Nucleo™

Fixture

Critical Dimension and Tolerance Matters

Outline:

This document outlines the considerations that should be made with regard to designing and manufacturing a fixture from sheet metal blanks.

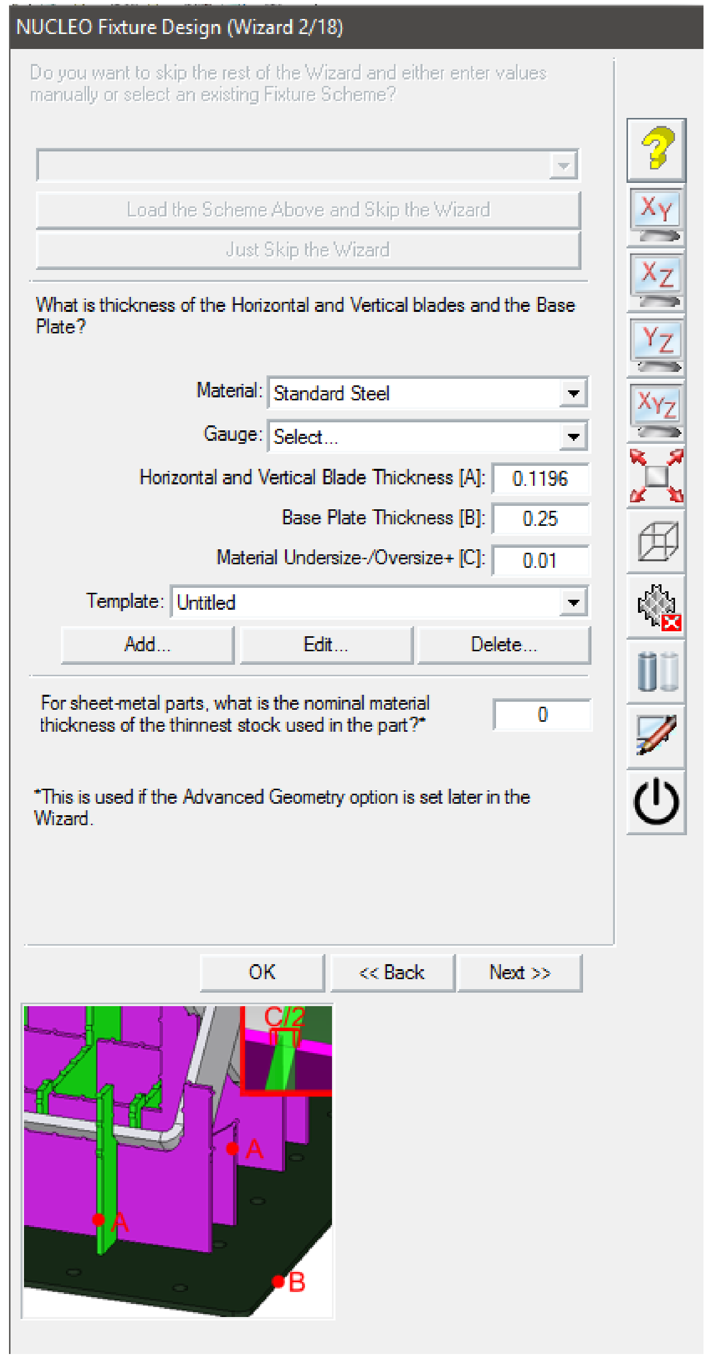
Contents:

Camtek software

Dimension and Tolerance Considerations

Material Thickness:

This is one critical step in ensuring the fixture is neither too tight nor too slack. It is important to state the correct material thickness value for both the blades and the baseplate. We recommend the stock material is measured and put aside for use prior to designing the first one or two fixtures at least, so this variable can be eliminated down-stream.



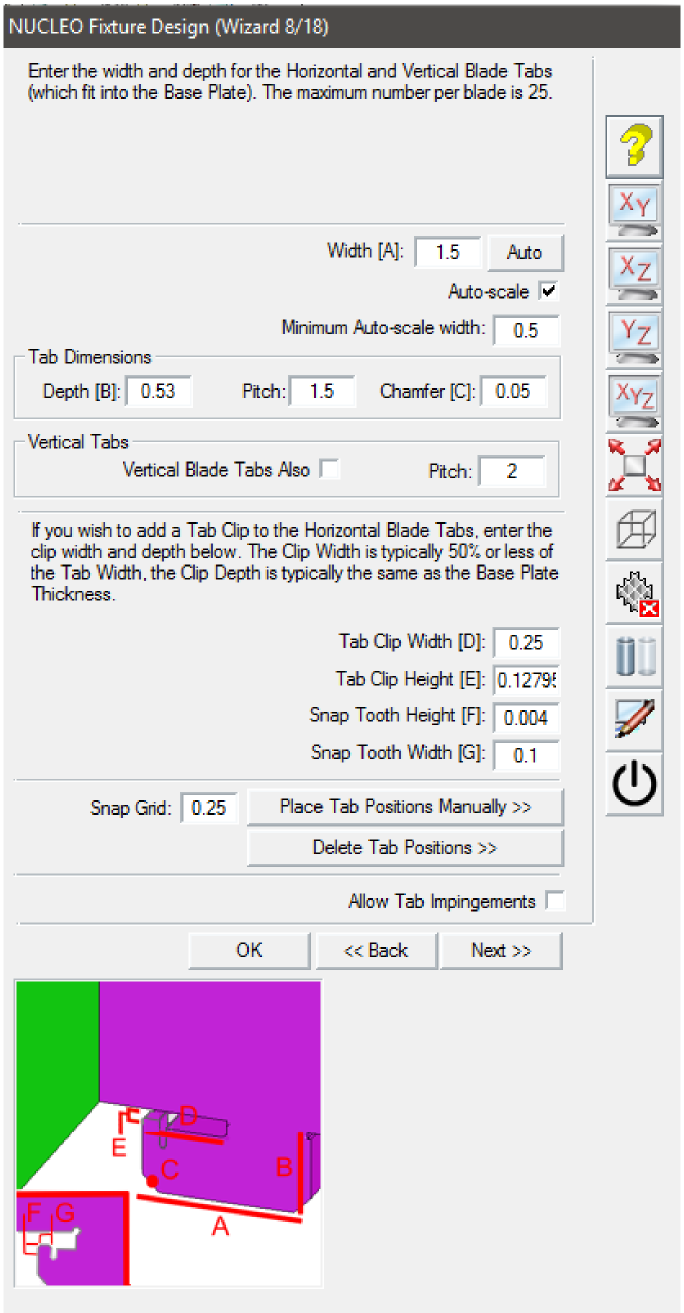
There are three parameters on this page that are important for this:

[A] Horizontal and Vertical Blade Thickness

[B] Base Plate Thickness

[C] Material Undersize/Oversize

Dimension [C] can be used to add in some oversize (typically) between the interlocking slots when the vertical and horizontal blades mate**. If this value is too big or the material from which the blades is cut is not nominally close enough to dimension [A]**, the fixture can end up being too loose/wobbly.



On step 8 in the Design Wizard, the tab-feet dimensions are defined. These need to be accurately entered.

The critical dimensions here are:

[D] Tab Clip Width

[E] Tab Clip Height

[F] Snap Tooth Height

[G] Snap Tooth Width

If the fixture is going to be spot-welded together then *Dimension [D]* is mostly likely 0, to prevent creating a hook geometry. Accordingly, *Dimension [B] (Depth)* will usually be no bigger than the base plate thickness.

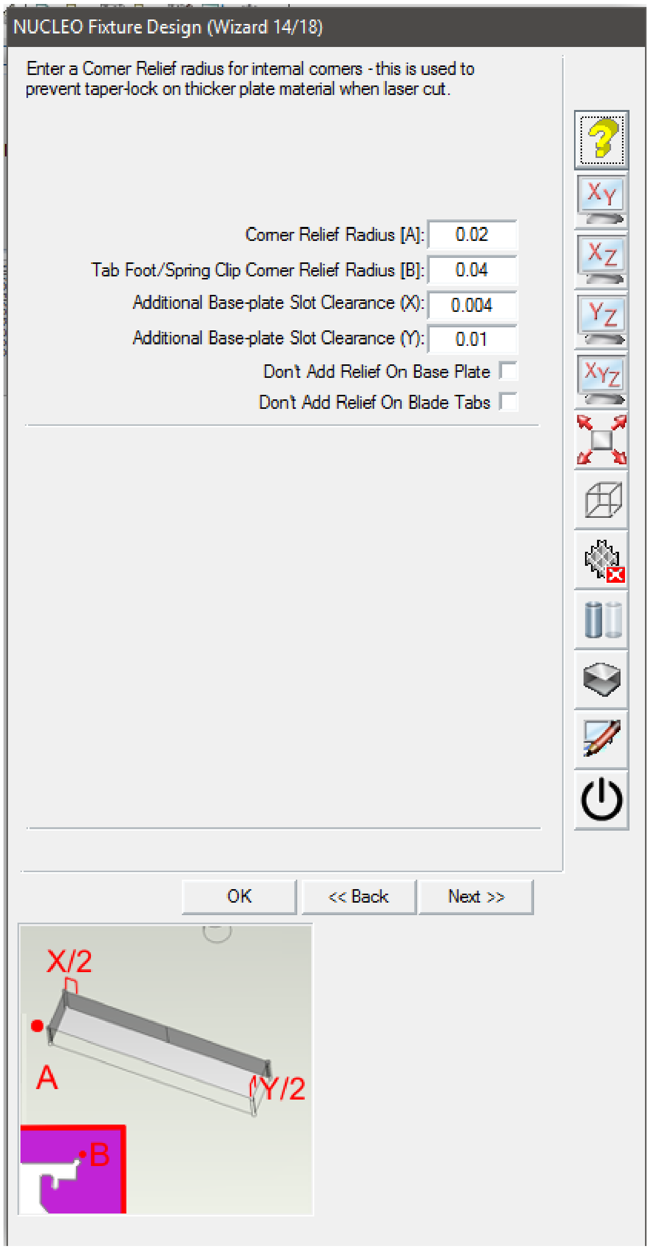
If the fixture is not spot-welded, *Dimension [B] (Depth)* should be at least 2 or three times bigger than the base plate thickness. An optional *Chamfer [C]* can also be stated, and this should be suitable in consideration on the *Depth [B]*.

Dimension [D] (Tab Clip Width) should be a good size compared to *Dimension [A] (Tab Width)* but of course, not the same or bigger (maybe 25-50%).

Dimension [E] (Tab Clip Height) should generally **equal the base plate thickness** but it could be - depending on the machining process – that this needs to be more to prevent it being too tight. Conversely, in some instances, subject to the machining kerf or non-compensated toolpath, it may need to be smaller.

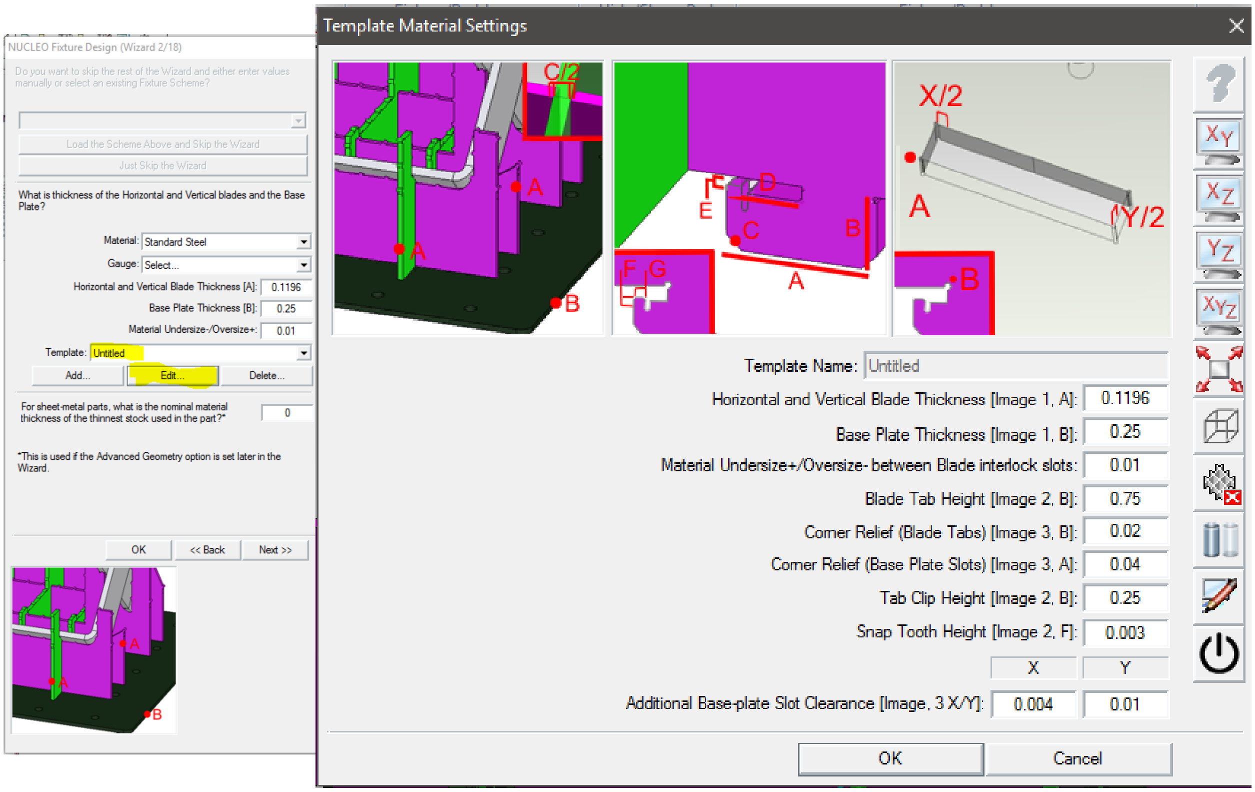
Dimension [F] (Snap Tooth Height) is optional for hook-type tab feet **– but they have proven to be useful for adding further rigidity** to this variant of fixture design. This value is a protrusion from the Tab *Clip Height [D]*, so it is small – but just enough to give resistance so that when the blade is inserted into the base plate – it needs a tap with a hammer sideways on the blade edge to get it to slide left and the tooth to meet up with its matching tooth hole (*Dimension [F] Snap Tooth Width* defines this hole feature).

As *Dimension [D] (Tab Clip Width)* needs to be appropriate to the value of *Dimension [A] (Width), Dimension [G] (Snap Tooth Width)* needs to be suitable (smaller) than *Dimension [D] (Tab Clip Width).*



Step 14 defines the oversize to apply to the base plate slot features into which the Tab Feet insert. The *Corner Relief [A] Dimension* adds an arc to 90-degree corners to clear any machining kerf; likewise *Dimension [B] (Tab Foot Corner Relief Radius)* does this for the tab foot geometry. **Both may be removed from the machining profile** by checking *"Don't add Relief"* – but of course, unless there is enough oversize in the slot, it could be that the resultant arc (generally the radius of the machine kerf) could interfere with the tab foot as it is inserted into the base plate.

Additional Clearance in the slot is defined by *Dimensions [X] and [Y]*, these are values across the slots – so 50% each side. Generally, tab feet are only present on the Horizontal (Y direction) Blades; in this case, the most critical value is the *[X] Dimension*.



All these important values are defaulted the next time the Fixture Wizard is used. For maximum flexibility, you can define your own library of base-practice values based on a single click in the Wizard (Step 2). Once tuned-in, the process is reliable and repeatable, time after time.

Part/Fixture Clearance Considerations

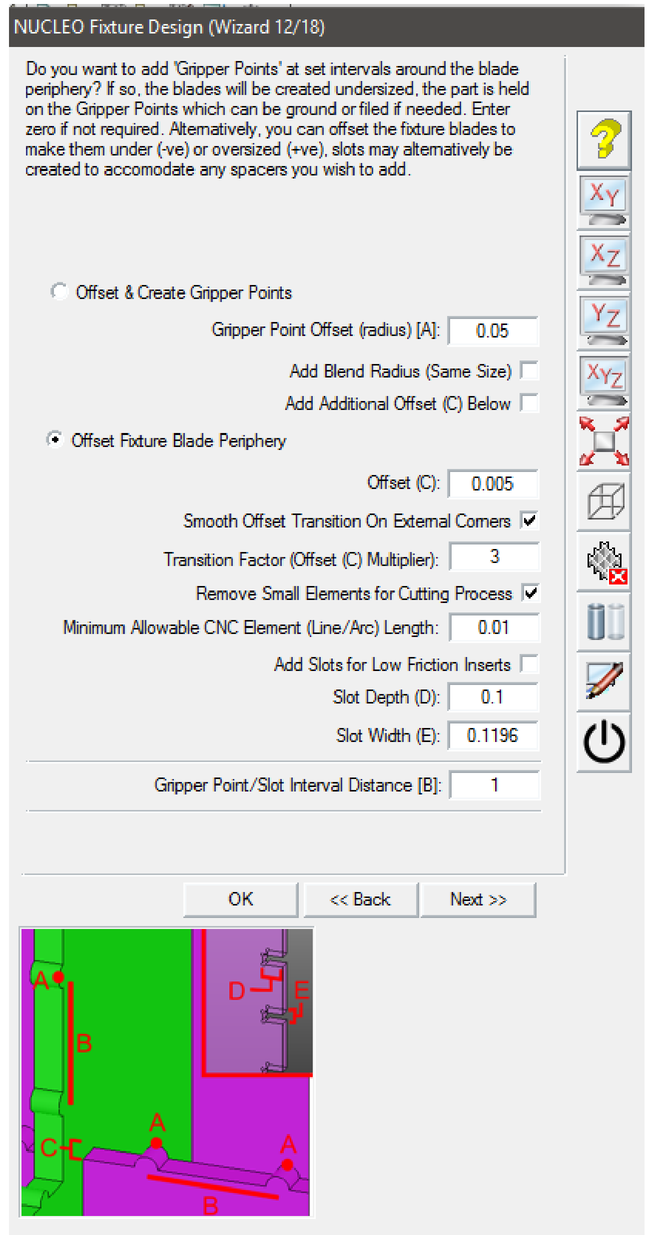
Aside from the "intra-fixture" dimensions and tolerances, the final factor to consider is the part-to-fixture clearance. Given that sheet metal components generally vary (have a wider tolerance) than machined parts, the actual solid model of the part may be somewhat different dimensionally from the actual part.

To cater for this situation, it is sometimes useful to include an offset (gap) between the part and the fixture, this is possible on step 12 within the Wizard.

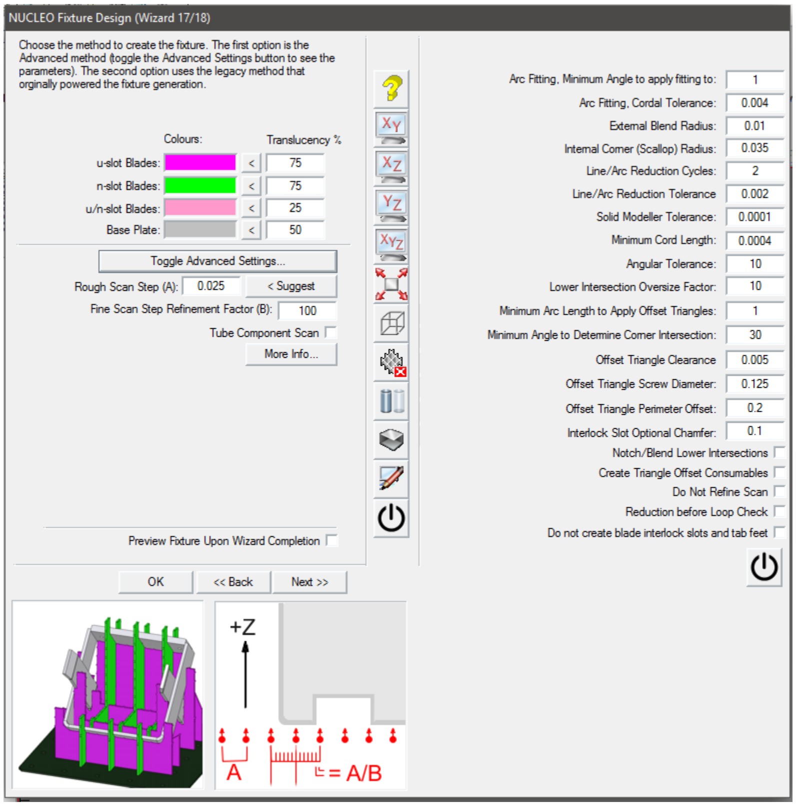
There are several options; the part may be simply offset (positive value) by entering a value into the edit box labelled *Offset [C].*

An alternative option is to use "Gripper Points", which define a series of radii along the blade edge, themselves offset from the original blade geometry by their radius (plus an optional, additional offset).

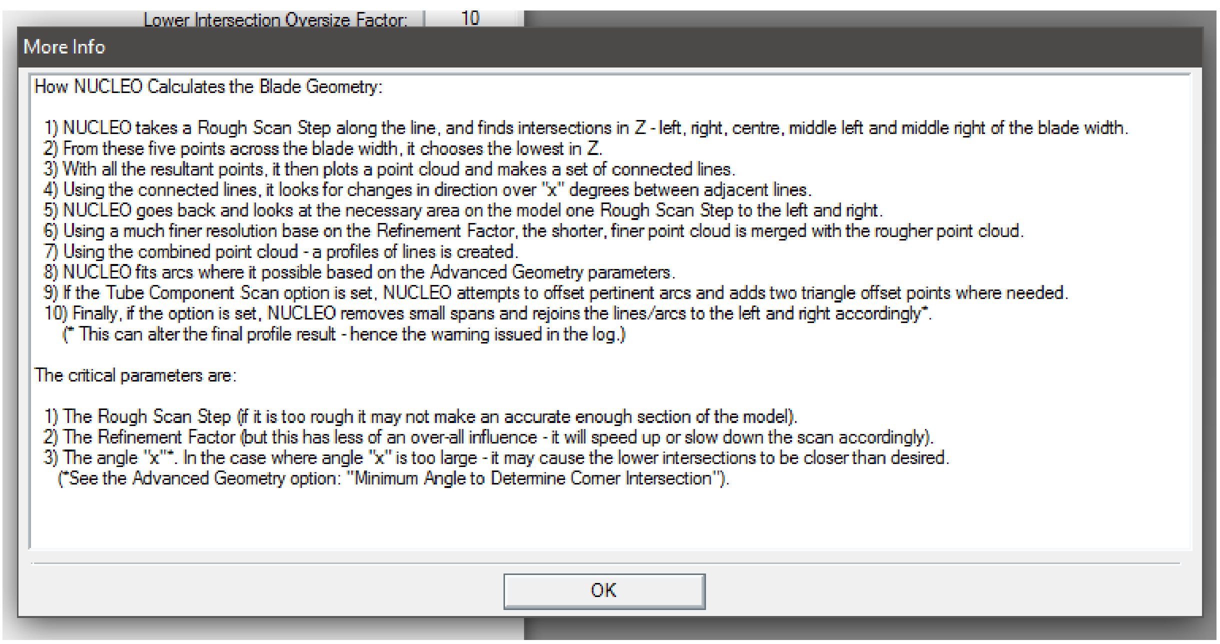
With this method, the radius value for the grippers is entered in the *Gripper Points Offset (radius) [A]* edit box, along with the *Gripper Point/Slot Interval Distance [B]* value – which states the distance between grippers. The benefit in some cases in using gripper points is that it facilitates the easy grinding/adjustment of the fixture along the blade edge. They can also assist in minimizing friction during removal of the part and help reduce heat transfer between weldment and fixture.



NUCLEO Scanning Values



Step 17 defines the accuracy for the fixture generation process. The basic way it works is explained by the pressing the "*More Info*" button (in reference to the diagram in the above dialog):



Lower Intersection Oversize Factor: 10

More Info

How NUCLEO Calculates the Blade Geometry:

1) NUCLEO takes a Rough Scan Step along the line, and finds intersections in Z - left, right, centre, middle left and middle right of the blade width.
2) From these five points across the blade width, it chooses the lowest in Z.
3) With all the resultant points, it then plots a point cloud and makes a set of connected lines.
4) Using the connected lines, it looks for changes in direction over "x" degrees between adjacent lines.
5) NUCLEO goes back and looks at the necessary area on the model one Rough Scan Step to the left and right.
6) Using a much finer resolution base on the Refinement Factor, the shorter, finer point cloud is merged with the rougher point cloud.
7) Using the combined point cloud - a profiles of lines is created.
8) NUCLEO fits arcs where it possible based on the Advanced Geometry parameters.
9) If the Tube Component Scan option is set, NUCLEO attempts to offset pertinent arcs and adds two triangle offset points where needed.
10) Finally, if the option is set, NUCLEO removes small spans and rejoins the lines/arcs to the left and right accordingly*.
(* This can alter the final profile result - hence the warning issued in the log.)

The critical parameters are:

1) The Rough Scan Step (if it is too rough it may not make an accurate enough section of the model).
2) The Refinement Factor (but this has less of an over-all influence - it will speed up or slow down the scan accordingly).
3) The angle "x"*. In the case where angle "x" is too large - it may cause the lower intersections to be closer than desired.
(*See the Advanced Geometry option: "Minimum Angle to Determine Corner Intersection").

OK

Setting these values that are suitable for your type of process will help to give you the results expected balanced to the speed of fixture development and tolerance. Tweaking the rough scan step can also help resolve any geometric issues that may happen.

It may be that a few experiments are needed before finding the optimum numbers for your situation. By changing the default view settings, you can set the graphics to *"Wire and Solid"* under the System Settings dialog, in this way, you can zoom into areas with blended corners to check for clearance (note that Wire and Solid" will slow down the graphics response a little).