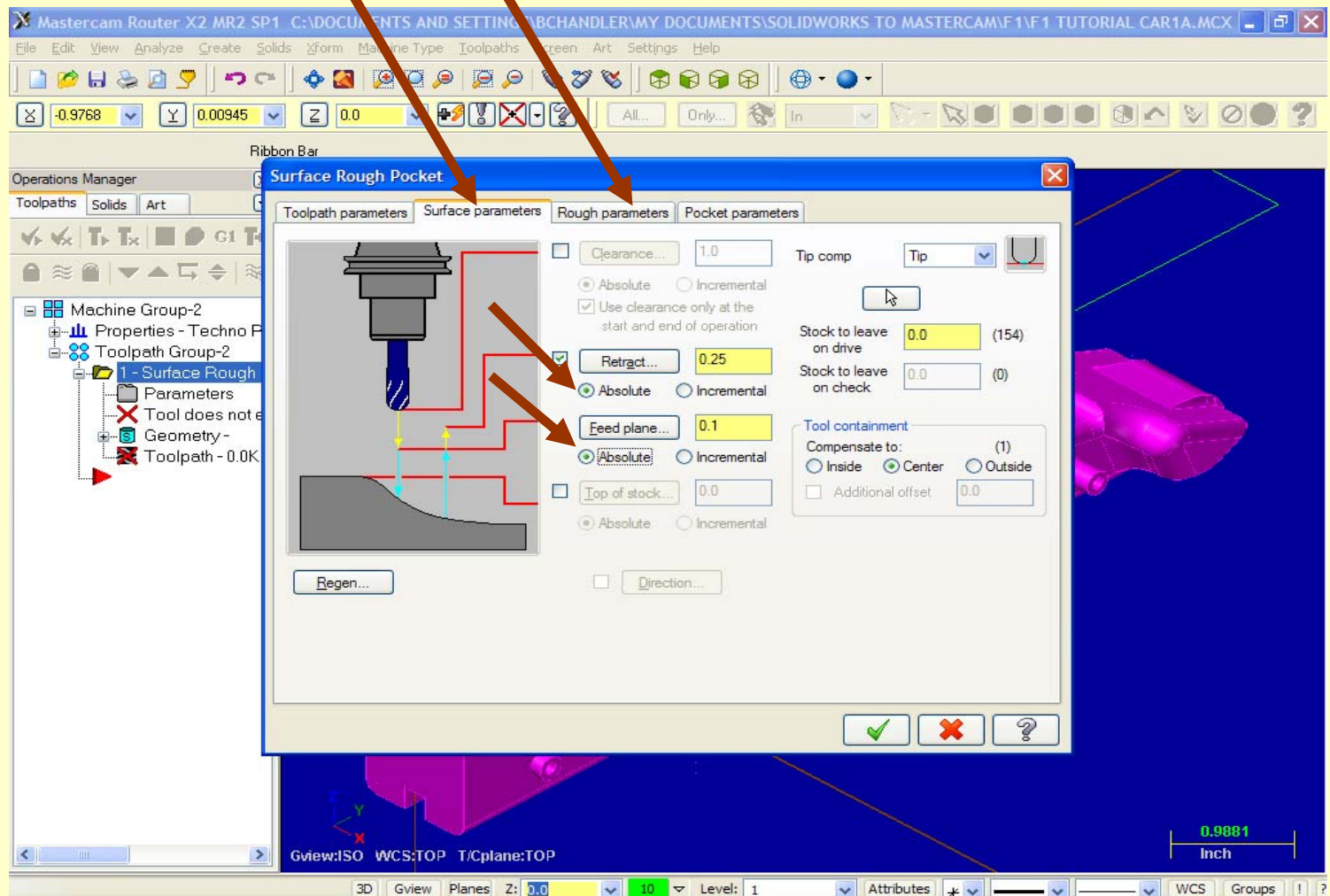
1. Select the appropriate size and shape bit...usually spherical or straight.
For roughing, you want the largest diameter possible...check with your instructor.
We'll choose 1/4" ball for example. Click the green Check.



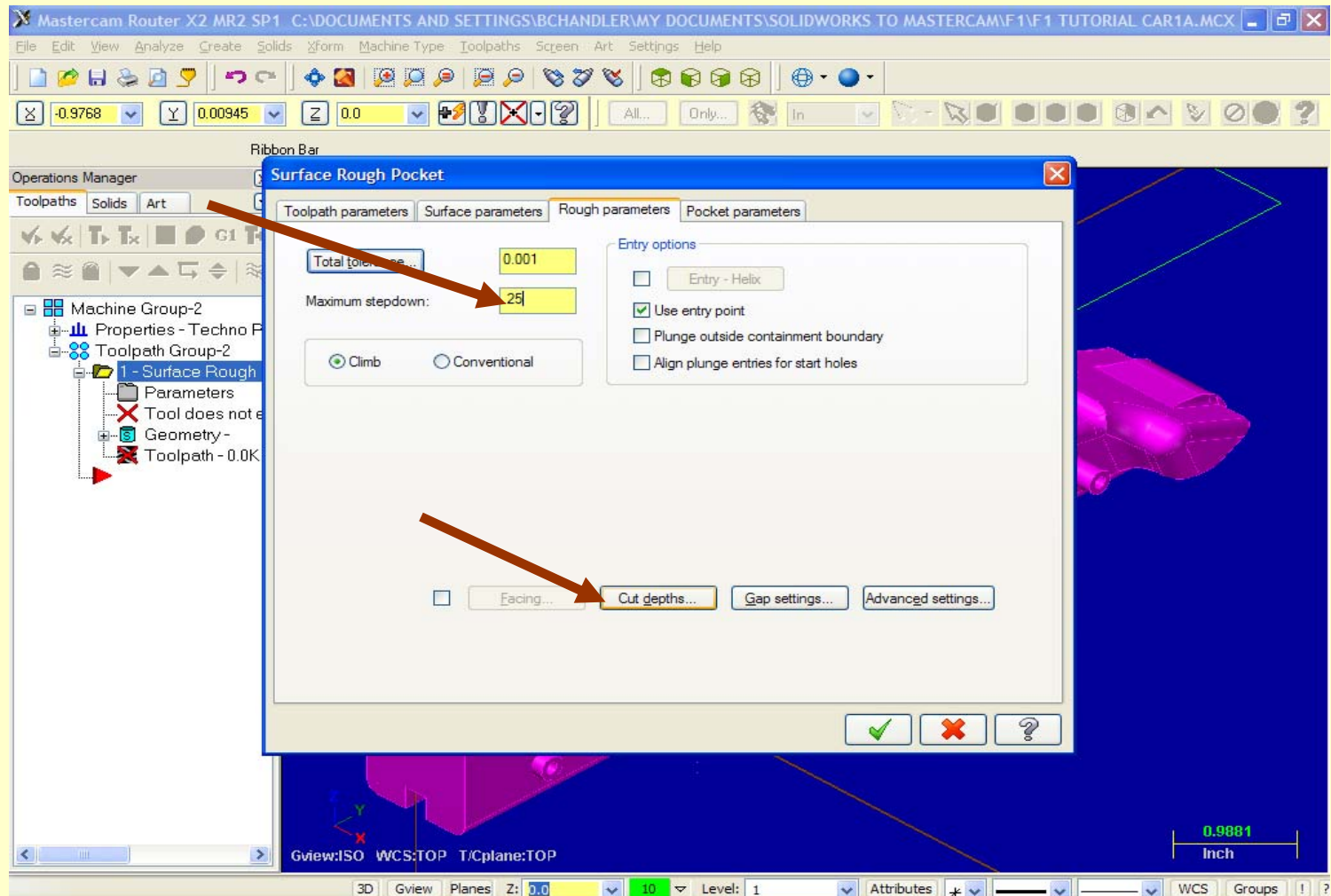
1. Your selected tool appears.
2. **Do not** click the green check at the bottom until we have set parameters across every Tab.



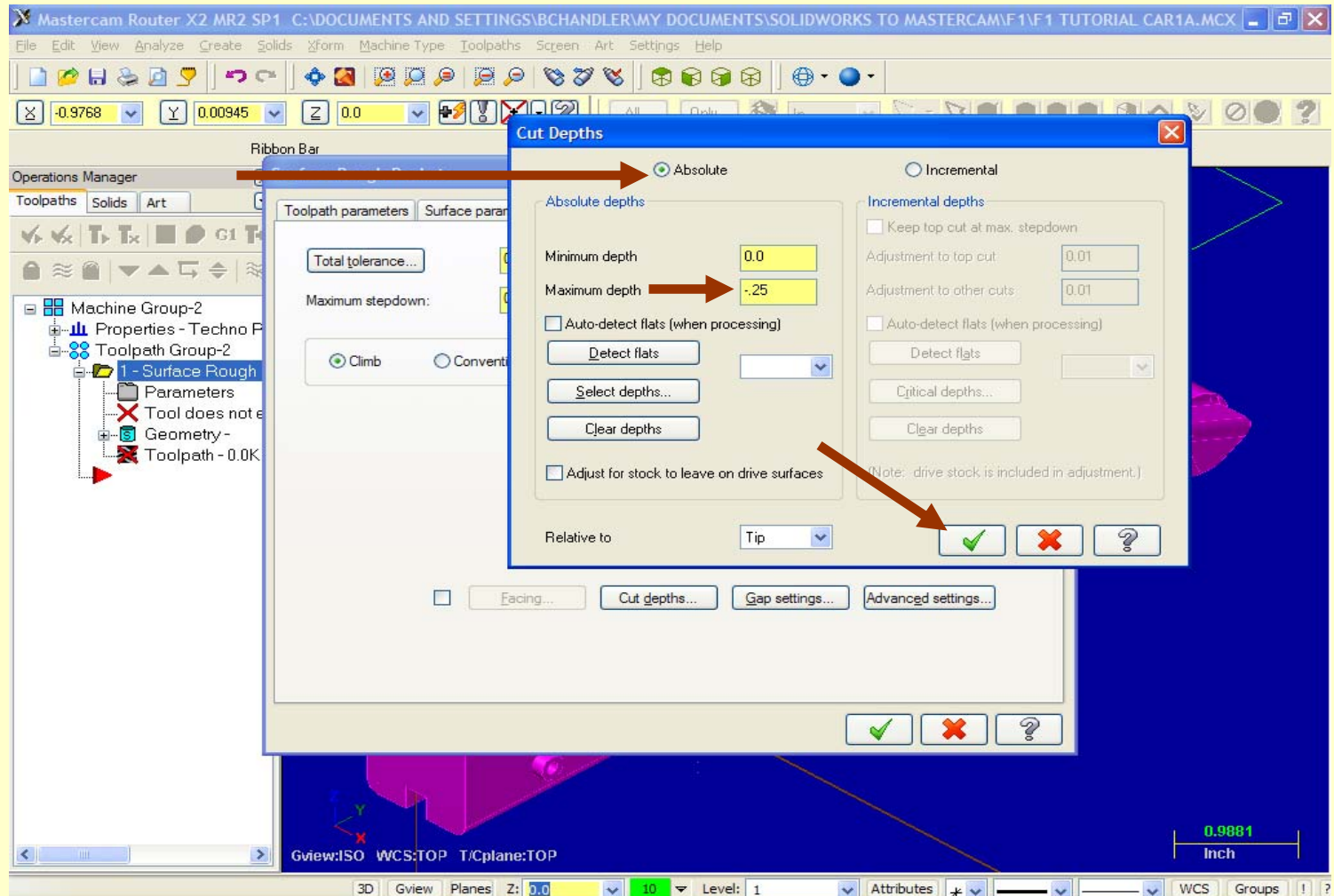
1. Click the next Tab, Surface Parameters.
2. Click to set Retract and Feed to ABSOLUTE.
3. Click the next tab.



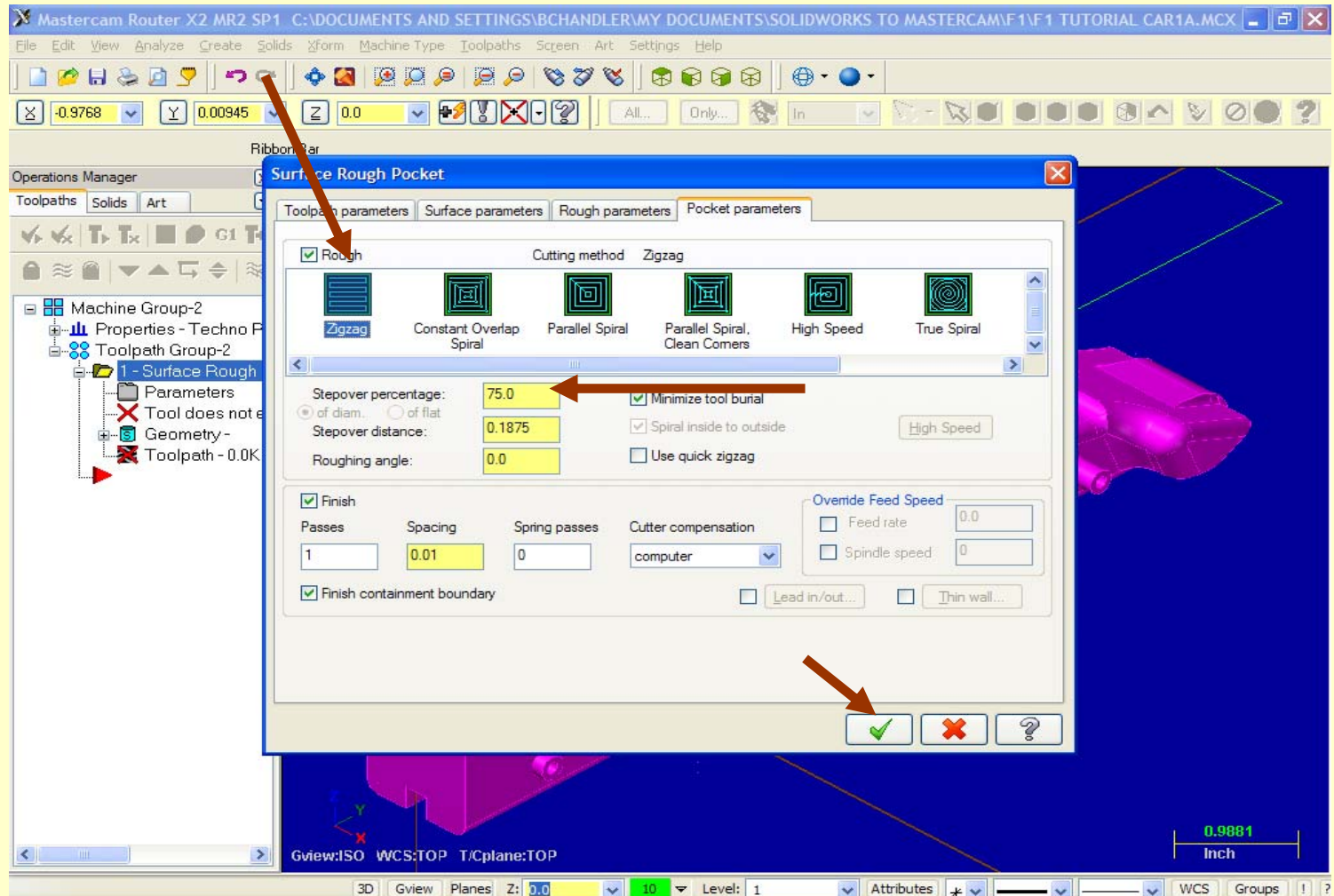
1. Type in .25 for Max Stepdown.
2. Then click on Cut Depths.



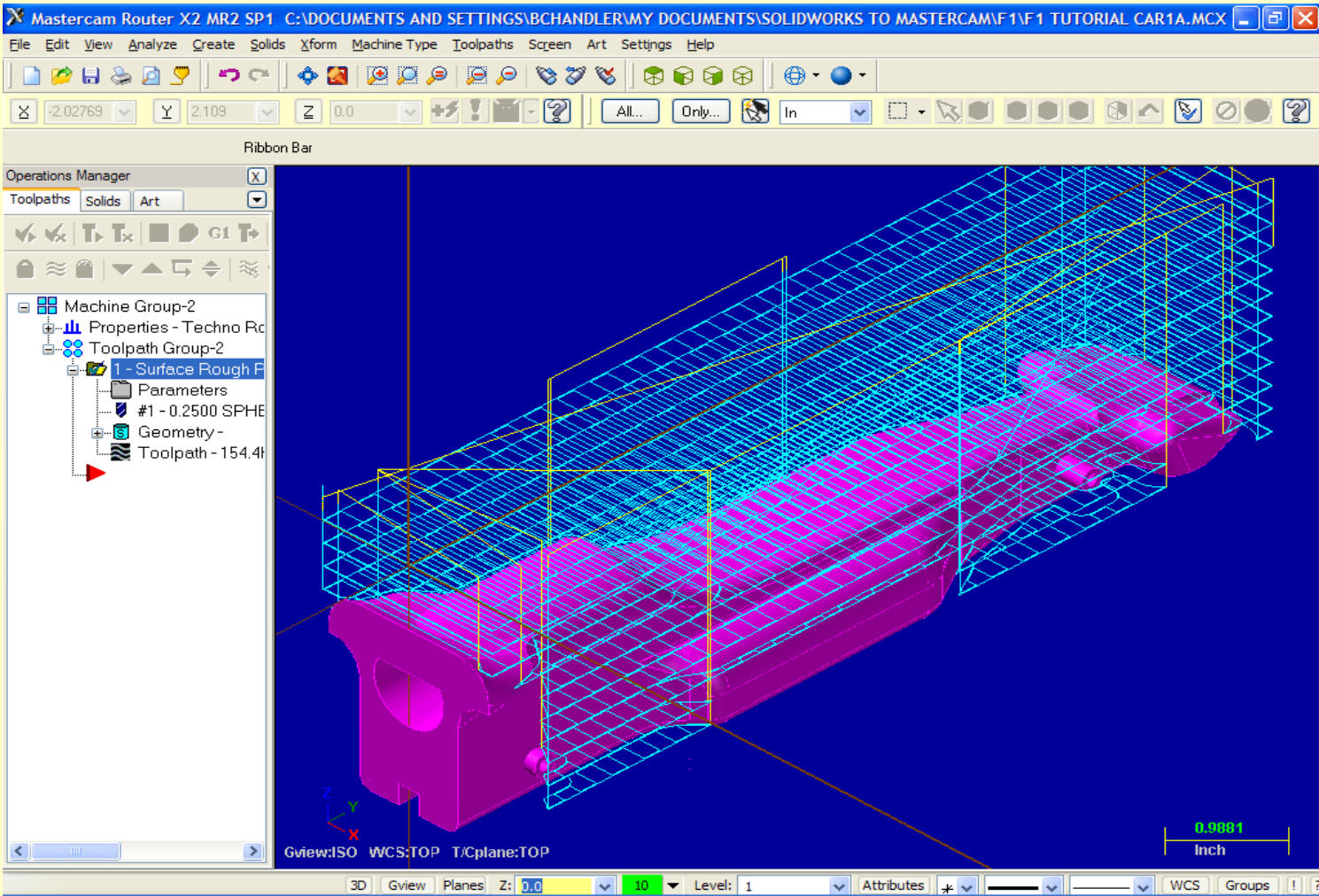
1. Click Absolute then type -2.5 for Max Depth.
2. Click this green check.



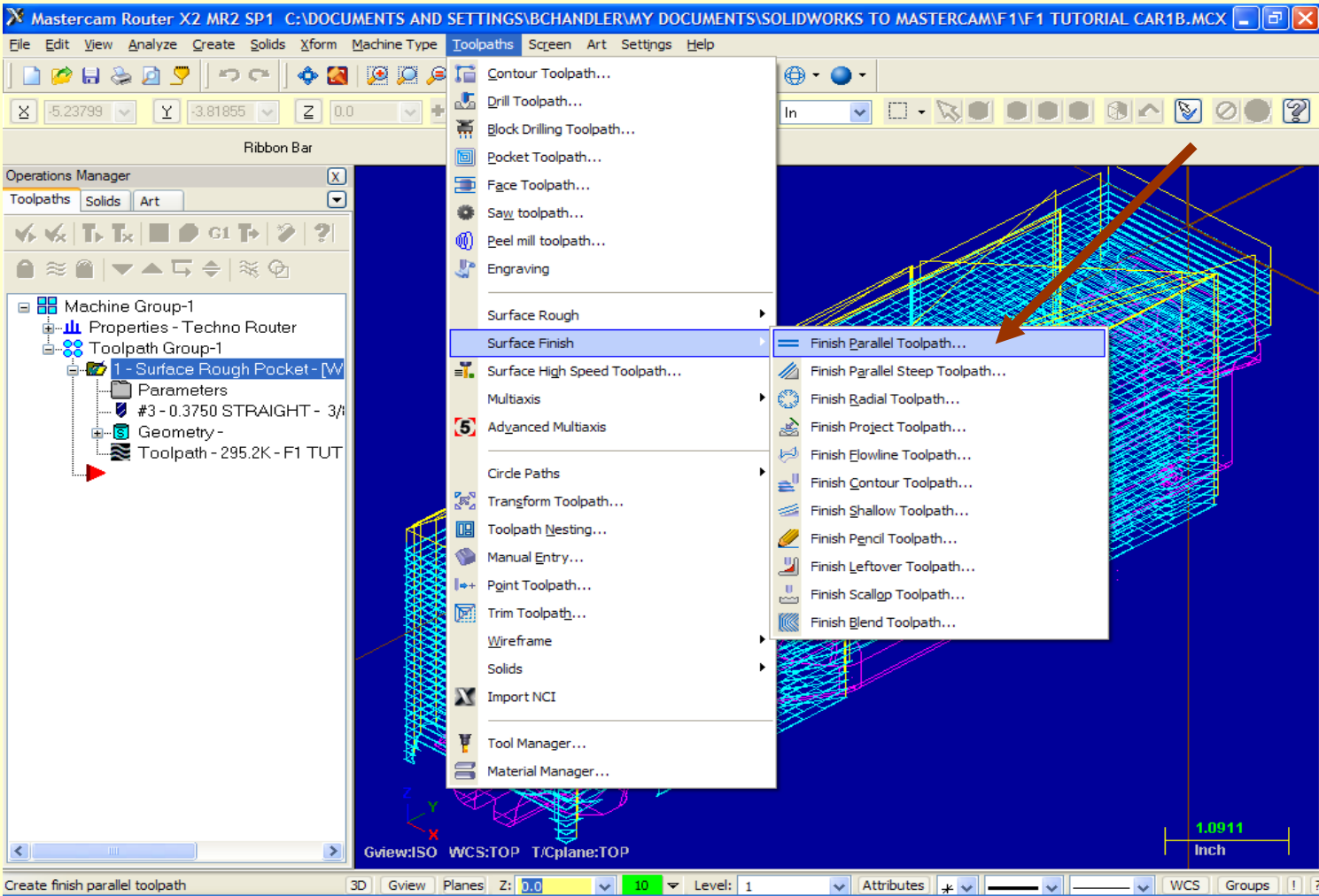
1. Click on the next tab, Pocket parameters.
2. Type in 75 for Stepmover Percentage and the stepover distance will automatically fill in.
3. Choose Zigzag, from the cutting methods. Then click the green check mark.



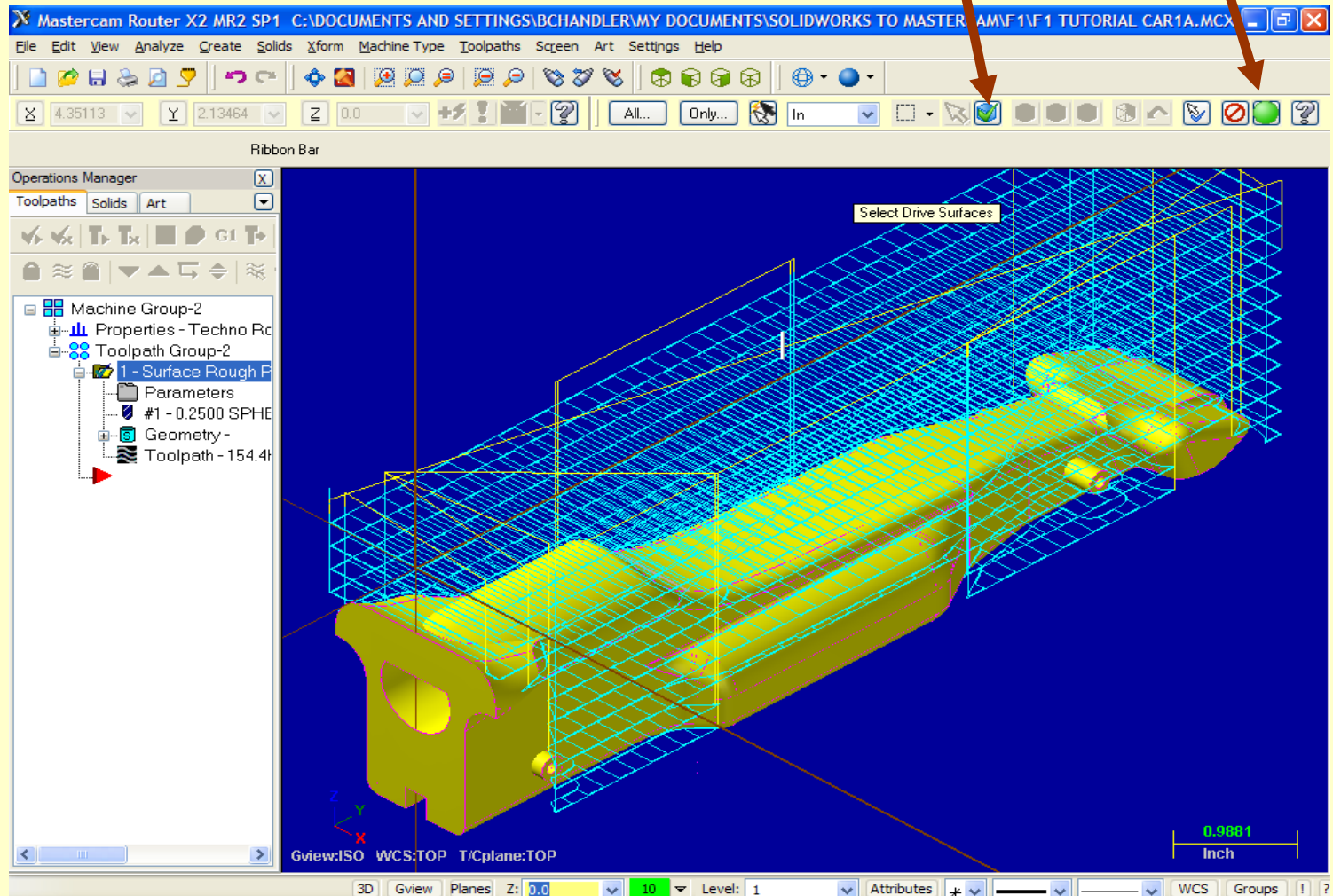
1. The first toolpath appears in blue.



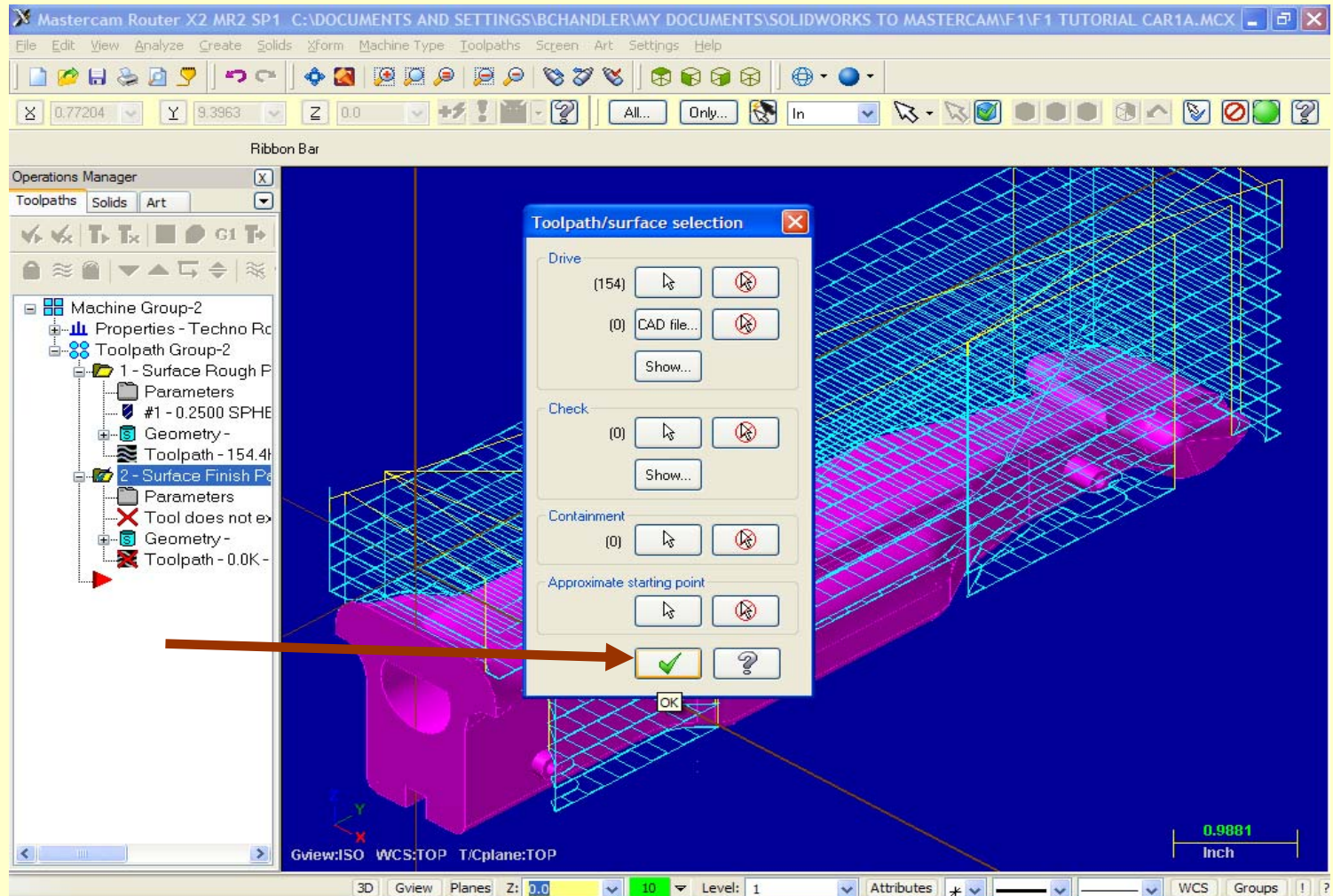
1. For the second toolpath, select Toolpaths > Surface Finish > Finish Parallel Toolpath.



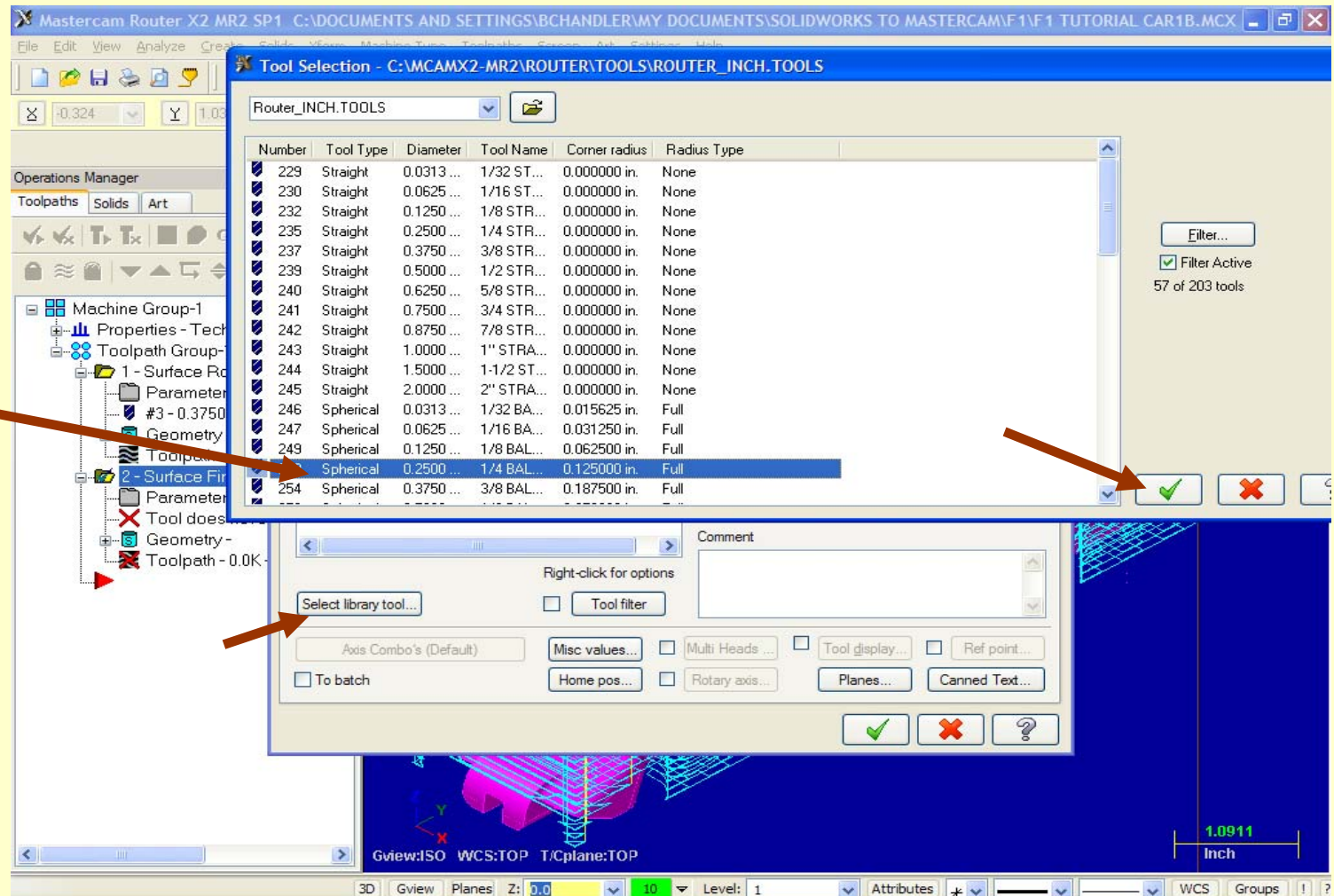
1. Select activate body selection
2. Click on the body of the car until it highlights yellow.
3. Click the green “GO” button.



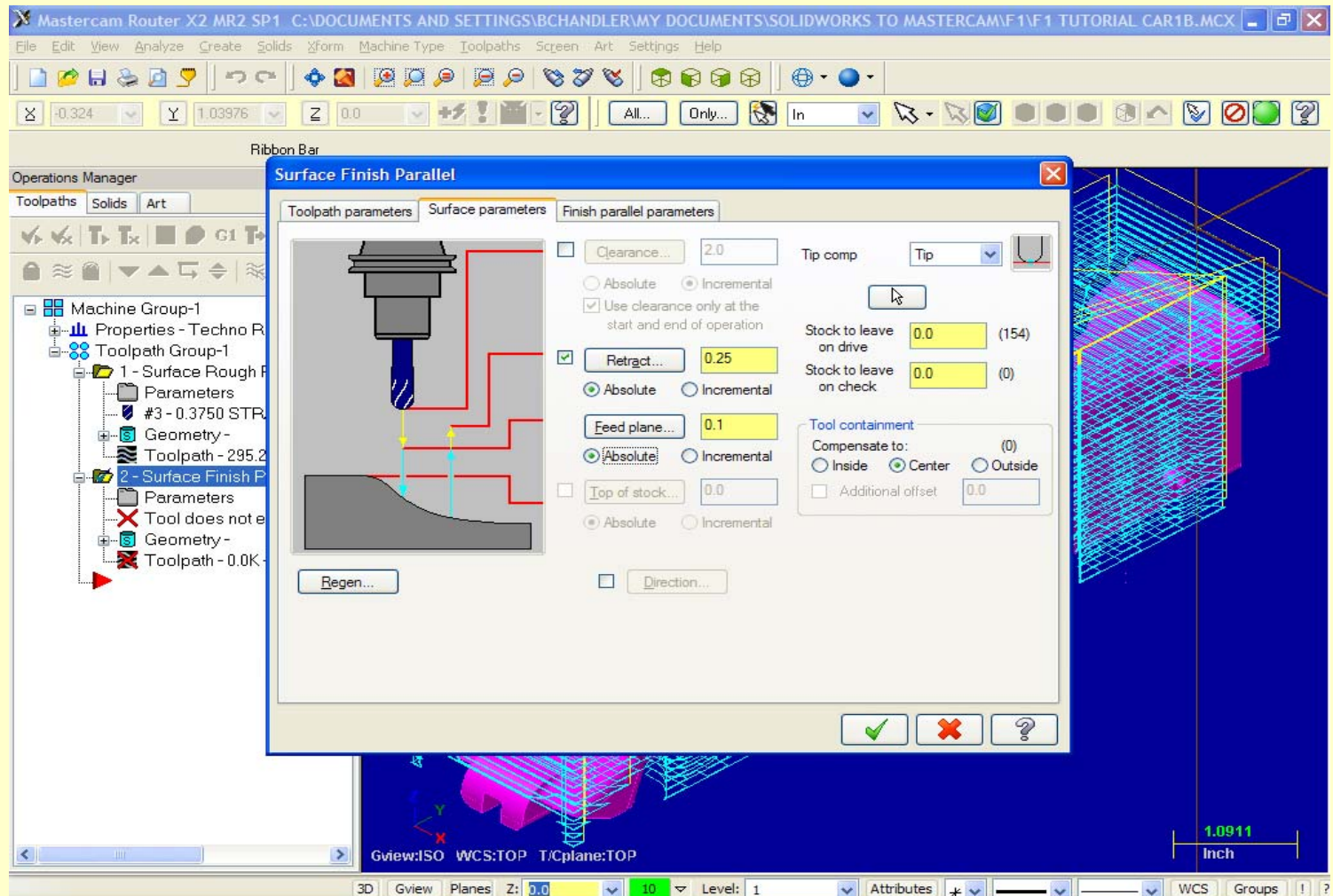
1. Click the green check.



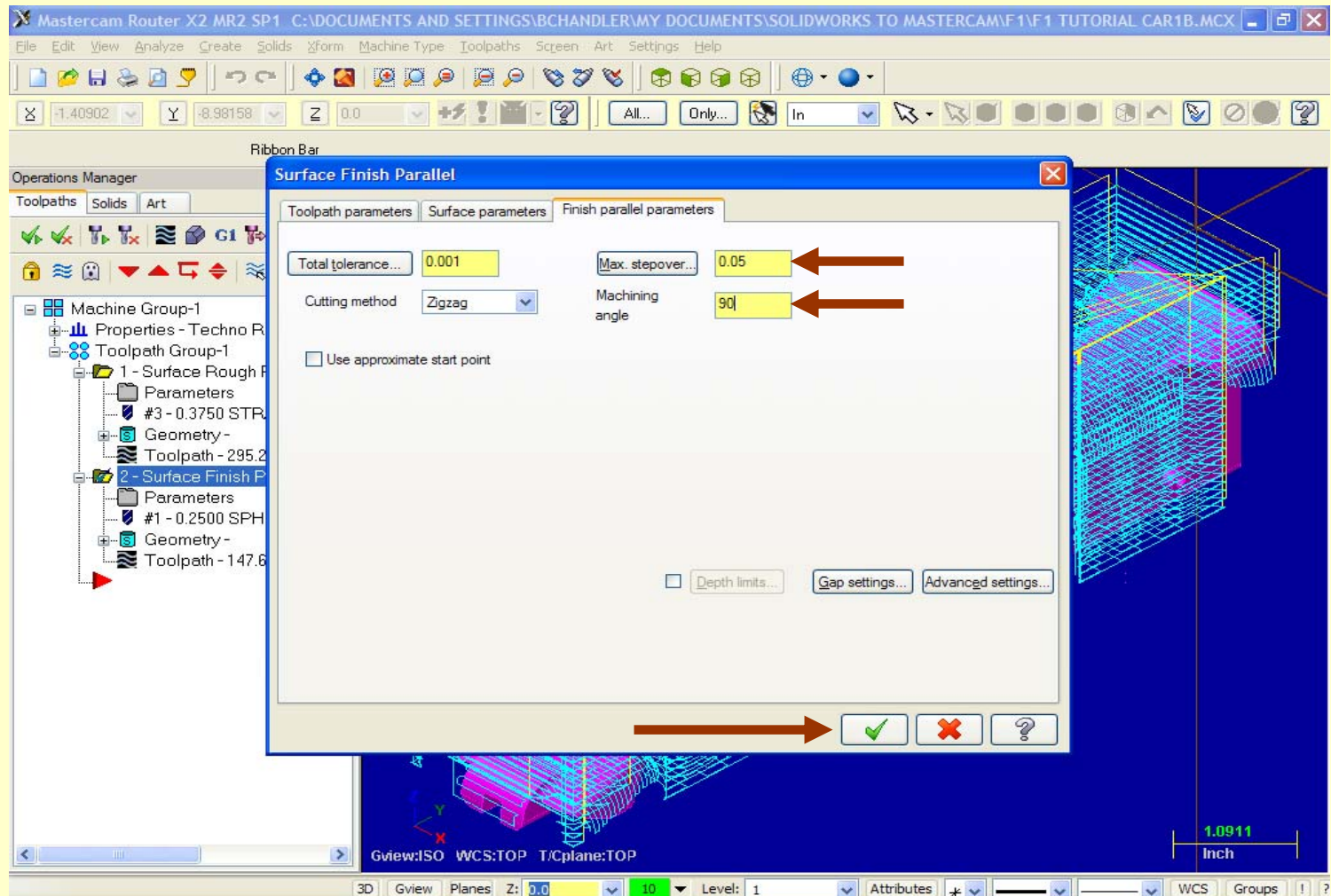
1. Click Select Library Tool, choose the same spherical bit like 1/4".
2. Then click the green check.



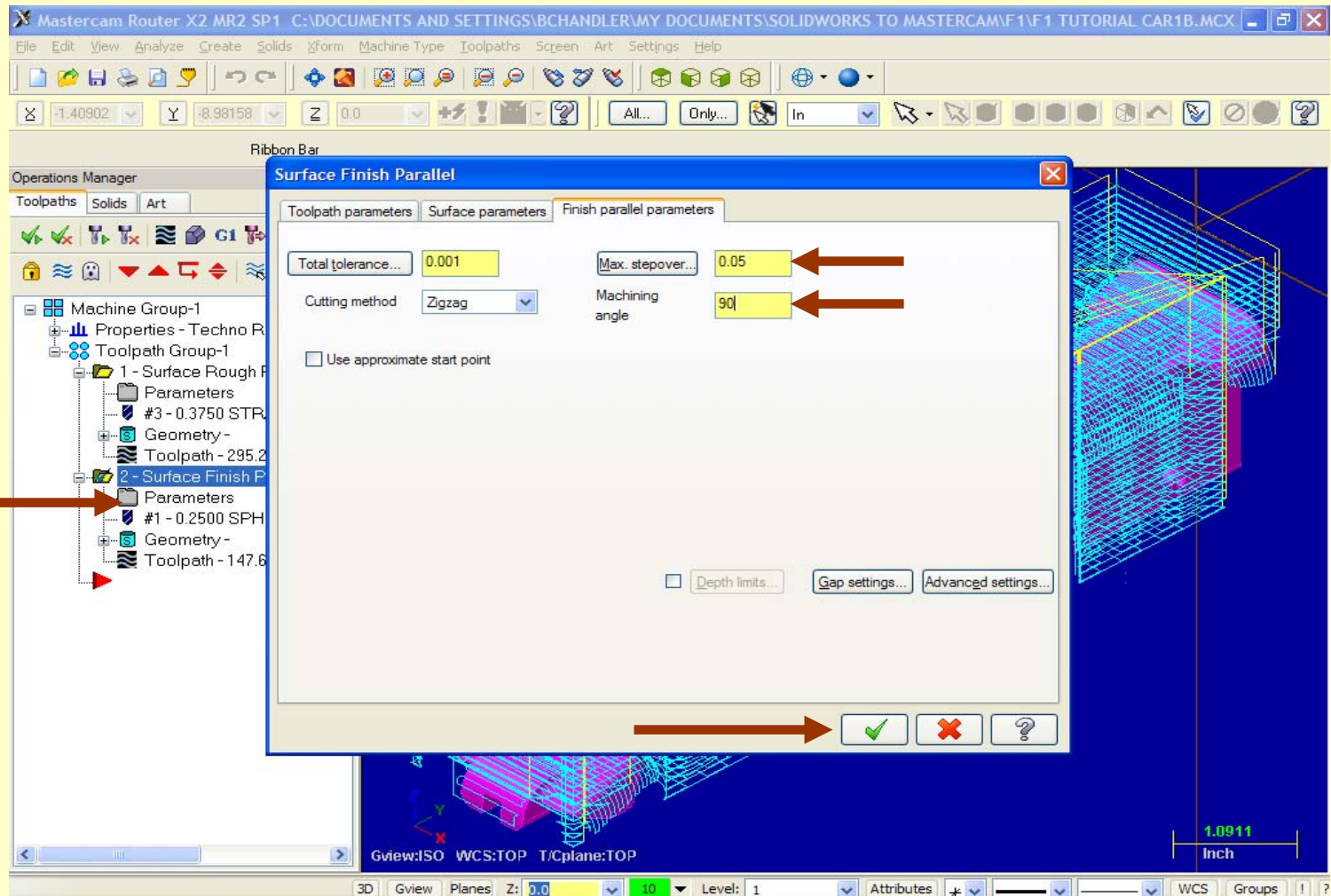
1. Click on the next tab, Surface Parameters
2. Check Absolute for Retract and Feed
3. Click the next tab, Finish Parallel



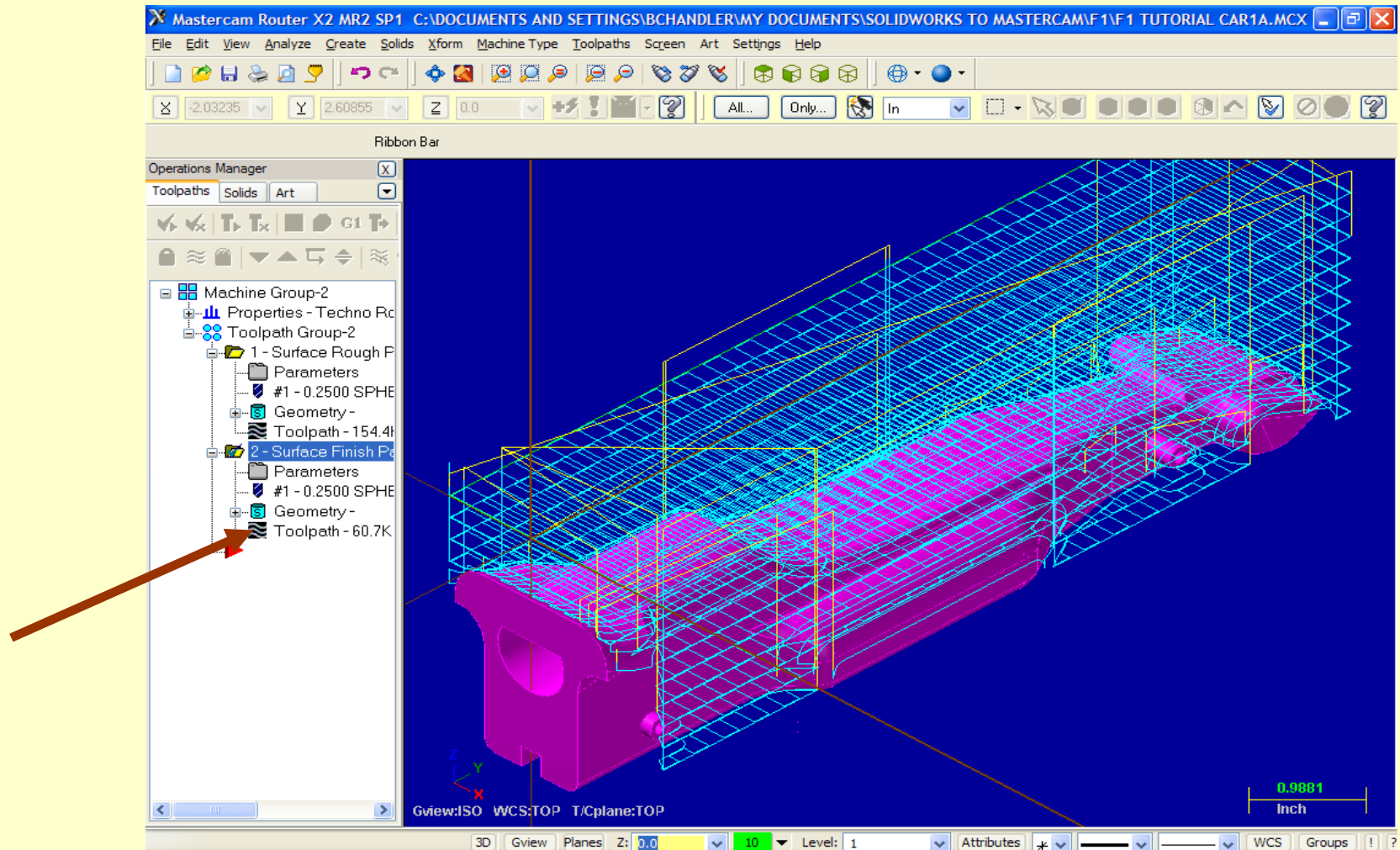
1. Type .05 for Max Stepover and 90 for Machining Angle.
2. Click the green check mark.



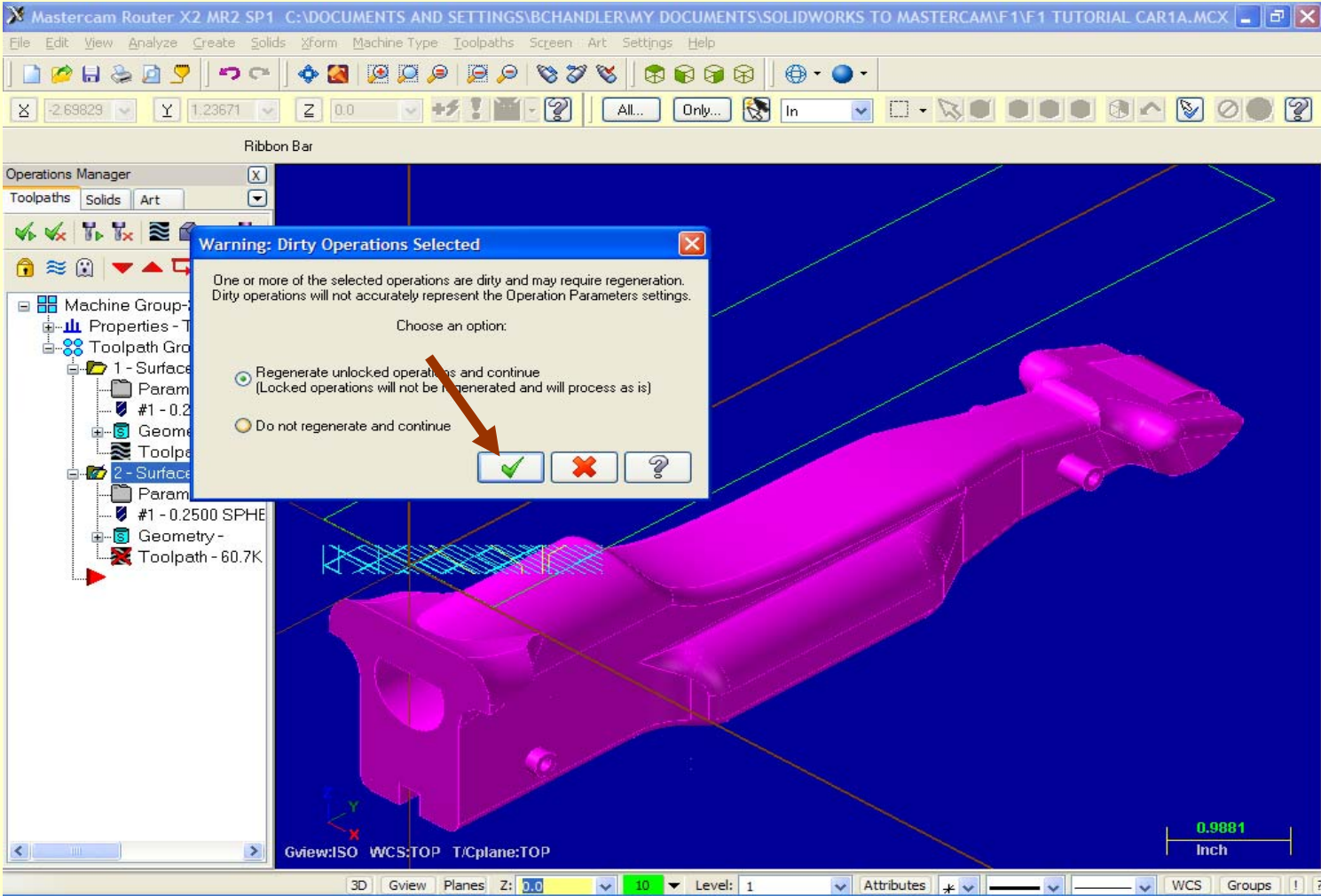
1. You may change any parameters later by clicking the parameters folder.
2. You may later want to set the stepover to a larger or smaller number which effects the finish quality of the surface but also effects the amount of time to machine.



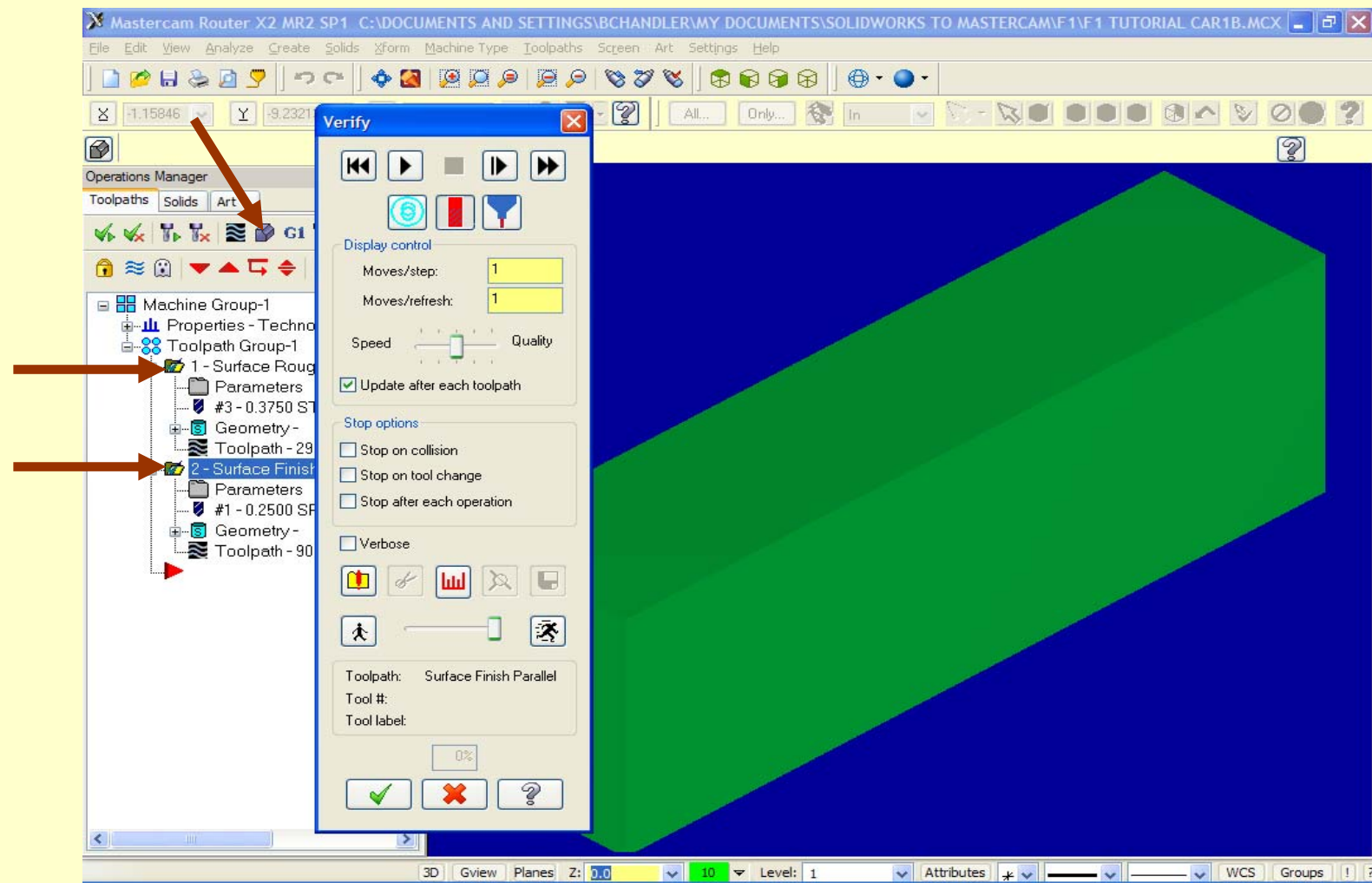
1. If you do make a change, a red X appears through the toolpath icon.
2. Simply click on it.



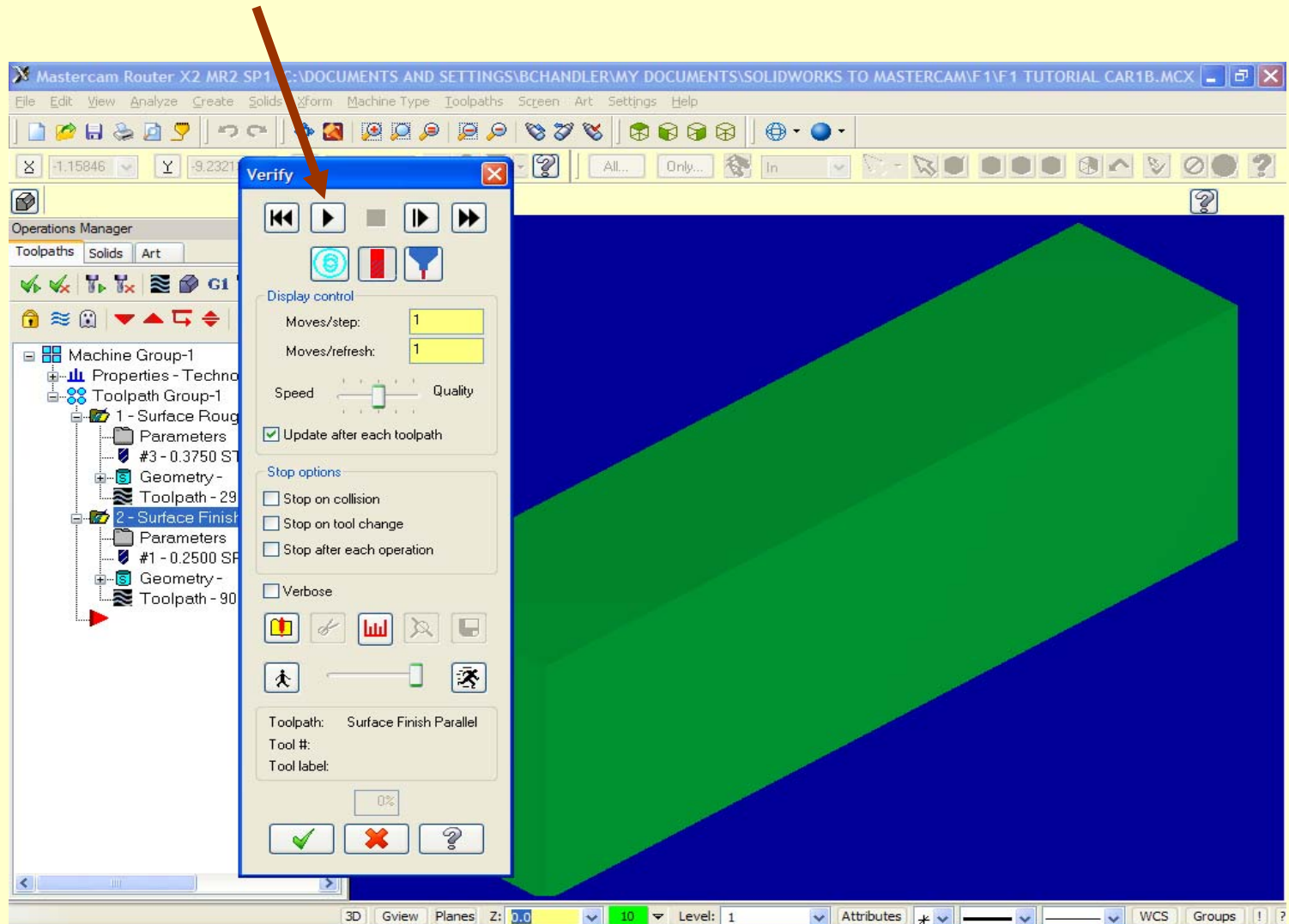
1. Click the green check in the prompt to regenerate the toolpath with the new settings.



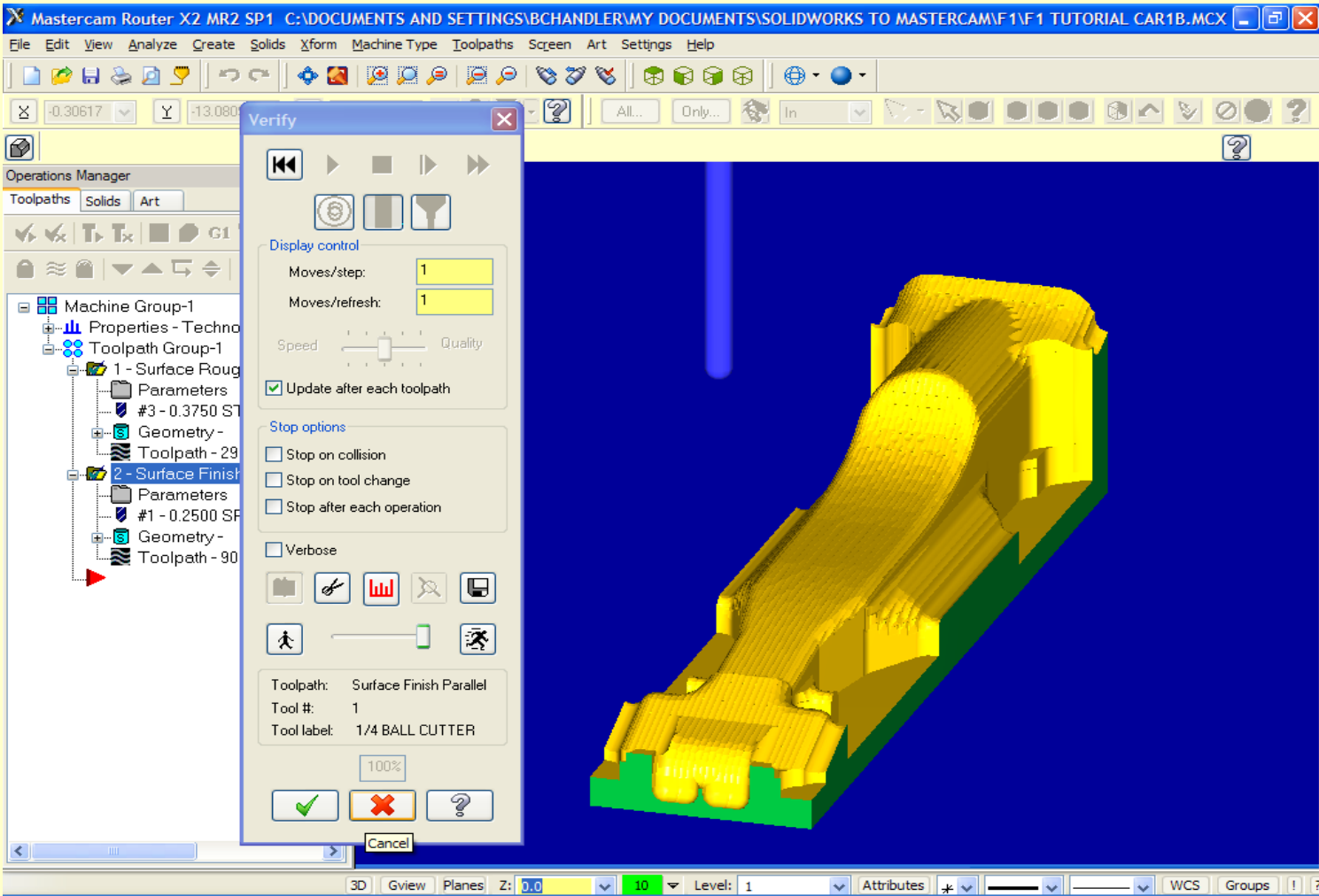
1. Hold the ctrl key and select both of the toolpath operations.
2. Then click on the Verify button, a chamfered block icon.



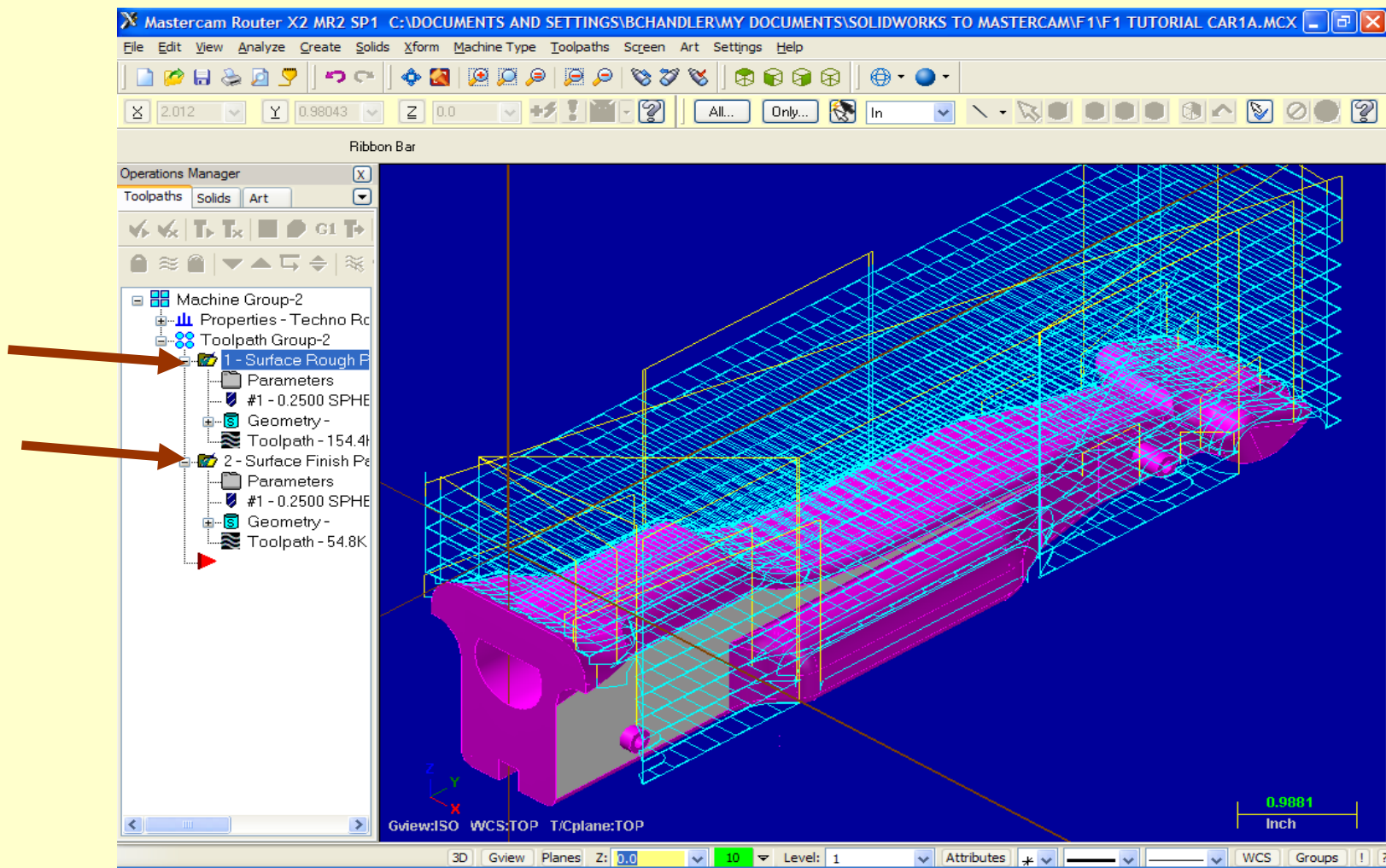
1. Click on the Play button to view an animated simulation of the CNC machining.



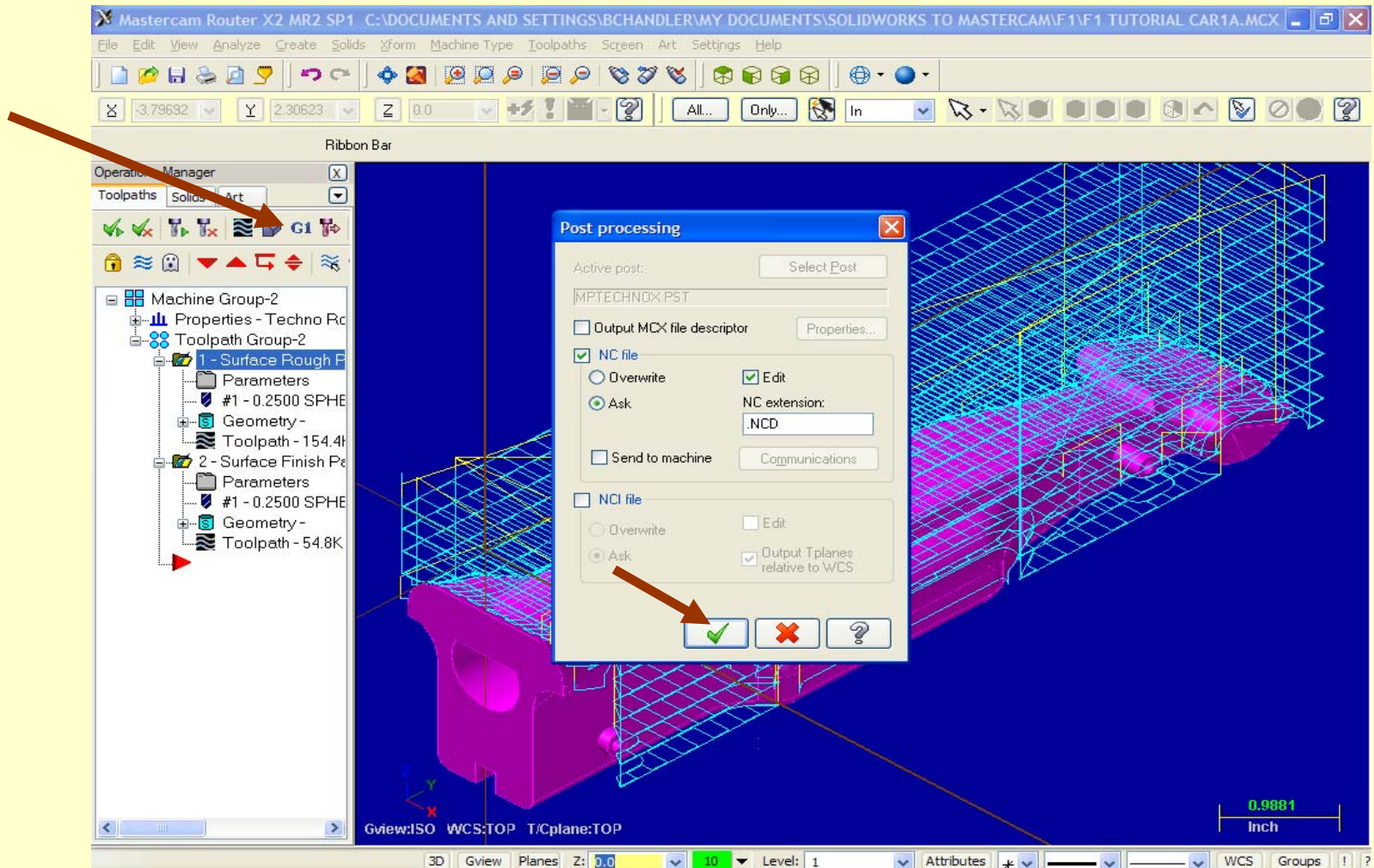
1. If the surfaces are too rough, you can always go back into the parameters and change stepover or stepdown to get a smoother finish.



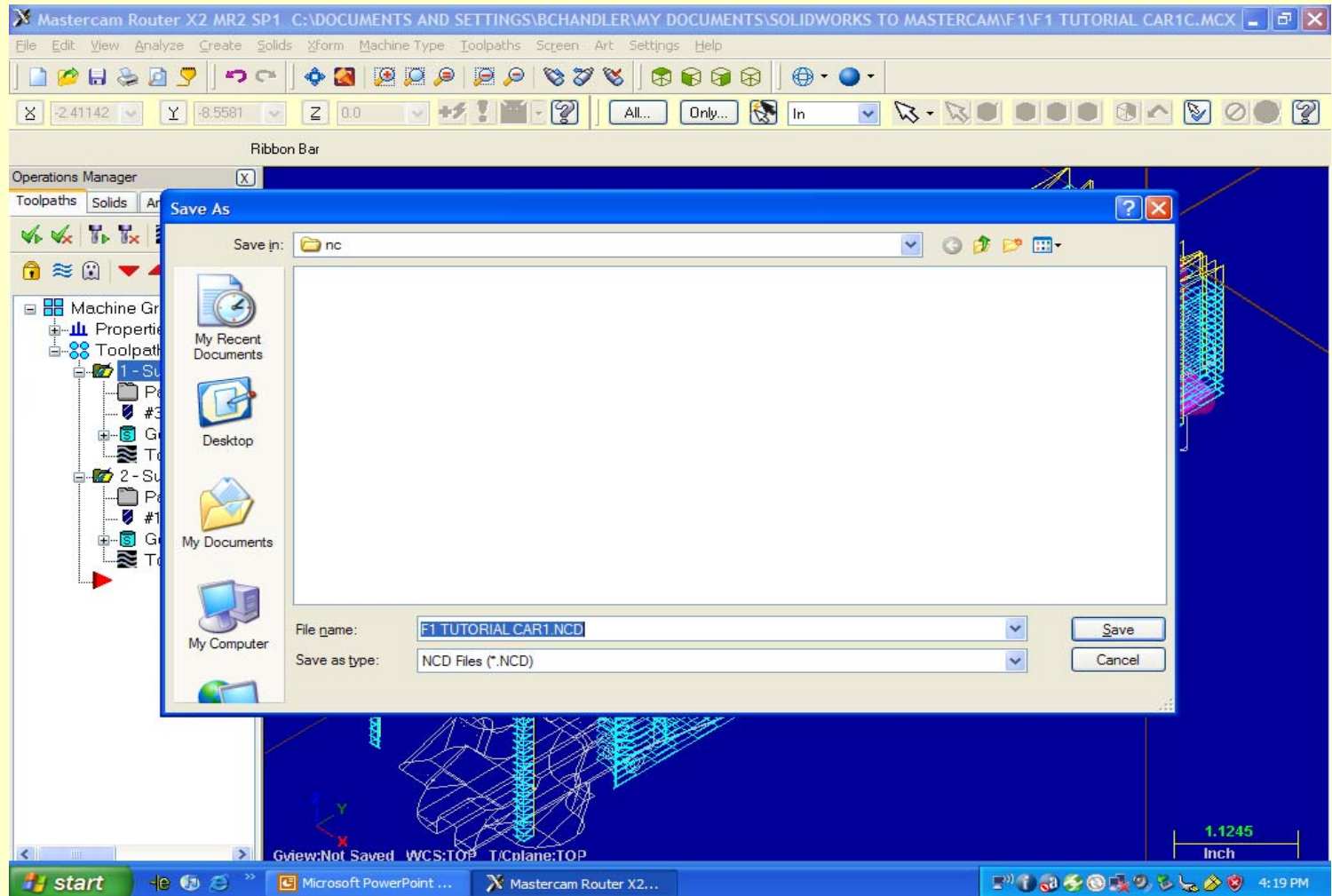
1. Hold shift or Ctrl to be sure that both toolpath folders have a check mark.



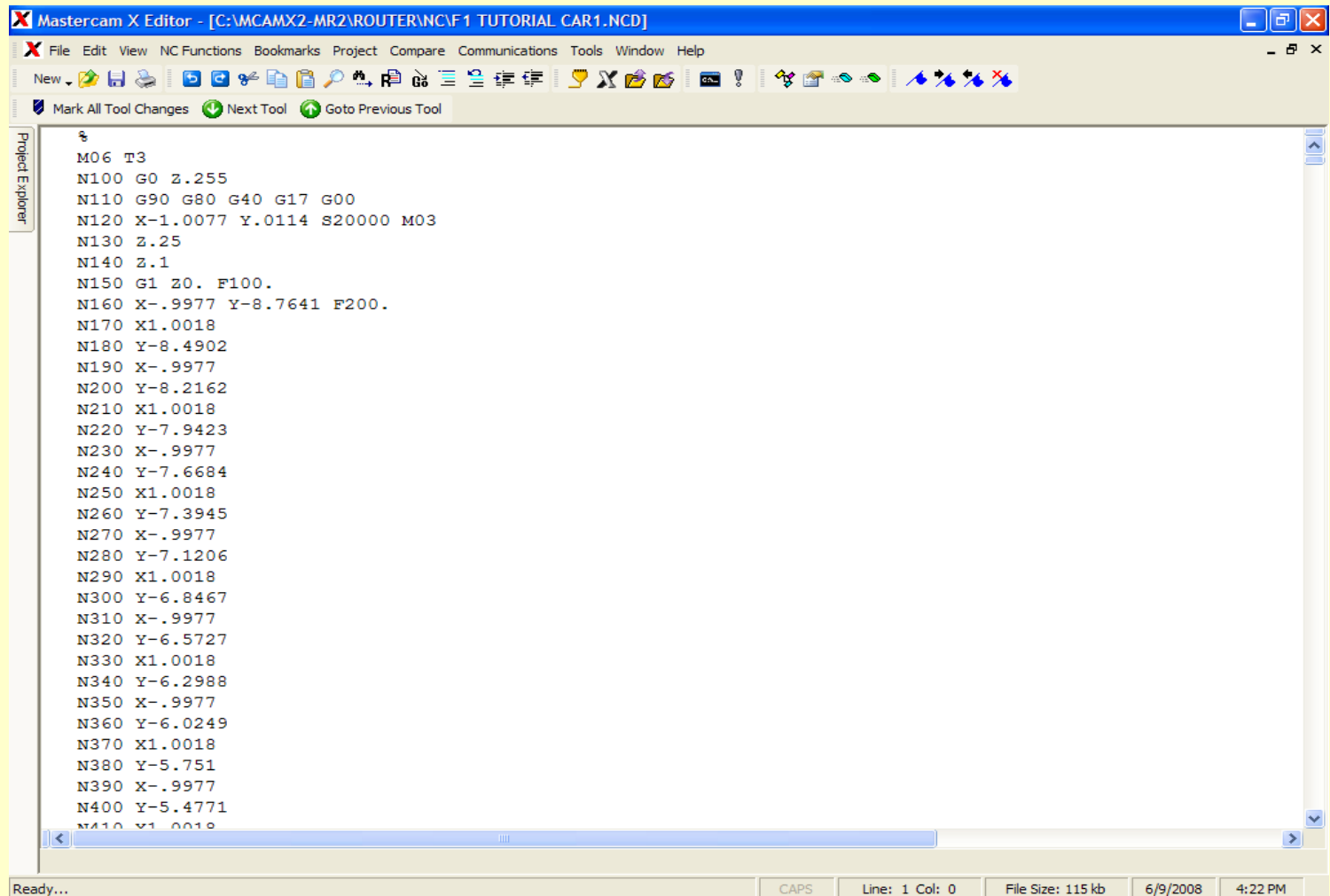
1. Click on G1 button to post the NC file for you router interface.
2. Click the green check when this post processing window pops up...all defaults are correct.



1. Specify a location for the file and name it as the Top of your car.



1. Once the G-code window pops up you may close it and now save your MCAMX file.
2. Take your top and bottom *.nc files over to the router and get your instructor's help to setup and cut your own F1 Car.

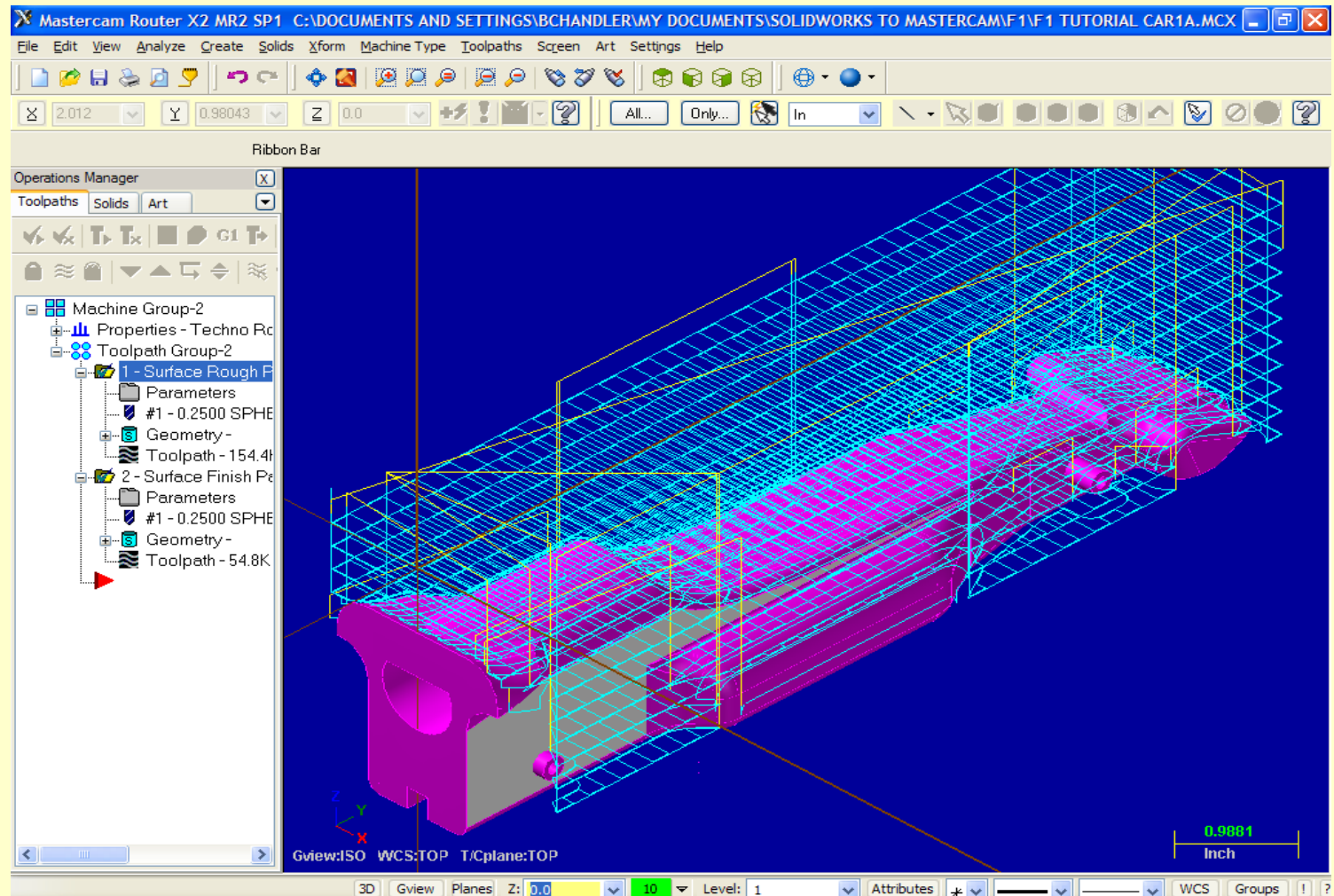


The screenshot shows the Mastercam X Editor interface. The title bar reads "Mastercam X Editor - [C:\MCAMX2-MR2\ROUTER\NC\F1 TUTORIAL CAR1.NCD]". The menu bar includes File, Edit, View, NC Functions, Bookmarks, Project, Compare, Communications, Tools, Window, and Help. The toolbar contains various icons for file operations, editing, and tool management. The main window displays a G-code program with the following lines:

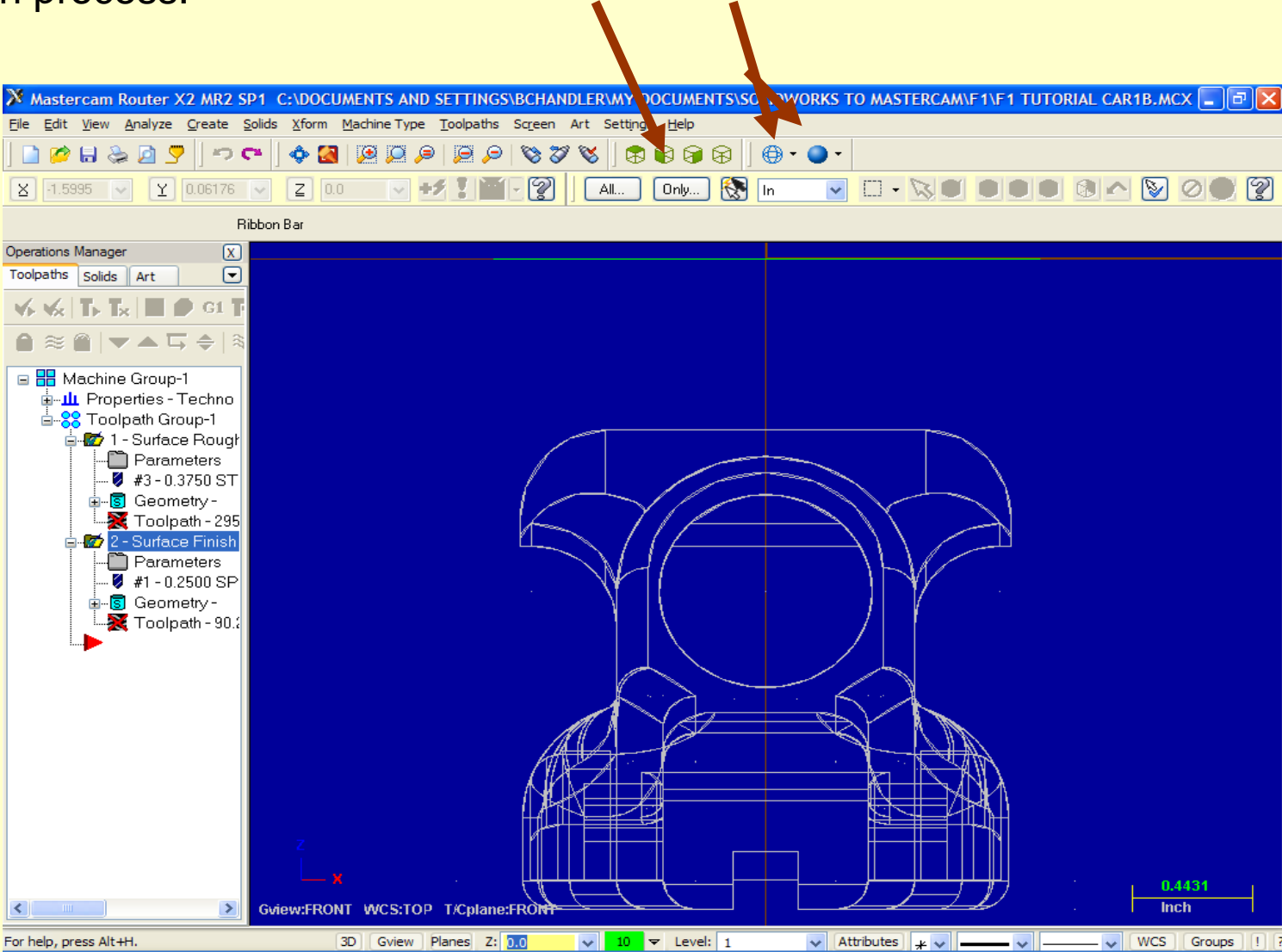
```
M06 T3
N100 G0 Z.255
N110 G90 G80 G40 G17 G00
N120 X-1.0077 Y.0114 S20000 M03
N130 Z.25
N140 Z.1
N150 G1 Z0. F100.
N160 X-.9977 Y-8.7641 F200.
N170 X1.0018
N180 Y-8.4902
N190 X-.9977
N200 Y-8.2162
N210 X1.0018
N220 Y-7.9423
N230 X-.9977
N240 Y-7.6684
N250 X1.0018
N260 Y-7.3945
N270 X-.9977
N280 Y-7.1206
N290 X1.0018
N300 Y-6.8467
N310 X-.9977
N320 Y-6.5727
N330 X1.0018
N340 Y-6.2988
N350 X-.9977
N360 Y-6.0249
N370 X1.0018
N380 Y-5.751
N390 X-.9977
N400 Y-5.4771
N410 X1.0018
```

The status bar at the bottom shows "Ready...", "CAPS", "Line: 1 Col: 0", "File Size: 115 kb", "6/9/2008", and "4:22 PM".

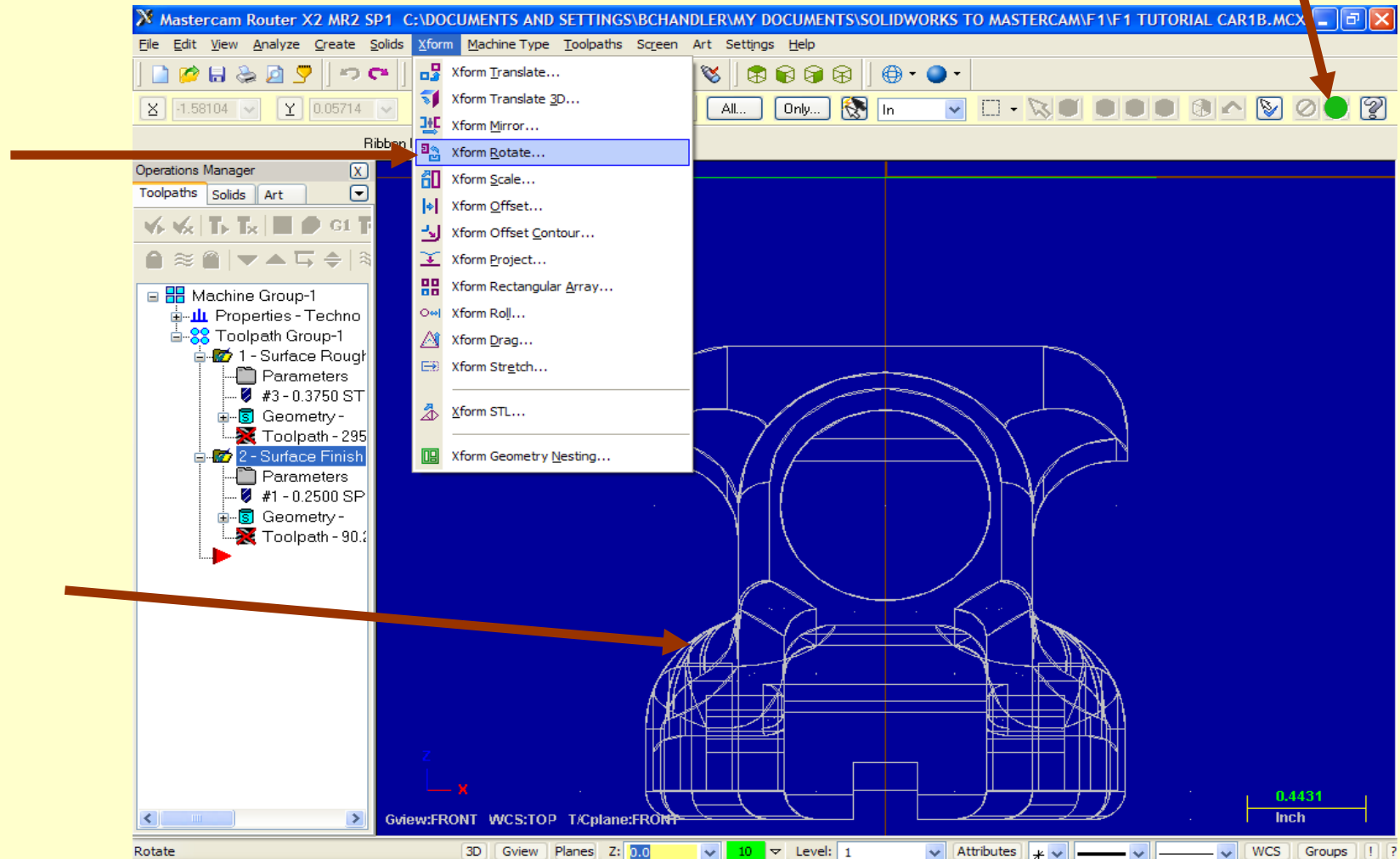
1. This is a good time to also save the MCAM file. So that if you ever need to change parameters you can go back to do so. The gcode file you just saved is only readable through your cnc machine's interface.



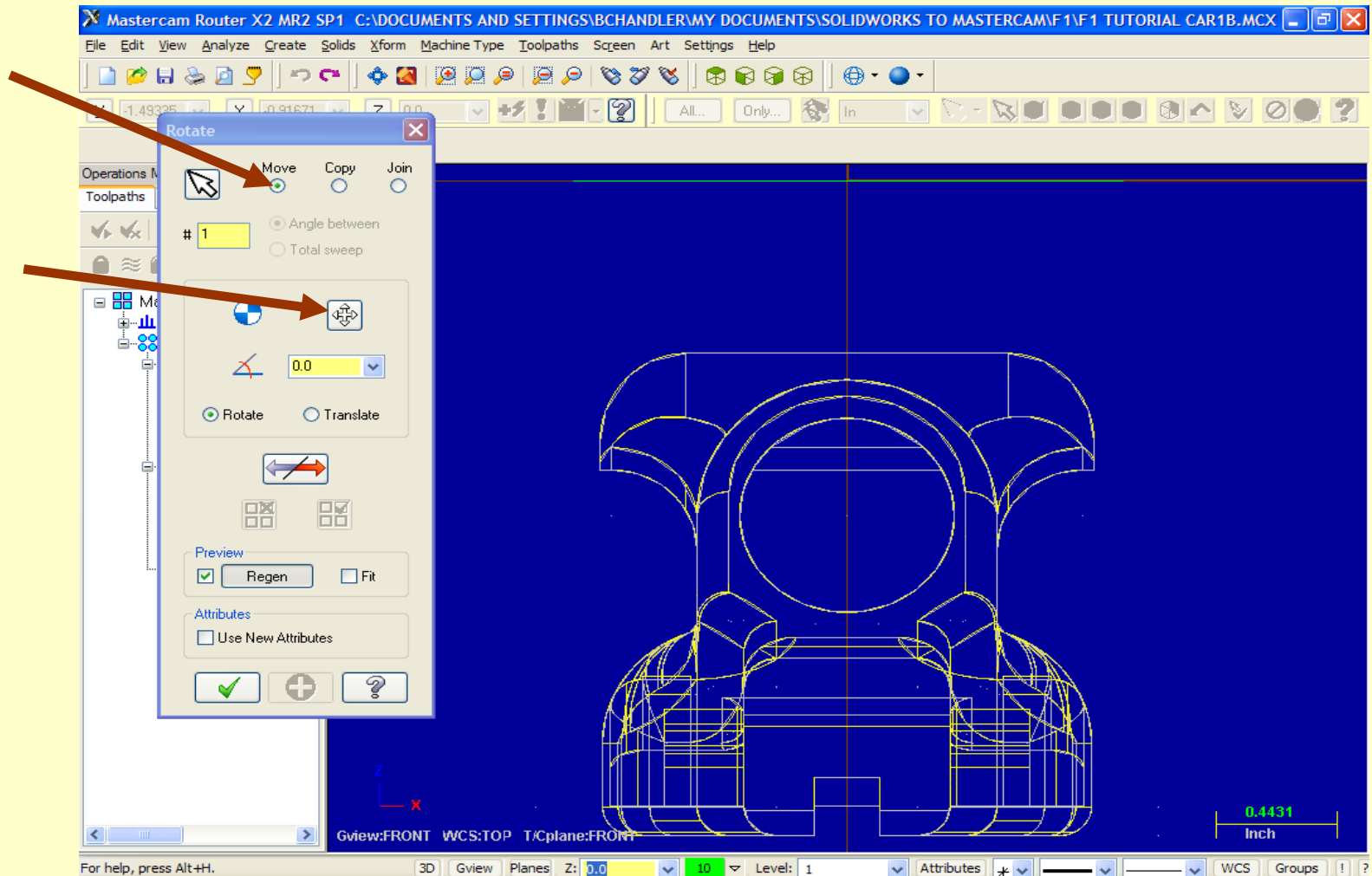
1. Select Front View, and Wireframe. It may be easier to switch back to shaded view during the rotation process.



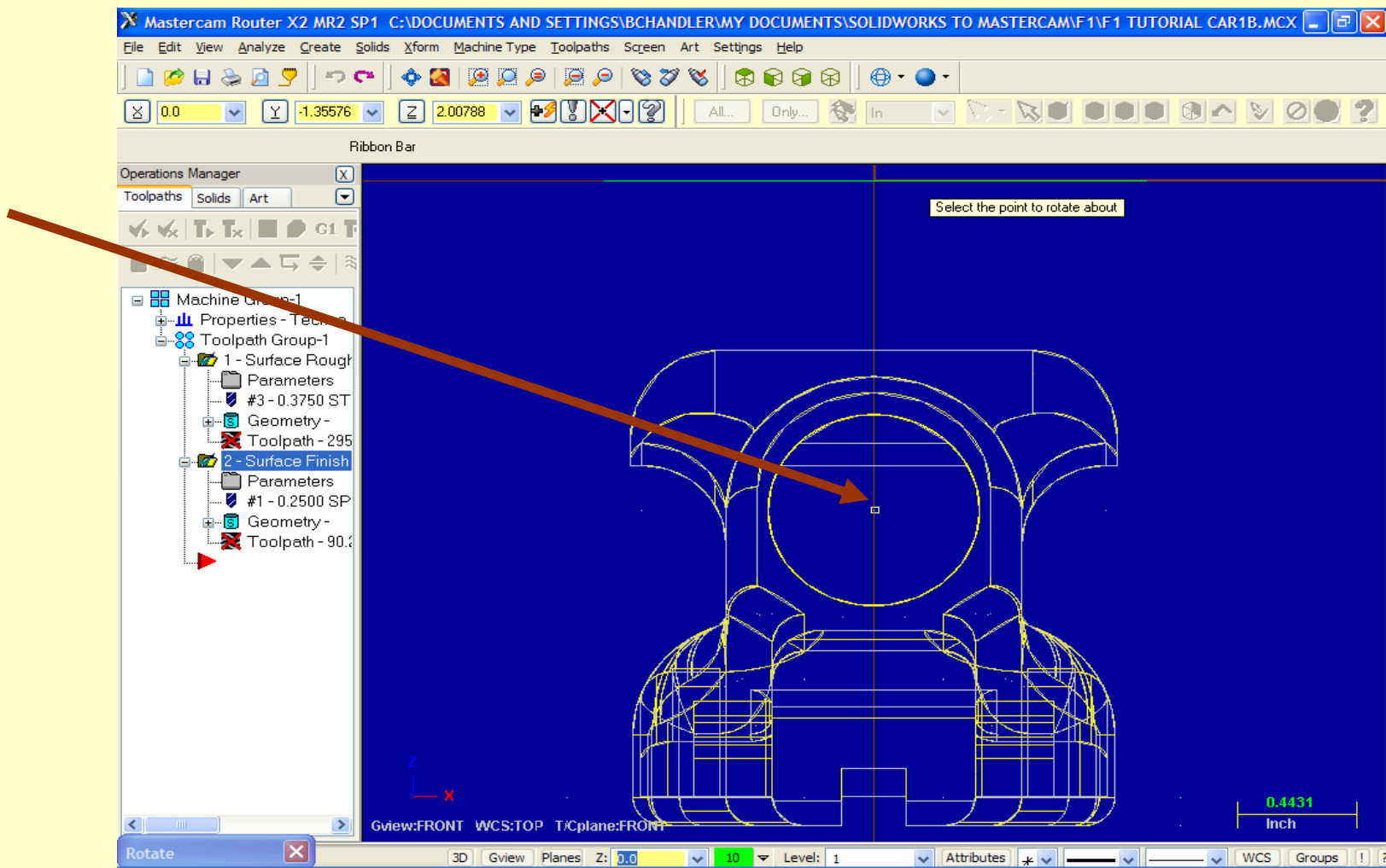
1. Select Xform > Rotate from the dropdown menu.
2. Then click on the car body so it highlights yellow. (Check this with shaded view)
3. Then click the green go button.



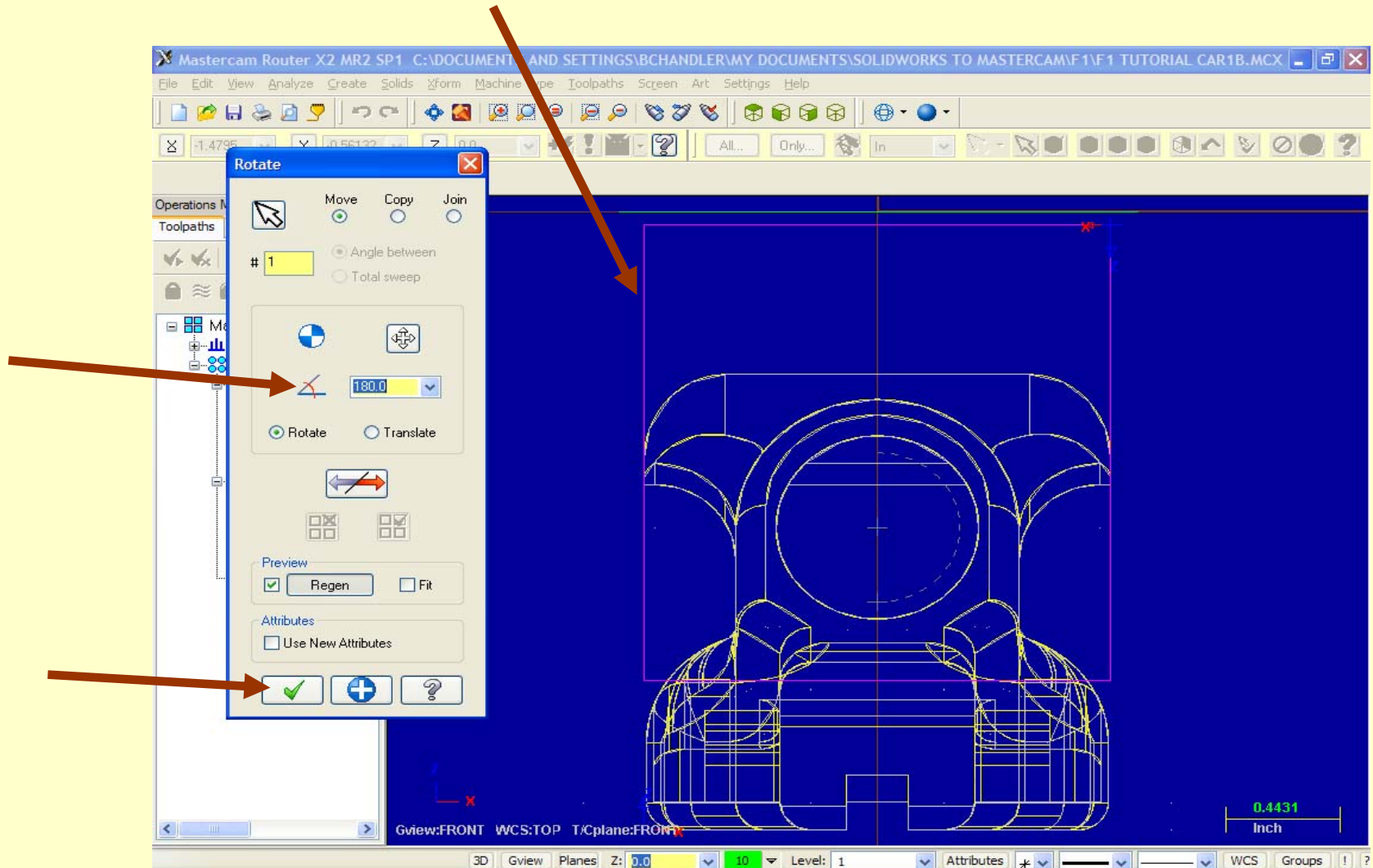
1. Select Move rather than copy.
2. Click on the crossed arrows to define a center of rotation.



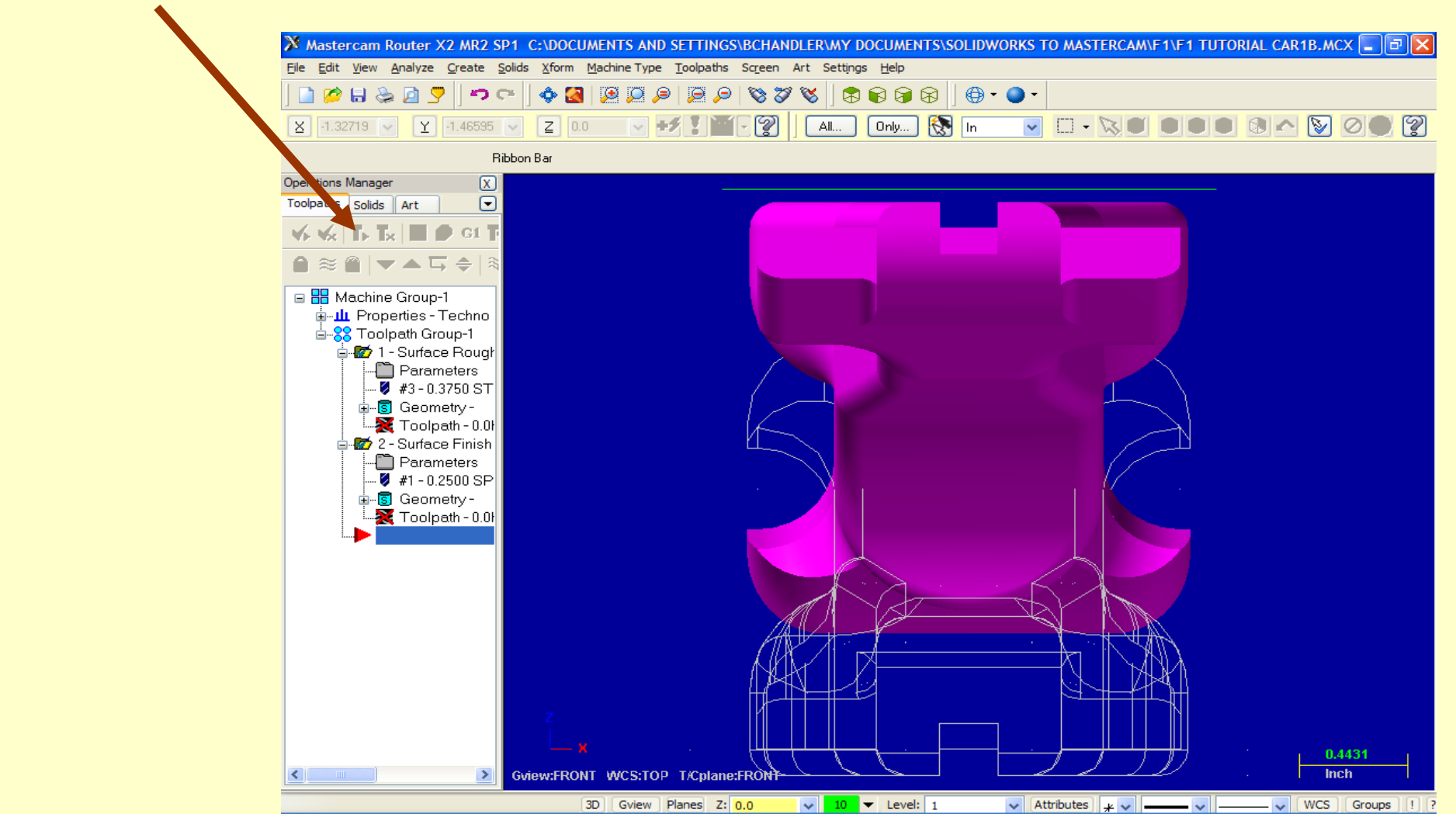
1. Mouse over the center of the hole, until the cursor snaps on center and then click.



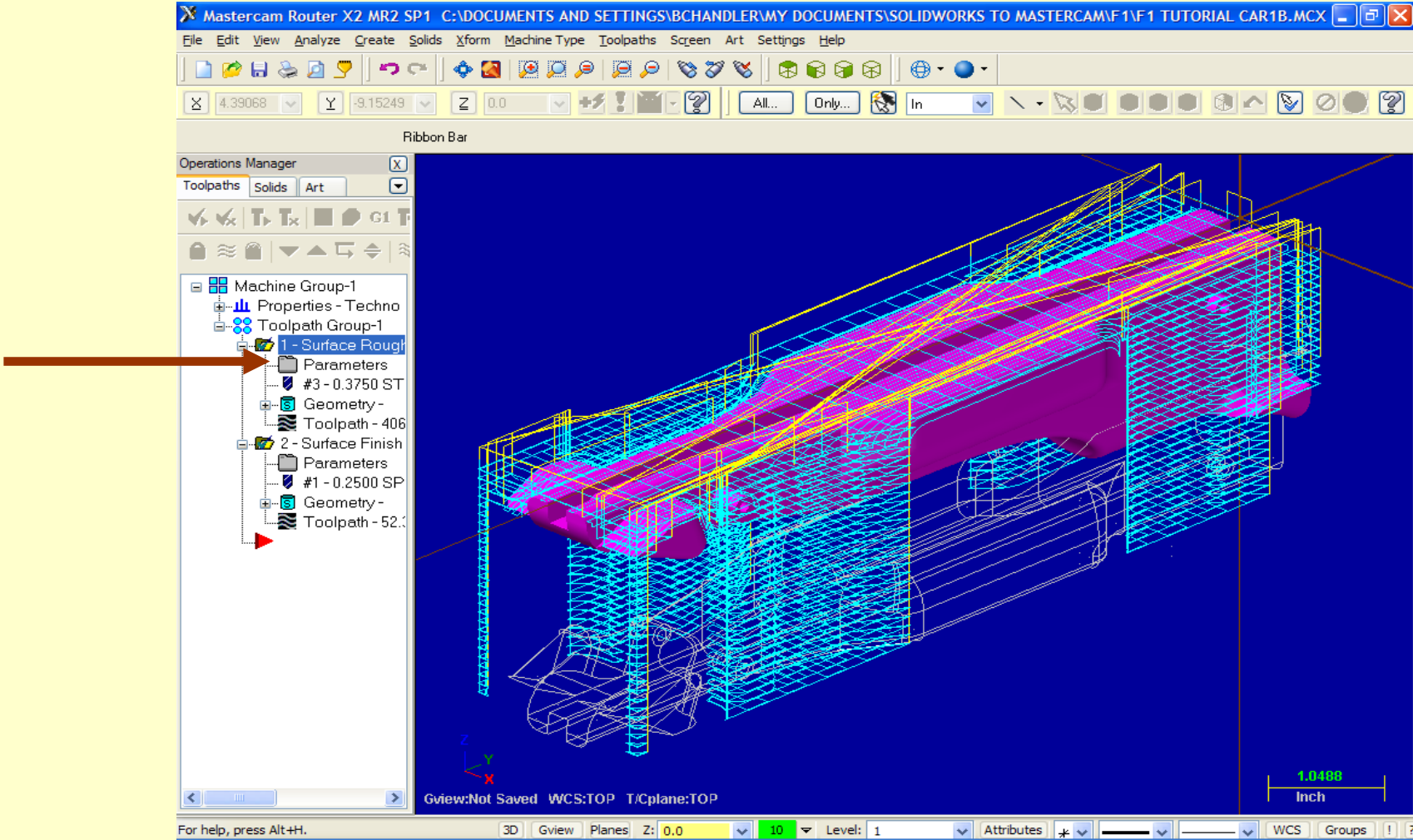
1. Now type in 180 and a purple preview box will appear.
2. Click the green check mark.



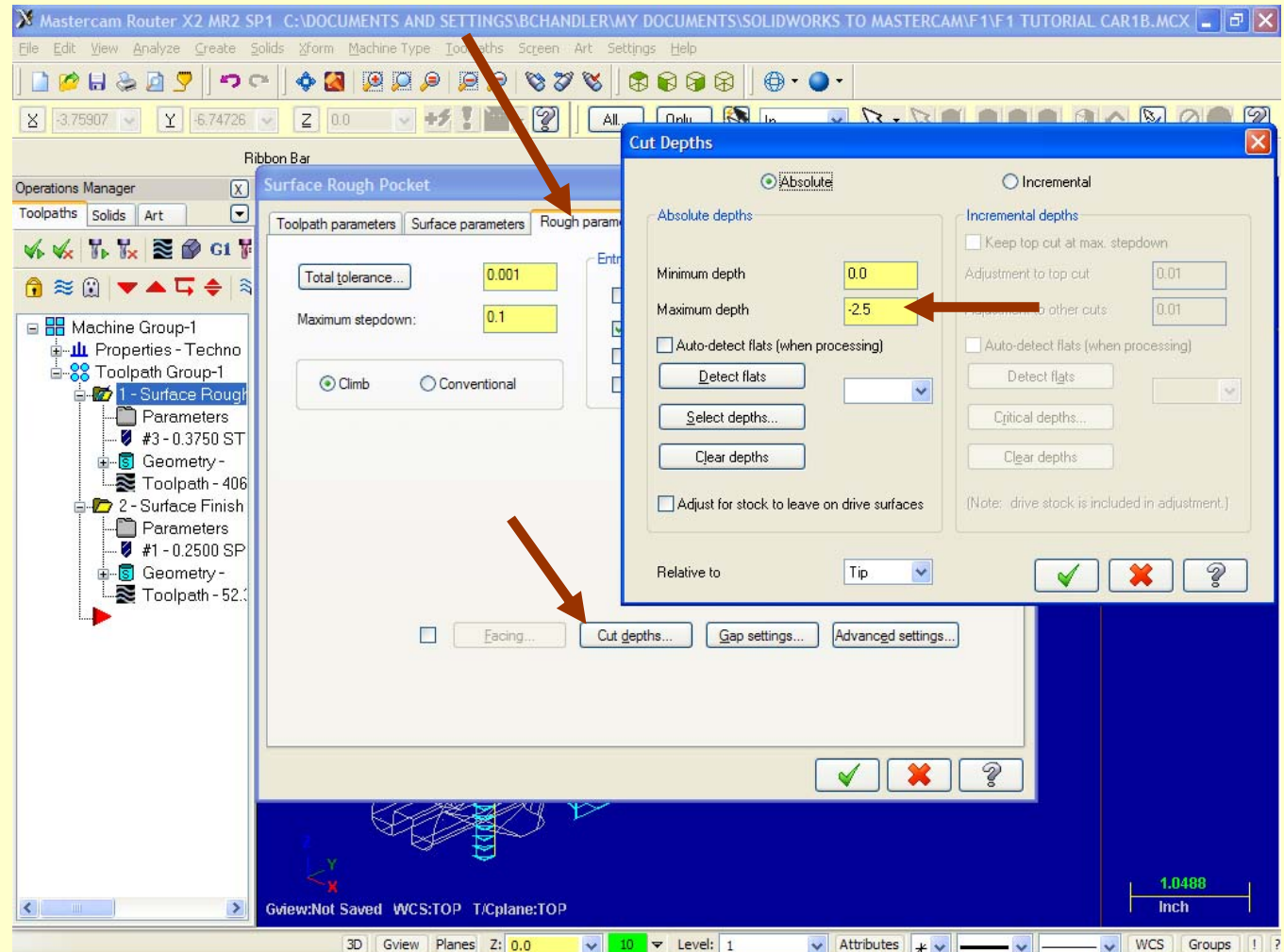
1. Now be sure both toolpath operation folders have green checks, then click on Regenerate all selected operations.



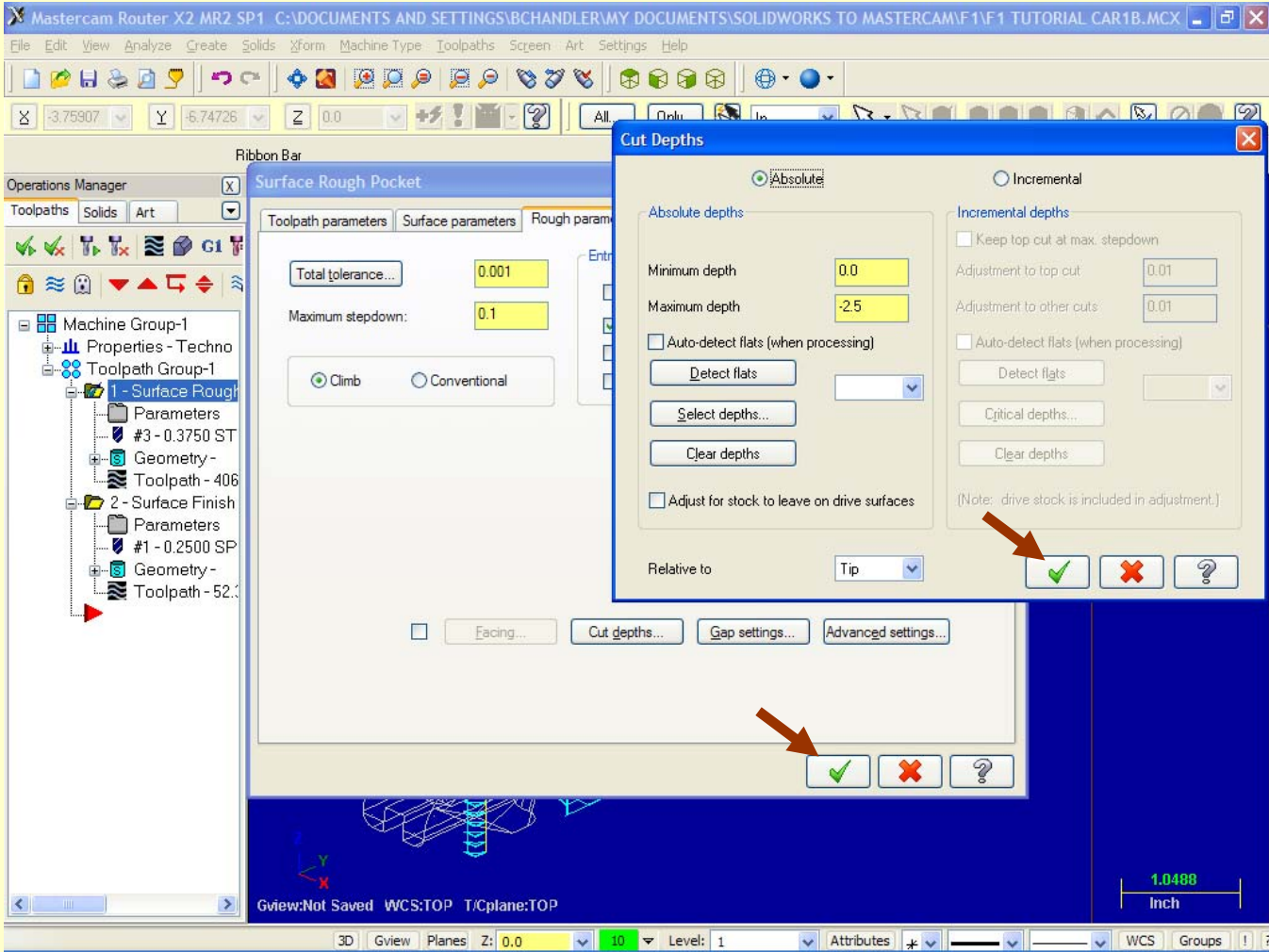
1. Select the Surface Rough, Parameters folder



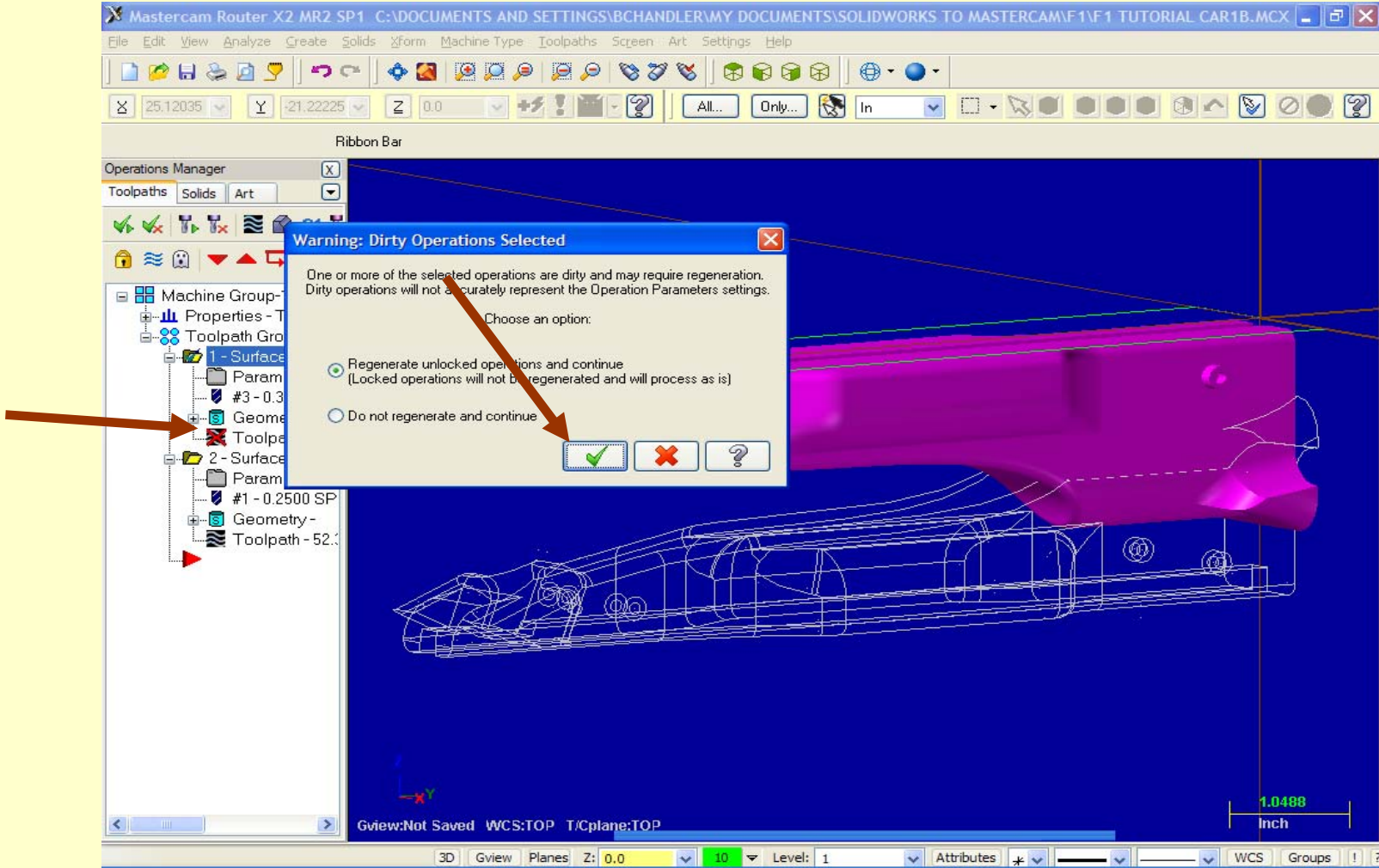
1. Select the Rough Parameters Tab, then click Cut Depths.
2. Change Max depth to -2.



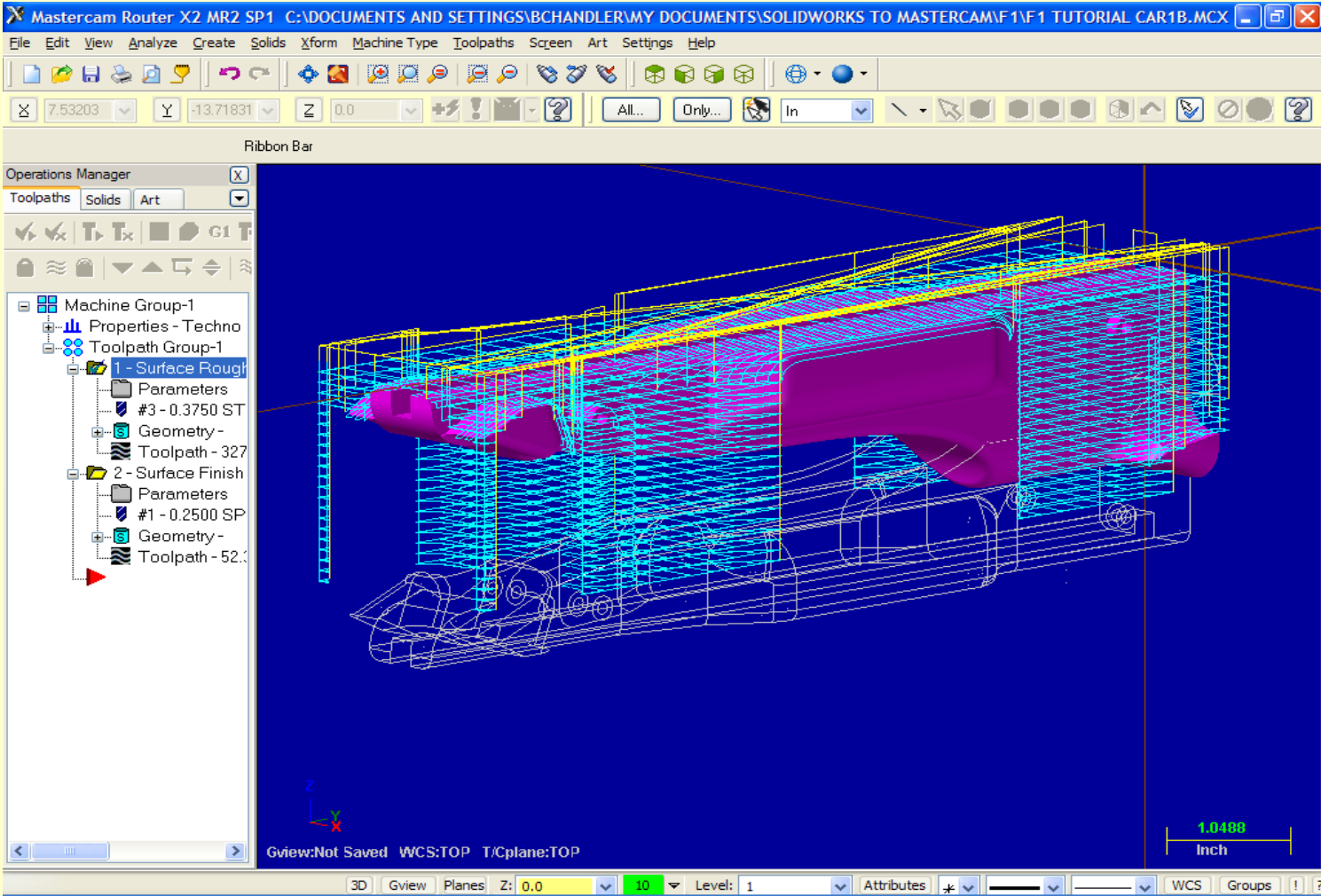
1. Then click both green checks.



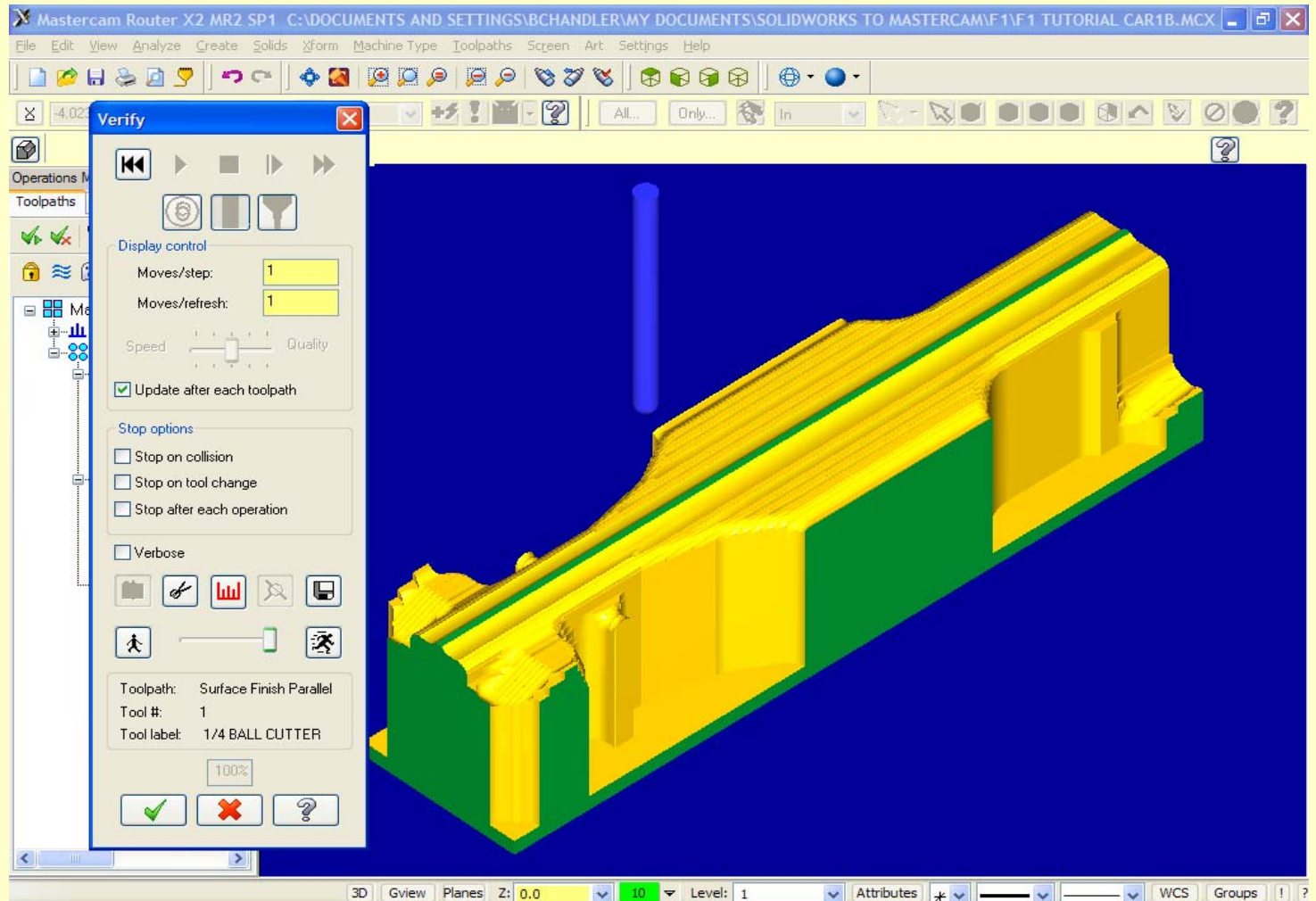
1. Click on red crossed Toolpath, then the green check to regenerate.



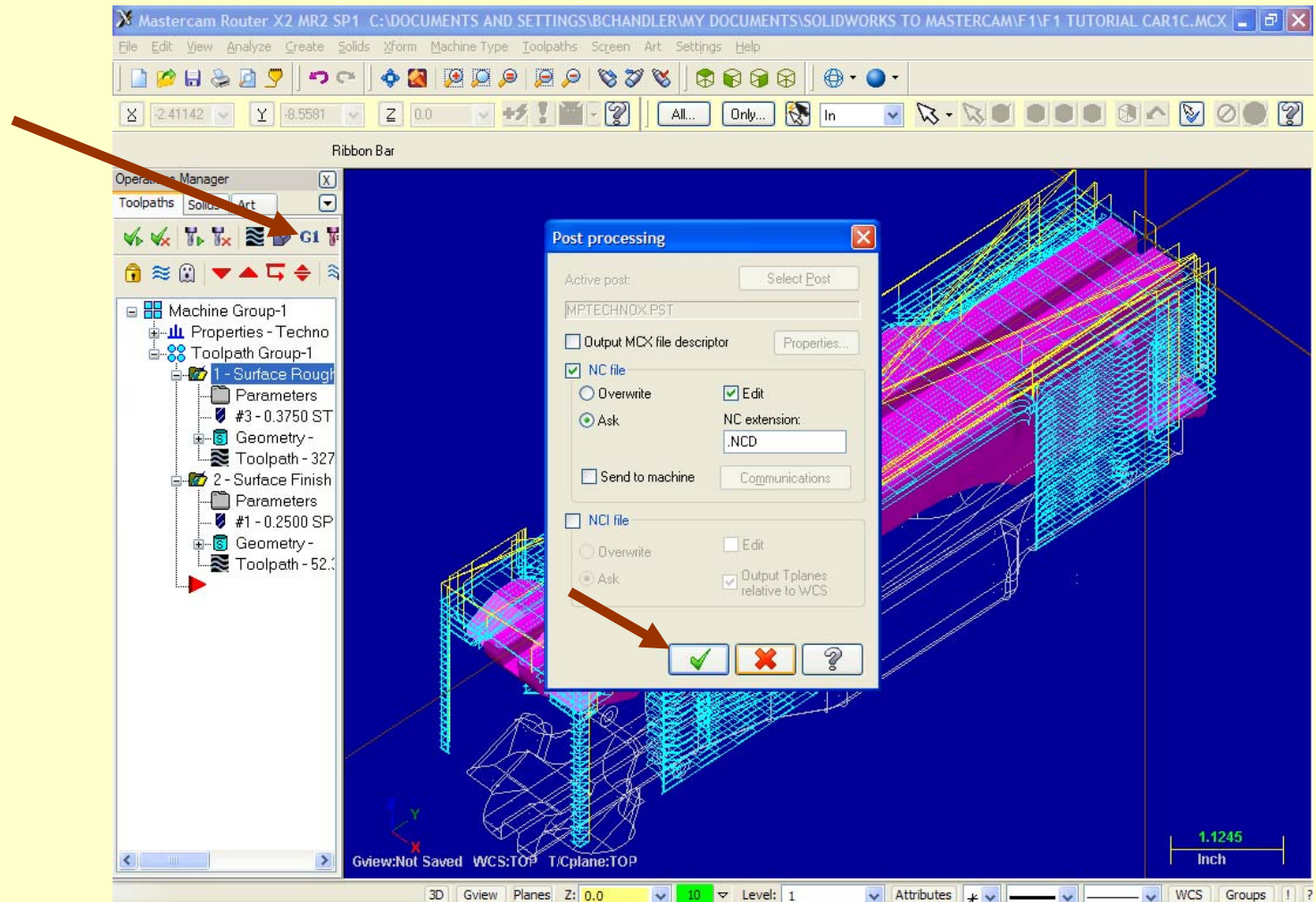
1. Click the Verify icon again to check the simulation.



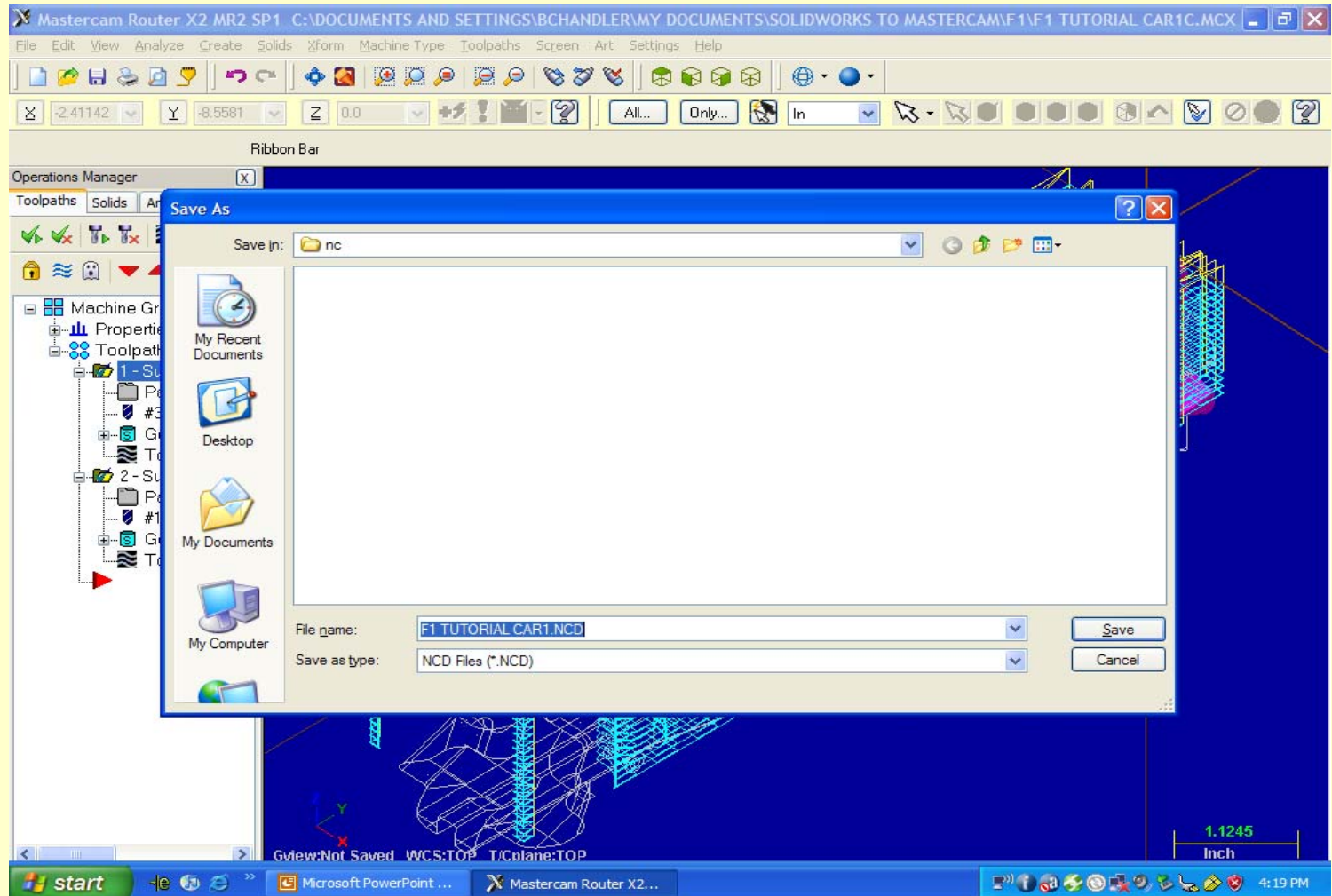
1. Click on Features



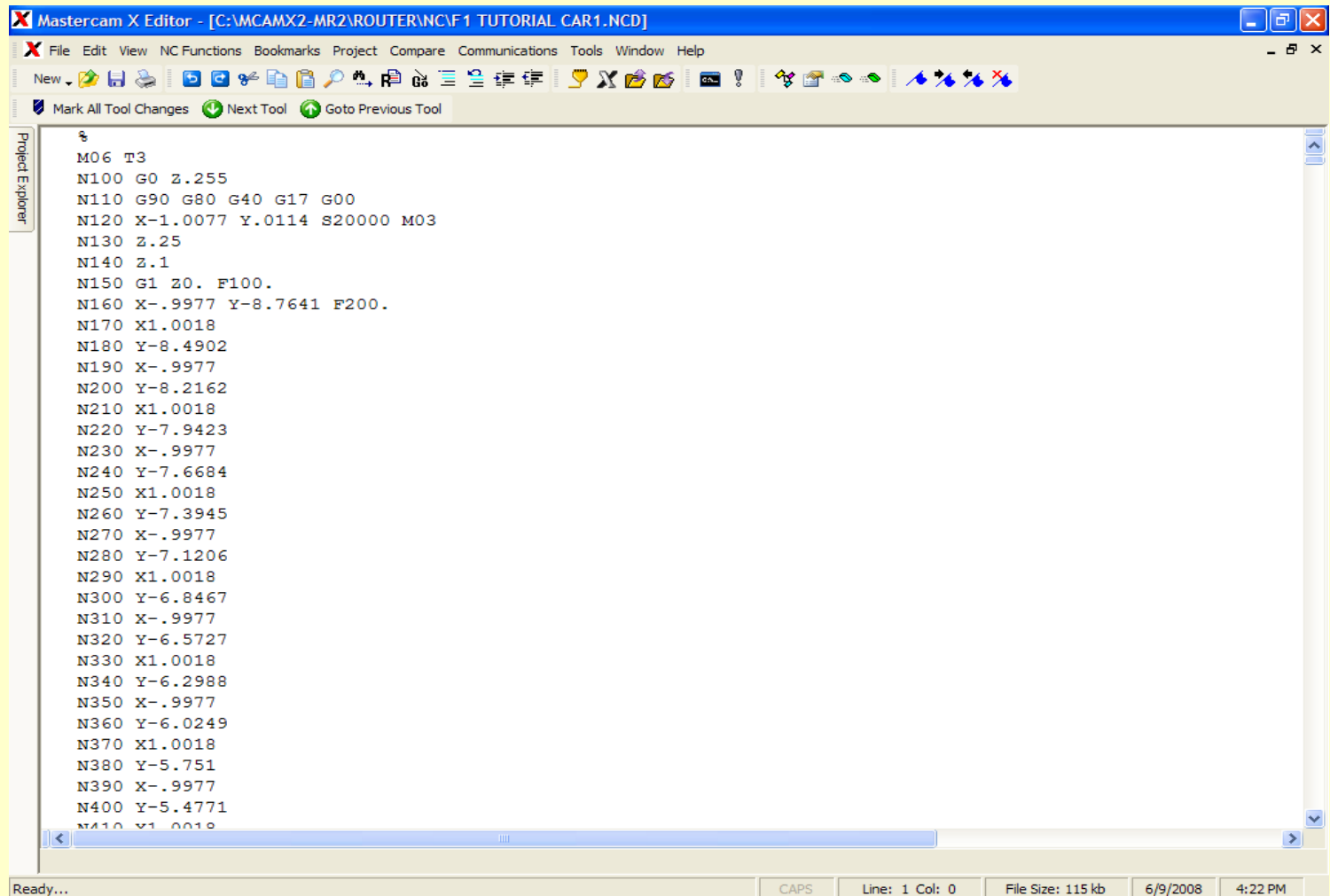
1. Click on G1 button to post the NC file for you router interface.
2. Click the green check when this post processing window pops up...all defaults are correct.



1. Specify a location for the file and name it.



1. Once the G-code window pops up you may close it and now save your MCAMX file.
2. Take your top and bottom *.nc files over to the router and get your instructor's help to setup and cut your own F1 Car.



The screenshot shows the Mastercam X Editor interface. The title bar reads "Mastercam X Editor - [C:\MCAMX2-MR2\ROUTER\NC\F1 TUTORIAL CAR1.NCD]". The menu bar includes File, Edit, View, NC Functions, Bookmarks, Project, Compare, Communications, Tools, Window, and Help. The toolbar contains icons for New, Open, Save, Print, and various editing tools. Below the toolbar are buttons for "Mark All Tool Changes", "Next Tool", and "Goto Previous Tool". The main workspace displays a G-code program with the following lines:

```
M06 T3
N100 G0 Z.255
N110 G90 G80 G40 G17 G00
N120 X-1.0077 Y.0114 S20000 M03
N130 Z.25
N140 Z.1
N150 G1 Z0. F100.
N160 X-.9977 Y-8.7641 F200.
N170 X1.0018
N180 Y-8.4902
N190 X-.9977
N200 Y-8.2162
N210 X1.0018
N220 Y-7.9423
N230 X-.9977
N240 Y-7.6684
N250 X1.0018
N260 Y-7.3945
N270 X-.9977
N280 Y-7.1206
N290 X1.0018
N300 Y-6.8467
N310 X-.9977
N320 Y-6.5727
N330 X1.0018
N340 Y-6.2988
N350 X-.9977
N360 Y-6.0249
N370 X1.0018
N380 Y-5.751
N390 X-.9977
N400 Y-5.4771
N410 X1.0018
```

The status bar at the bottom shows "Ready...", "CAPS", "Line: 1 Col: 0", "File Size: 115 kb", "6/9/2008", and "4:22 PM".