

10. THERM DRAWING TIPS

10.1. Drawing Tips

The *THERM User's Manual* describes in detail how to draw cross-sections in THERM. This section of the *NERC Simulation Training Manual* presents some additional key points which may help draw the models.

10.1.1. Drawing Methods

There are a few different ways that cross sections can be created in THERM. They are:

- Draw the cross sections from dimensioned drawings
- Draw the cross sections by tracing a DXF file used as an underlay
- Use the autoconvert feature to convert a DXF file into a THERM drawing

Each method has its advantages, and the method you choose will depend primarily on the type of information you have about the product to be analyzed. The *THERM User's Manual* has detailed instructions about each of these methods. The following sections contain specific drawing tips that are particularly useful when drawing fenestration cross sections.

10.1.2. DXF Files

THERM can interpret the polygons in DXF files, if the files are created correctly, and thus save much drawing time. There is extensive discussion of DXF files in the *THERM User's Manual* (Section 5); the following add to, reiterate, or clarify some of the information in that manual:

- DXF files are imported using the **File/Underlay** command (See *THERM User's Manual*, Section 5.2)
- The **Arc to Polygon Conversion** command under **Options/Preferences/Drawing** options determines how many straight line segments will be used to approximate curves in the DXF files. The value can be set from 1 to 45 degrees. The program is conservative in its determination of how many segments are needed to represent the curve. For example if **Arc to Polygon Conversion** is set to 45 degrees, and the angle is ≥ 90 degrees, the curve will be divided into a minimum of 3 segments. The *circles.dxf* file on the CD can be used to discover how changing the arc to polygon value changes the way the DXF file is imported. (See *THERM User's Manual*, Section 5.3.2)
- The horizontal and vertical scaling factors are only used with DXF files that are drawn at a scale other than 1:1. (See *THERM User's Manual*, Section 5, pg. 5-3)
- The choice of units is a scaling factor for DXF files that were originally drawn in SI units; by default THERM assumes that DXF files are drawn in IP units. This unit setting is different than the overall units setting for THERM. (See *THERM User's Manual*, Section 5, pg. 5-3)
- Note you will need to re-import the DXF file for changes in the arc conversion or scaling settings to take effect.

- By default, the THERM origin and DXF origin are the same. You can use the origin setting to change this if needed. (See *THERM User's Manual*, Section 5, pg. 5-4)
- Only one DXF file at a time can be used as an underlay. In a file that already has an underlay, you can pick a new underlay, but it will supercede the previous one.
- In THERM, the base unit is millimeters when drawing in SI units, and inches when drawing in IP units.

10.1.3. Representing Curves with Line Segments

THERM can draw straight lines at any angle but it currently must approximate curves with a series of straight line segments. The guidelines for geometric representation of curved surfaces are still being discussed by the ASHRAE committee charged with coming up with a standard for calculating heat transfer in windows (SPC 142P). Some parameters to consider in evaluating the accuracy of the geometric representation are path length, displacement, and area.

For NFRC simulations, the model must be within 5 mm (0.2 in) of the actual product. In most cases, using either 30 or 45 degrees per side for the **Arc to Polygon Conversion** parameter will create a drawing that is within 0.2 inches (5 mm) of the product and eliminate unnecessary complexity in the drawing. A drawing with many points very close together may result in problems when creating the boundary conditions or during the simulation when the mesh is being generated by THERM.

Interpreting Arcs in DXF Files

The **Arc to Polygon** conversion setting in the **Options/Preferences** menu option, **Drawing Options** tab controls how many line segments THERM will use to translate an arc in a DXF file. THERM treats every curve the same regardless of radius. The **circles.dxf** file, which contains many arcs, can be used to illustrate how using the **Arc to Polygon** conversion setting when autoconverting a DXF file can affect the resulting THERM polygons. If you decide to model curves in detail setting the **Snap to Angle** value to the value chosen to divide up the arc will make drawing easier. The **lowhoriz.dxf** on the accompanying CD can also be used to learn how THERM interprets arcs when autoconverting a DXF file.

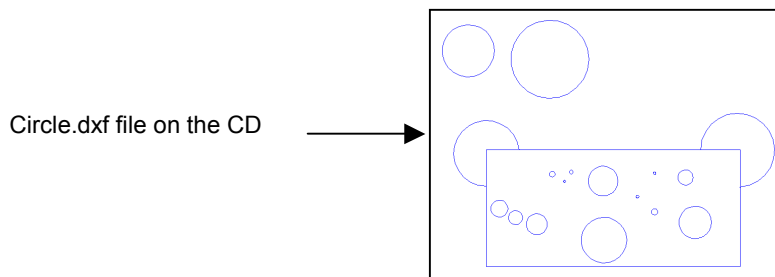


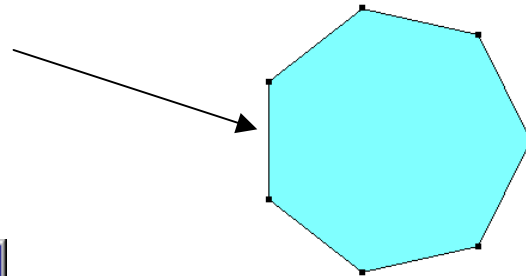
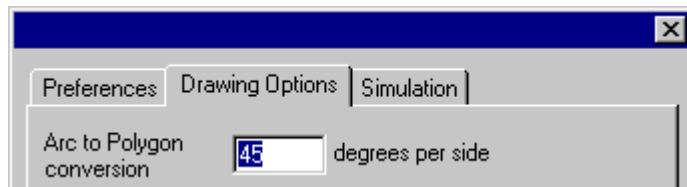
Figure 10-1. Circle.dxf sample file.

DXF Filter Settings

The DXF Filter settings in the DXF Underlay also control how the dxf file is translated by THERM. This can be seen using the circles.dxf file.

1:

When the Arc to Polygon conversion setting is 45 degrees per side, the autoconverted polygon for circles.dxf looks like this. Setting this value to 30 or 45 is recommended because it results in sufficient detail for proper modeling and eliminates unnecessary complexity which may result in problems with boundary conditions or the mesh generation.



2:

When the Arc to Polygon conversion setting is 15 degrees per side, the autoconverted polygon for circles.dxf looks like this. There are many more line segments representing the arc. This level of detail is usually unnecessary and may lead to problems when generating boundary conditions or during simulation meshing.

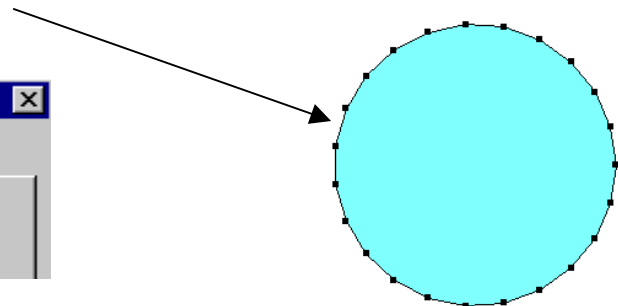
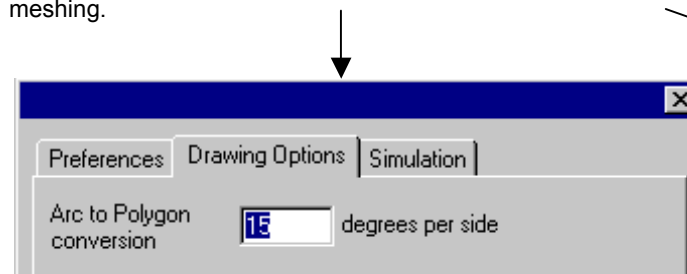


Figure 10-2. Arc to Polygon Conversion in THERM.

10.1.4. DXF Files -- AutoConvert

- For **Autoconvert** to work the DXF file needs to be created with closed polylines and curves. A polyline is a shape created in a CAD program made up of joined line segments and curves. (See *THERM User's Manual*, Section 5.2.3, pg. 5-6)
- Autoconvert may create overlapping polygons if polylines are defined multiple times in the CAD program and if the polylines in the CAD files overlap. Use the **View/Show Voids and Overlaps** (See *THERM User's Manual*, Section 5.3.5, pg 5-11) to check if this has happened. A single overlapping region will show as an overlap but if yet another region exists it will look like there is no overlap. A further check can be made by deleting (or moving) one of the polygons. If there is nothing underneath it the polygon can be restored using the **Edit/Undo** feature.
- Extrusions are often drawn using polylines. The external profile is one polyline and each of the cavities is a separate polyline. (See discussion about "Drawing Extrusions from DXF Files", and look at the *auto.dxf* file on the CD.)
- Import the DXF file *auto.dxf* (from the CD) using the Autoconvert feature. Check for overlapping polygons. Delete any overlapping polygons. Use the **Undo** feature to restore any inadvertently deleted polygons.
- Import *auto.dxf* (from the CD) with only polylines checked using the **DXF filter**. The rounded corners of the extrusion are chopped off, which greatly simplifies the model.

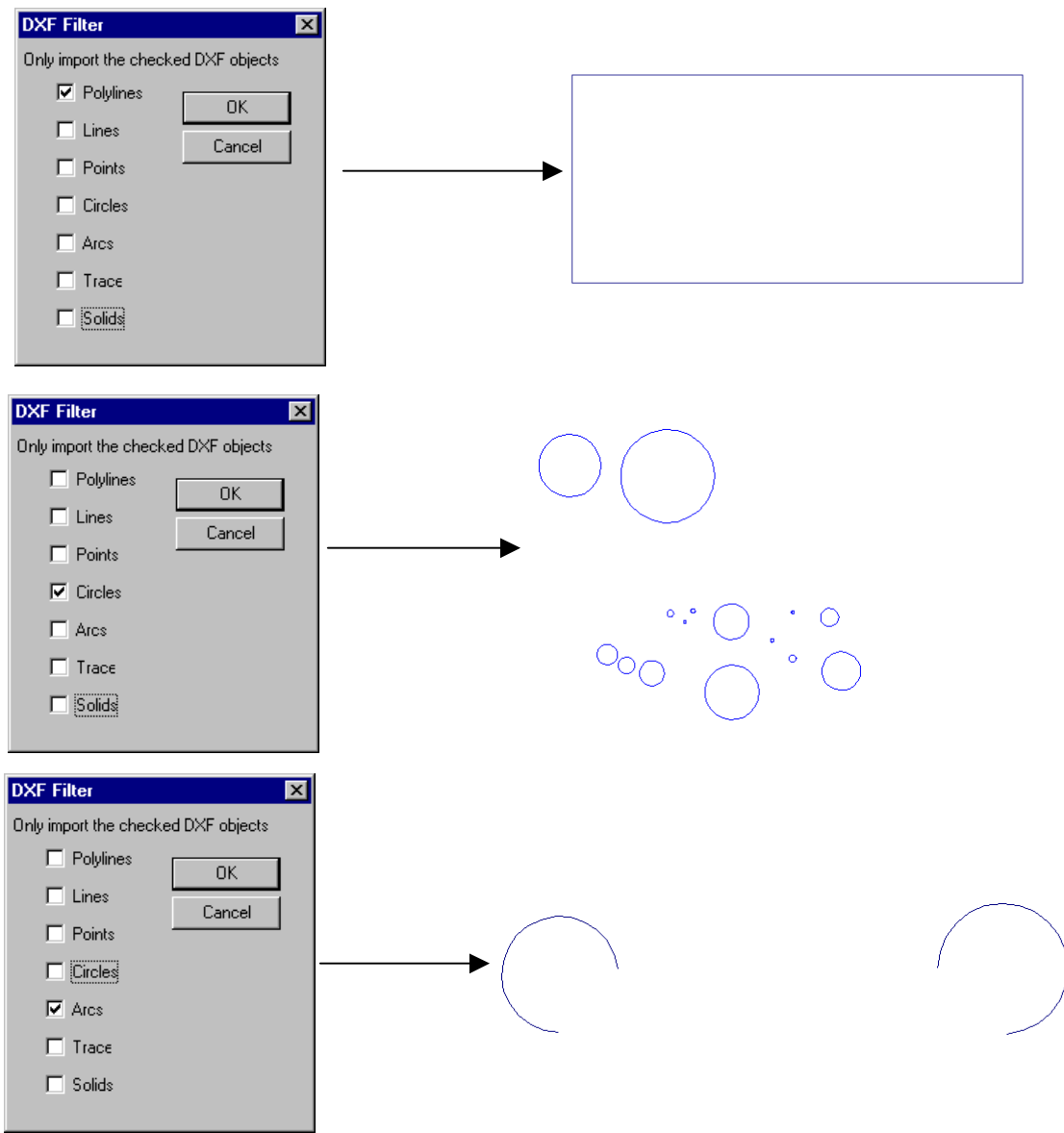


Figure 10-3. DXF Filter settings.

10.1.5. Sticky Distance and Snapping



- Drawing in THERM is facilitated by the fact that the cursor will jump to a DXF file vertex, polygon vertex or polygon line, if the cursor is within the "sticky distance" from those objects.
- The " sticky distance" is equal to one half of one side of the drawing cross-hair. This is equal to 3mm if the drawing is viewed at 100%. (See *THERM User's Manual*, Section 5.3.1, pg. 5-7)
- When zooming in on the drawing, the sticky distance is still equal to one half of one side of the drawing cross hair, but the drawing has become more detailed. If there are 2 points next to each other that are both within the sticky distance of the cursor at 100%, so it is not possible to control which point the cursor sticks to, zoom in to that area of the drawing and the the cursor will stick to the desired point.
- While drawing, if an error message appears saying that a point can not be placed on top of another or that overlapping polygons cannot be created, the sticky distance may be causing the cursor to stick to points that are not desired, such as a point that is within the sticky distance of the previously drawn point. In this case, zoom in to the drawing and it is usually possible to get to the desired points.
- There are several snap features that can help with drawing. **Snap to Vertical and Horizontal** and **Snap to Underlay** are the defaults. **Snap to Angle** is helpful for drawing detailed curves. **Smart Snap** extends the edges of existing polygons and helps to line up polygons that aren't adjacent. The **Snap** features can be easily turned on and off through the toolbar. (See *THERM User's Manual*, Section 5.3.3, "Snap Settings", pgs 5-8 through 5-10)

10.1.6. Drawing Tips

- **Moving points and lines:** Press the **Modify Points** button on the toolbar to be able to modify points. A double headed arrow is the cursor for moving points. (See *THERM User's Manual*, Section 5.6.4, pgs. 5-21 through 5-22). A four headed arrow is the cursor for moving lines. (See *THERM User's Manual*, Section 5.6.5, pgs. 5-22 through 5-23). Holding down the shift key will constrain the movement to the horizontal and vertical directions. Sometimes line move has trouble sticking to adjacent polygons and it is possible to draw overlapping polygon errors when moving.
- **Space Bar to snap:** Use the space bar to snap to a point (and also to DXF file vertices) without changing the model. This is useful for determining the start of a line when measuring, and to move or measure relative to a certain point.
- **Copying and Pasting:** When using the **Edit/Copy** and **Edit/Paste** features within the same drawing, it is possible to create overlapping polygons. Make sure when pasting a polygon that the Locator (Shift F2) is moved before the paste is performed, or that the pasted polygon is moved after pasting if it is located directly over the copied polygon.
- **Scooting:** While drawing, **Zoom Out (Shift right click)** to see a point that is off the drawing area, move the cursor to that point, then **Zoom In (right click)** to actually draw the point. This is the best way to move the cursor large distances while drawing.
- **Scroll Bars:** The Scroll Bars can be accessed while drawing a polygon (a much better method than pushing the drawing cursor against the edge of the drawing window, which can result in display problems.)
- **Switching Units:** - The ° F/°C toolbar button switches between IP/SI units.

- **Display clean-up:** Sometimes when deleting points from a polygon there is residue left on the screen. Press **Escape** to force the screen to redraw and the extraneous images will go away.

Scrolling up and down makes the labels of the isotherms get bunched together. **Escape** will redraw them with the labels positioned correctly.

- **Editing Points on Multiple Adjacent Polygons:** Move, add or delete the same point on all adjacent polygons (by selecting all the affected polygons) at the same time -- moving them separately may cause voids and overlaps.
- **Windows™ Operating System:** Make sure the Windows95™ option is unchecked if you are using WindowsNT™ (**Options/Preferences**).
- **Select Material/BC toolbar button:** The **Select Material/BC** toolbar button  can be used to set the **Material Library** or **Boundary Condition Library** choice. To use this feature, click on the **Select Material/BC** toolbar button, move the cursor to the material or boundary condition to be selected, and click the left mouse button. This sets the value of the object selected. The cursor will  change to the **Fill** cursor. Move it to the object (polygon, void or boundary segment) to be set to the selected material or boundary condition, and click the left mouse button.

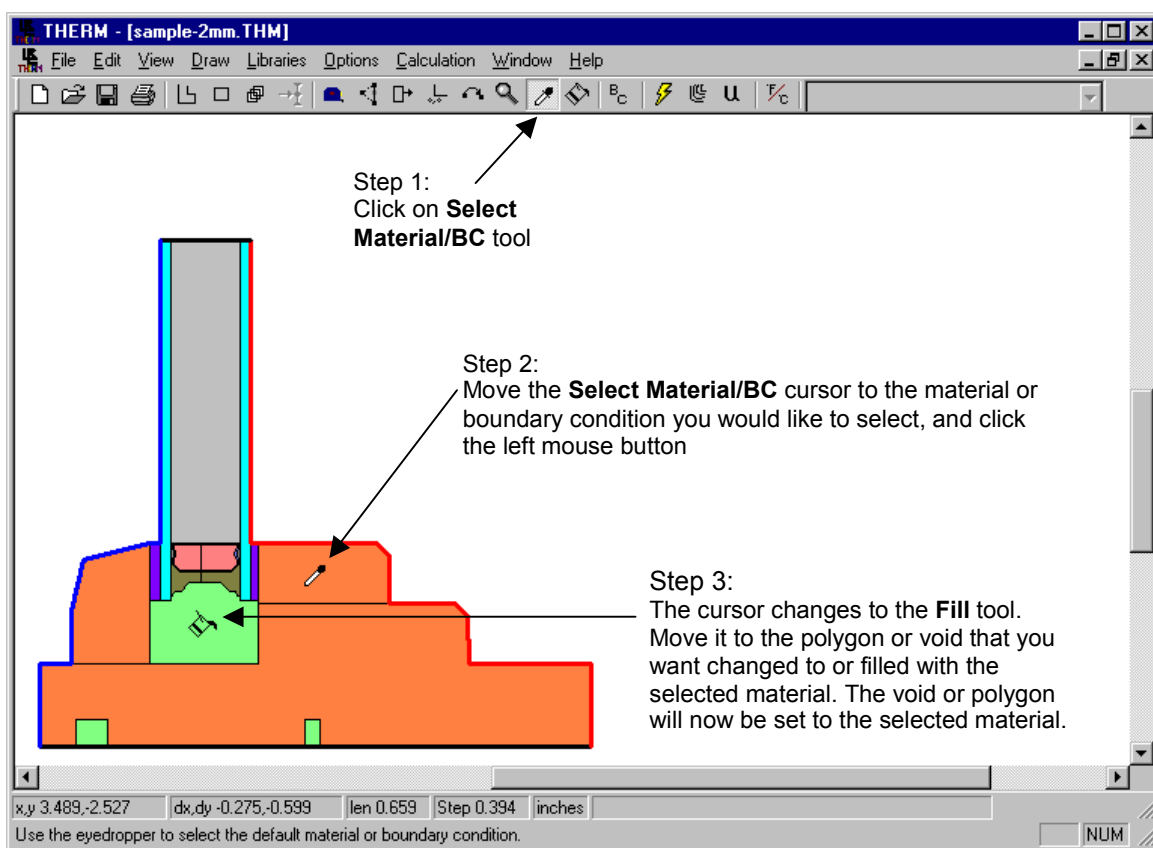



Figure 10-4. Steps for using the **Select Material/BC** toolbar button.

- Fill toolbar button:** The Fill toolbar button  can be used to either fill a void with a selected material, or change a polygon from one material to another. To use this feature, click on the Fill toolbar button, select the desired choice from the **Material** list, and move the Fill cursor to the void or polygon to be set to the selected material. Click the left mouse button, and the void or polygon will be set to the selected material.

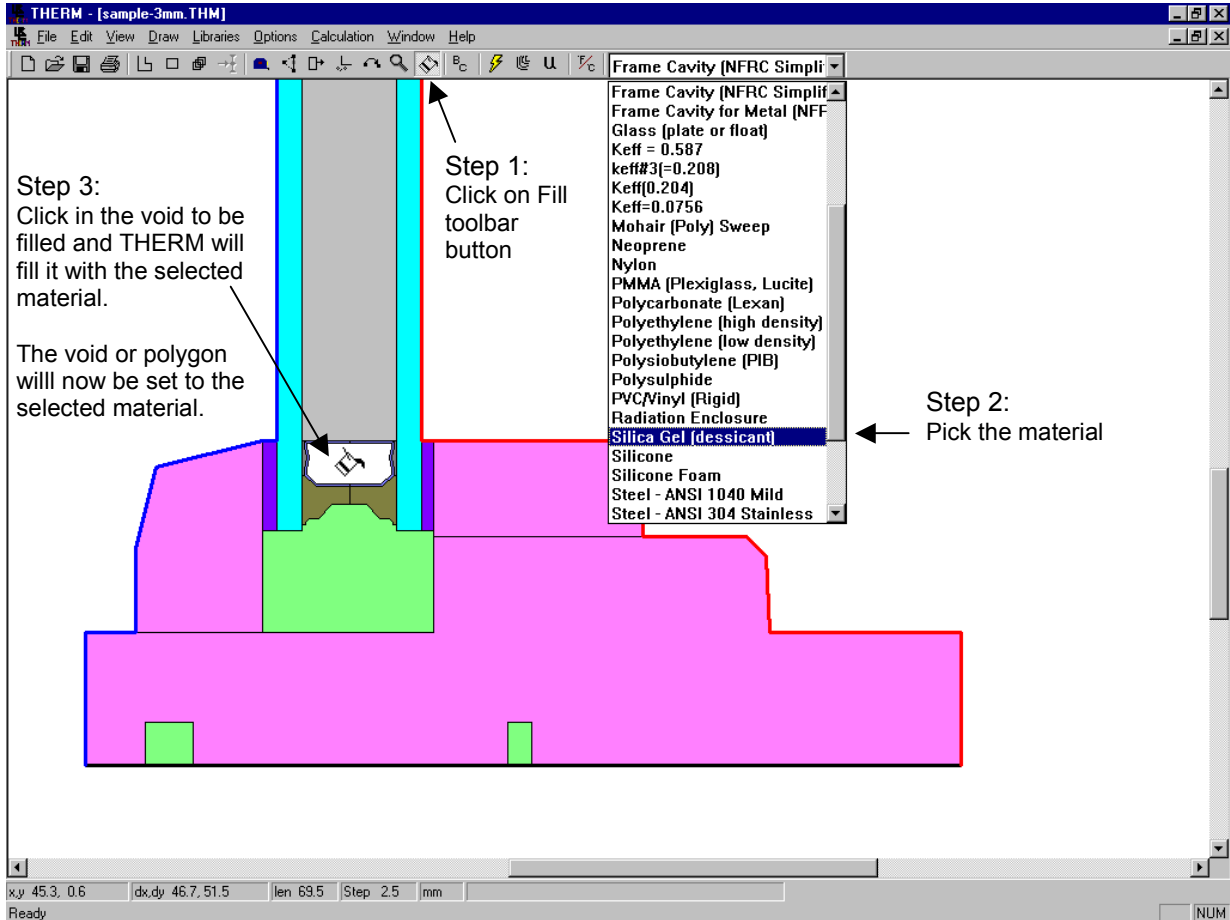
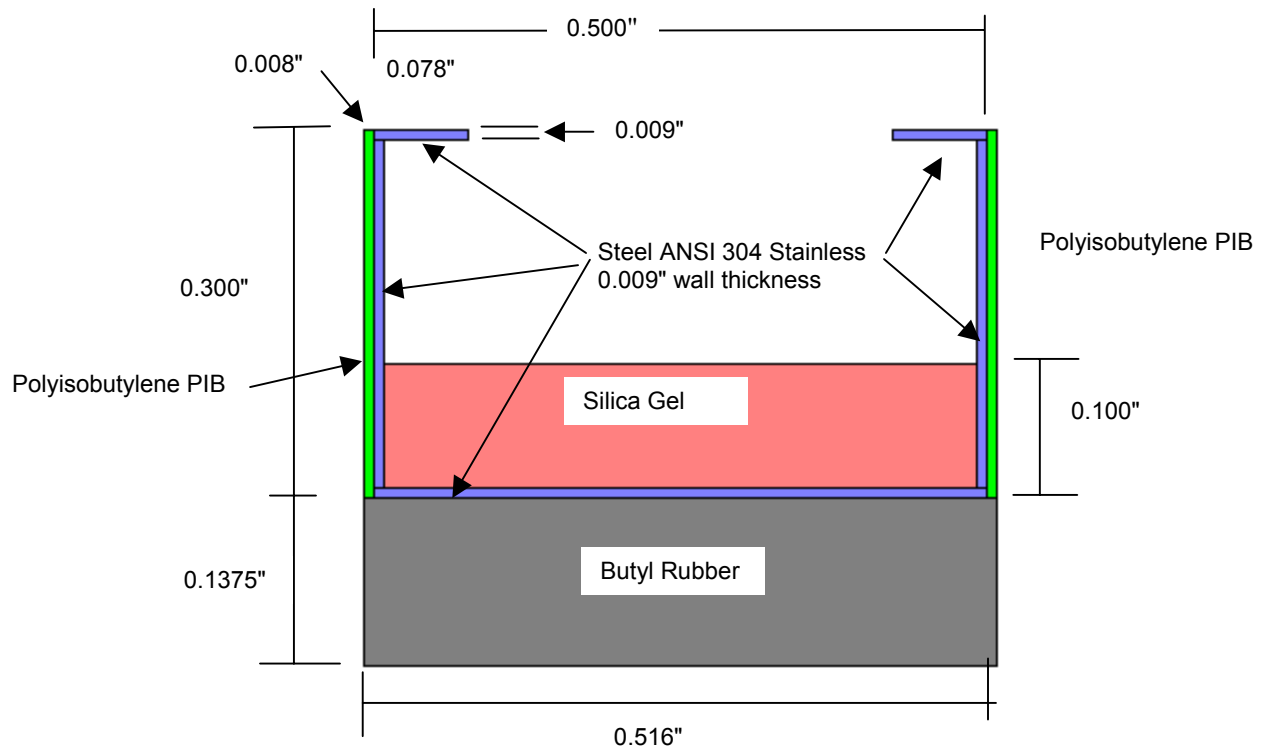


Figure 10-5. Steps for using the Fill toolbar button.

10.1.7. Drawing with the Keyboard

- Typing a number will bring up the **Step Size** box, and set the **Step Size**. Then the arrow keys will move the distance set in the **Step Size**. Rectangles and polygons can be drawn entering dimension values into the step size box and moving the arrow keys in the appropriate direction. See Section 5.5, "Drawing Using the Keyboard (Numeric Cursor Positioning)" in the *THERM User's Manual* for more



information about drawing with the keyboard.

Figure 10-6. A sample spacer to use for drawing with the keyboard from a dimensioned drawing.

10.1.8. Donuts

- A region that connects back onto itself, such as a "donut", must be broken into multiple polygons in THERM
- When breaking up the "donut" regions, try not to create angles that are extremely acute. (There are many examples of extremely acute angles in *Bad4.thm* on the CD).

"Donut"

Methods for breaking up "donut" in THERM

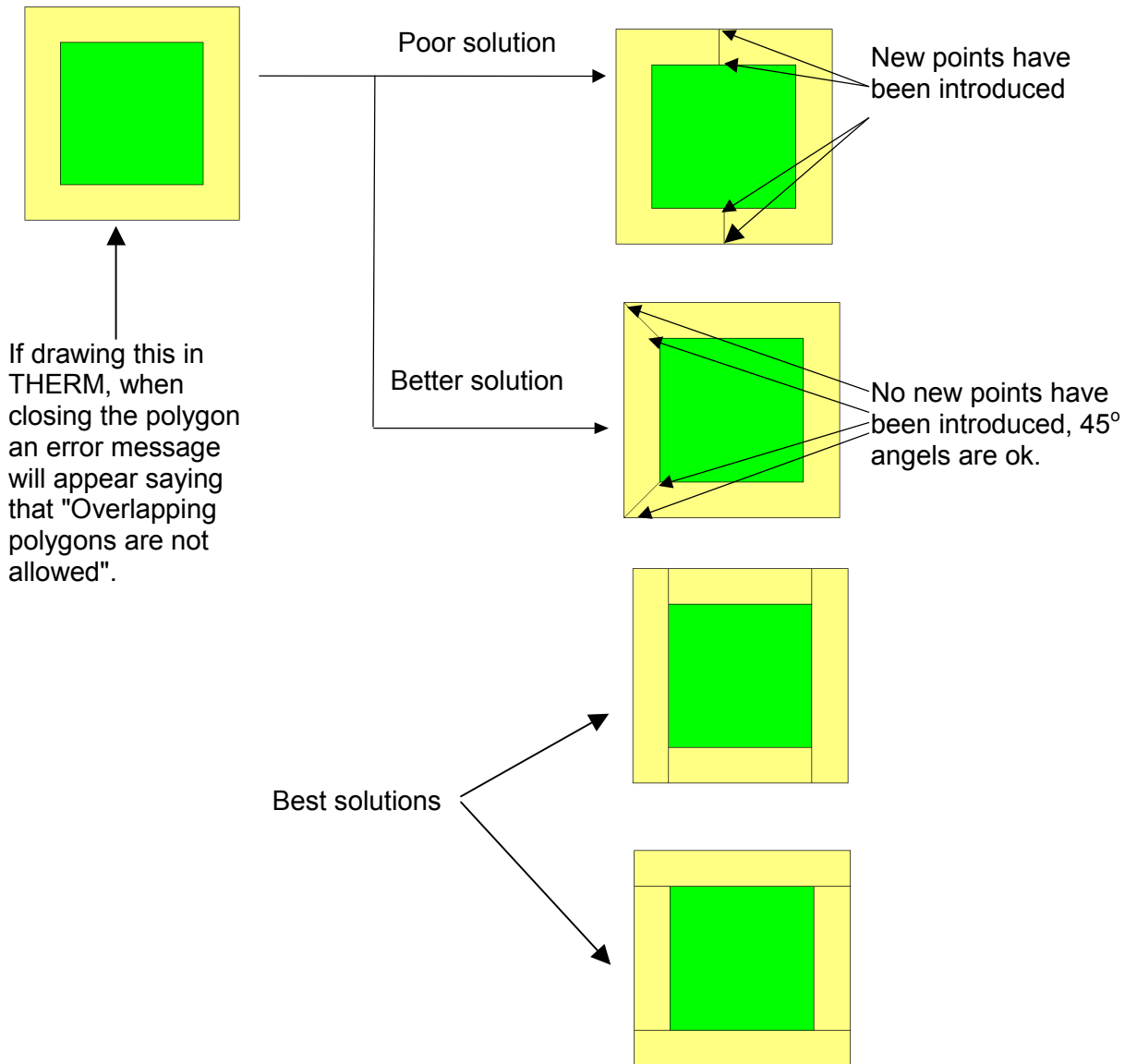


Figure 10-7. Breaking up "donut" regions in a cross section.

10.1.9. Breaking Up Extrusions into Polygons

- THERM currently does not allow polygons that come back on themselves such as "donuts".
- When working with a CAD drawing it is usually necessary to break extrusions into polygons that THERM can handle.
- THERM can handle very complicated polygons. The method for breaking up the extrusion is a matter of personal working style, although for generating boundary conditions and the mesh during simulation, it is usually better to have more simple polygons than just a few very complicated ones:
 - Make many simple rectangles and polygons OR
 - Make fewer, more complicated polygons
- Basic rules in breaking up extrusions
 - Try not to create new points-- use points (vertices) that are already there
 - Try not to create extremely acute angles (less than 5°)
 - If an extrusion cannot be broken up without creating an extremely acute angle, then introduce a point.
 - It's easy to get lost while making very complicated polygons, which is one reason to make smaller, more simple polygons.
- The *cen1.dxf*, *cen2.dxf*, *autofill.dxf* and *autofill2.dxf* underlays (on the CD) can be used to practice breaking up extrusions.

Cen2.dxf

The Cen2.dxf file found on the CD contains donuts which must be broken up when drawing the extrusion.

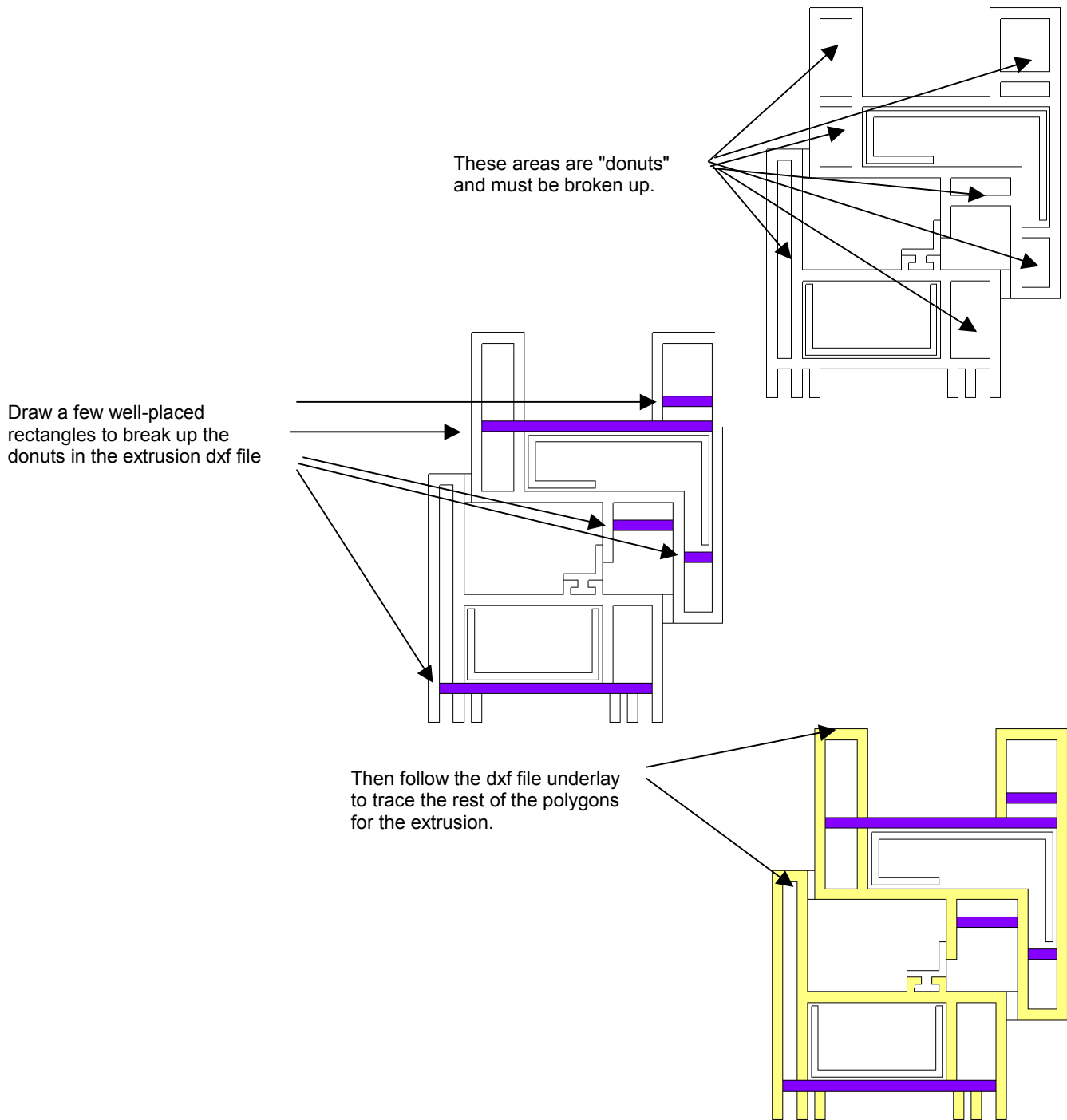


Figure 10-8. Breaking up "donut" regions in a cross section.

10.1.10. Drawing Extrusions from DXF Files -- False Die Mold Method

- Many DXF files of extrusions are drawn as polylines, with the external profile as one polyline and each of the air cavities is a separate polyline -- *auto.dxf* is an example of this.

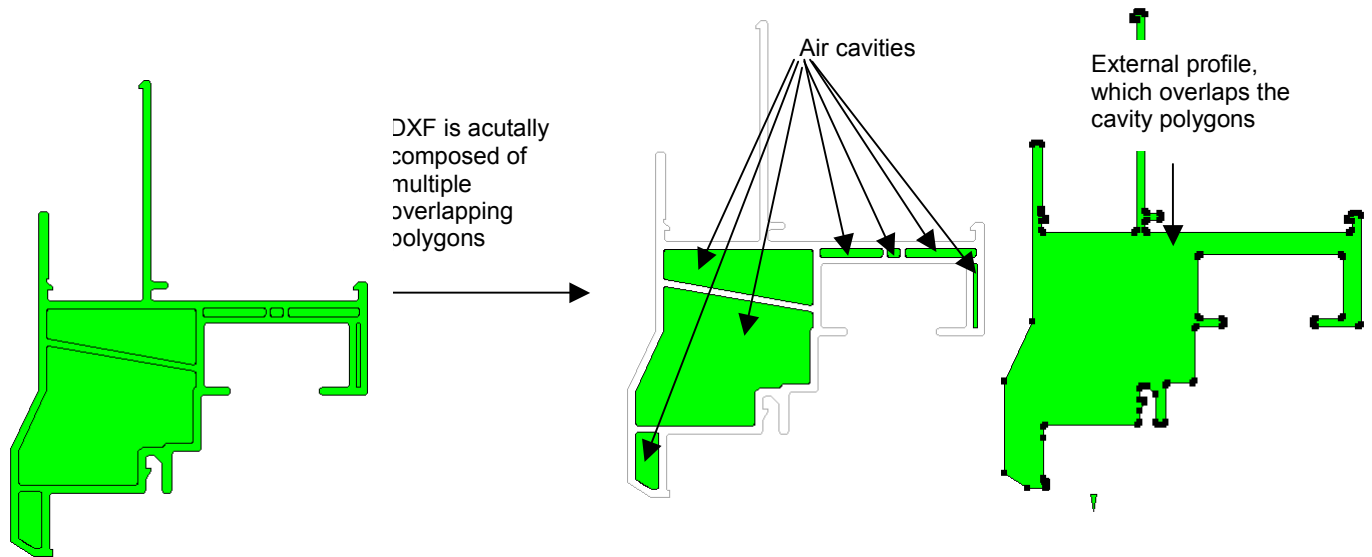


Figure 10-9. *Auto.dxf* has multiple polygons on top of each other.

- Keeping the external profile polygon in place overlapping the cavity polygons, create a series of polygons that enclose the external profile (remember that you can't draw donuts).
- Use **Fill Void** to fill in the areas between the enclosing polygons and the external extrusion profile

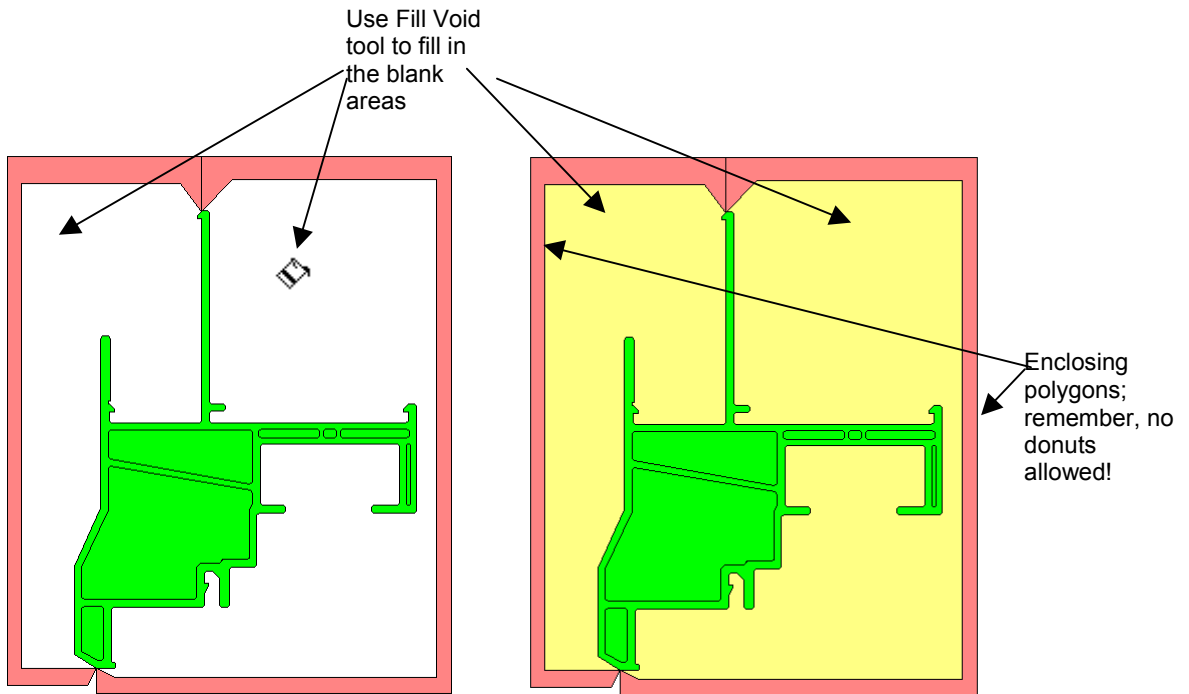


Figure 10-10. Method for getting the external extrusion shape.

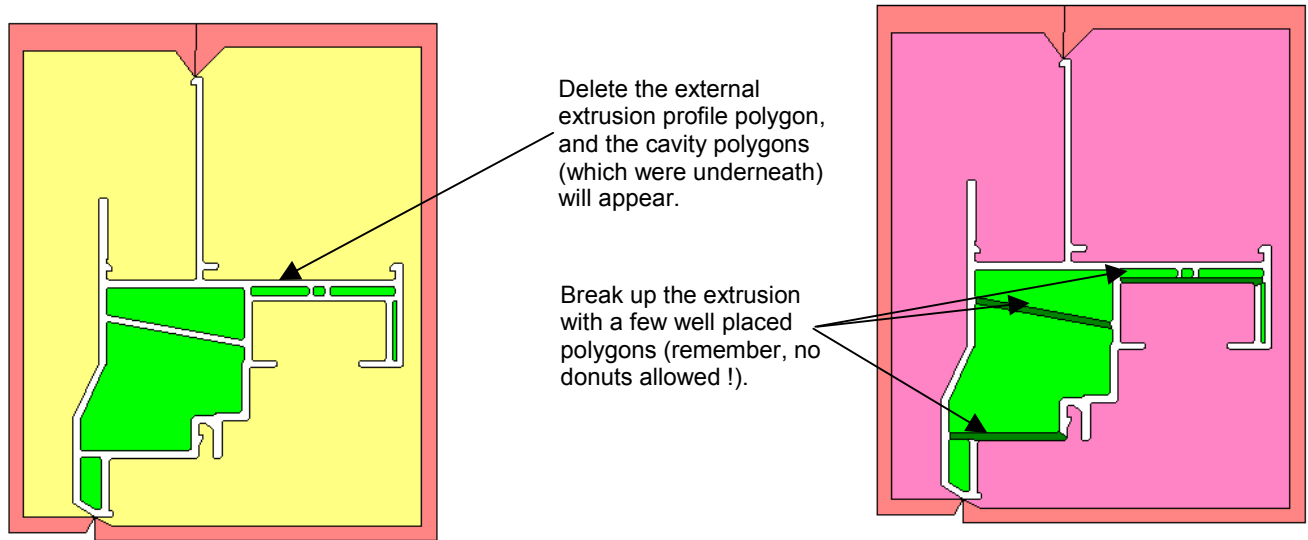


Figure 10-11. Get the extrusion profile and break up the extrusion so there are no "donuts".

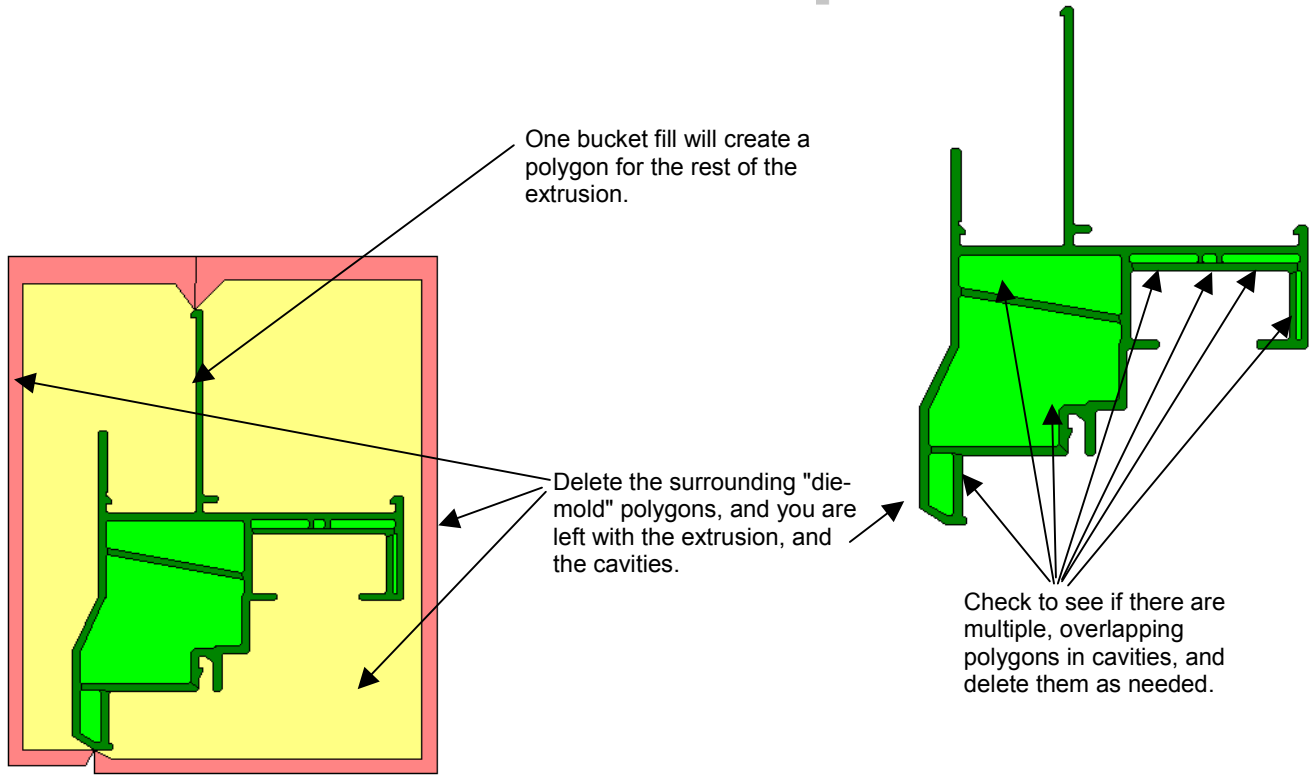


Figure 10-12. Finish creating the extrusion profile.

10.1.11. Cuttins, Relocating, Flipping and Rotating Discussion

- There are several ways to select polygons in THERM.
- Edit/Special Select
- The Drag Box
- Mouse clicks, shift clicks, tabs
- There are two ways to move polygon
- The Draw/Move Polygon command
- Using the Draw Locator - this is recommended for precise moves
- THERM has **Flip** and **Rotate** features but they rotate and flip everything in the drawing so you need to **Cut** and **Paste** the polygons that need to be manipulated to a temporary file, perform the operation and paste them back into the original drawing.
- The **Cut** and **Paste** feature in THERM eliminates unnecessary redrawing of parts that are exactly duplicated in multiple cross sections. You can make libraries of spacers and other components in THERM files to be used in many cross sections.
- The files *spacerhalf.thm* and *cut&paste.thm* can be used to practices these features.

The *cut&paste.thm* file can be used to practice these concepts.

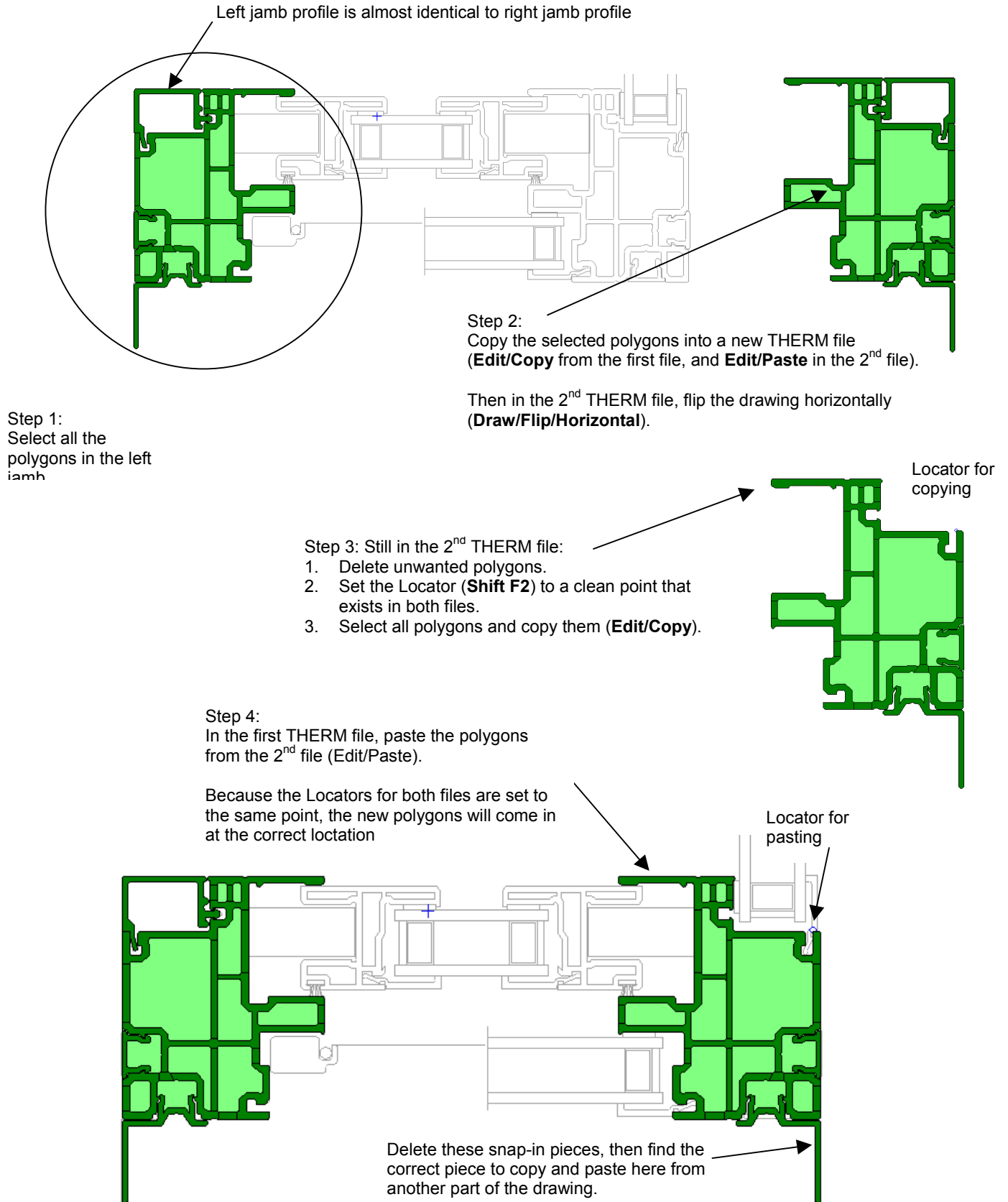


Figure 10-13. Use **Edit/Cut** and **Edit/Paste** to copy similar components within a drawing or to another THERM file