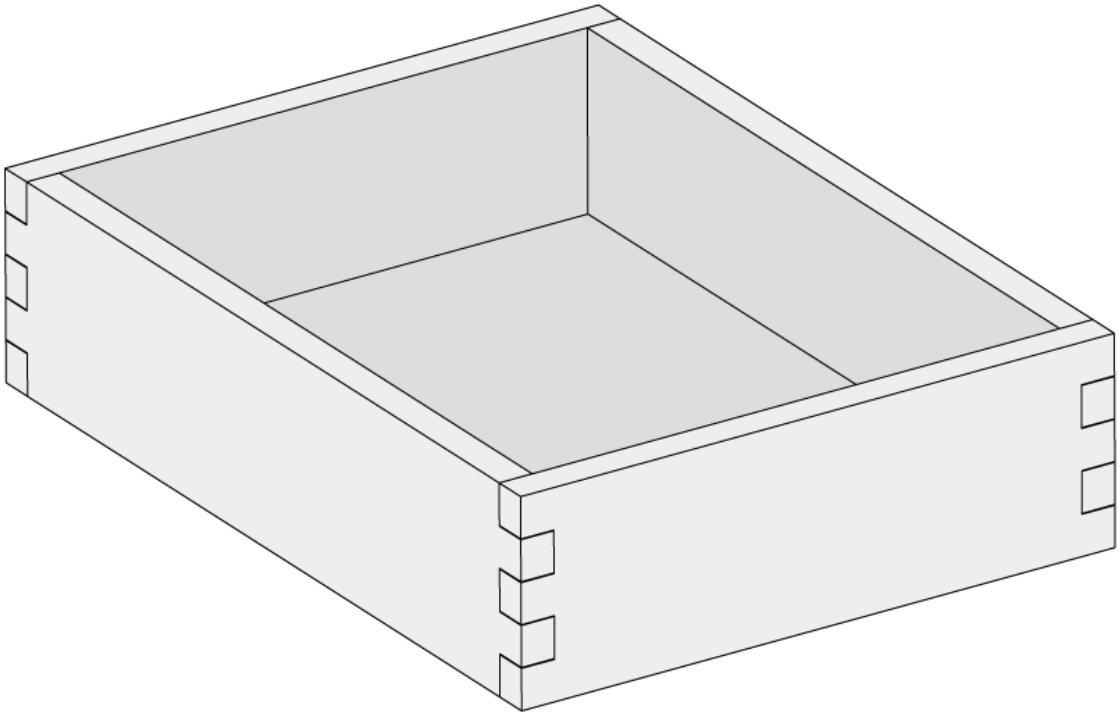
BOX JOINT BASIC

THE COMPREHENSIVE GUIDE 1.0



SHAPER | ORIGIN™

Introduction

Box Joint Basic is a powerful new Extension for your Shaper Origin that makes it easy to design and create traditional box joints without any physical templates. In this comprehensive guide, we will introduce you to these new capabilities of your Origin by walking you through the construction of a simple box designed and cut with Box Joint Basic.

We suggest that the first time you read through this guide, you use the recommended stock dimensions and similar fixturing strategies. Once you've built your first Origin-designed box,, you can print out these instructions to use as a handy—if heavy!—reference guide to keep in your shop for all your future projects using Box Joint Basic.

We'll keep making adjustments to this guide, based on user experiences and feedback, so please share your experiences using this Guide on the Community and you can always find the latest version of this guide.

What is an Extension and how do I enable one?

Shaper Origin contains many powerful features right out-of-the-box. These include the ability to import digital design files, as well as a suite of onboard drawing tools that help you design without ever needing to touch a computer. Extensions, which we introduced in our Golden Gate software release, further extend the stock capabilities of your Origin with more specialized functionality. They represent our commitment to the idea that power tools should improve over time. To add the Box Joint Basic Extension to your Origin, just update your Origin to the latest software and sign into ShaperHub. Installed extensions can be viewed in the *Settings* > *Extensions* menu.

Note: this guide is intended for use with Golden Gate software

Initial Preparation and Setup

Step 1: Preparing Material

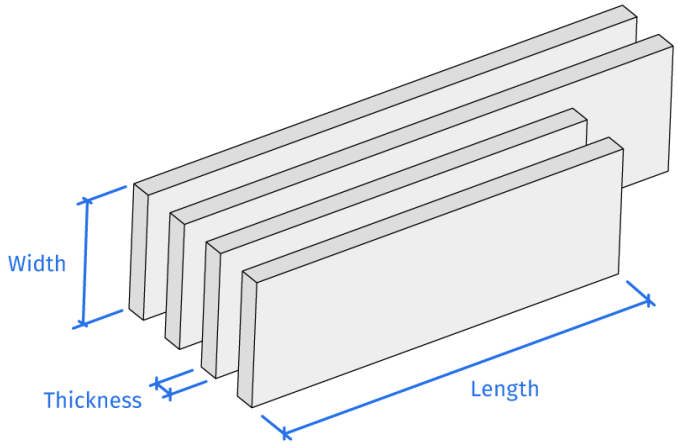


Figure 1

The first step is to get your material to the correct dimensions (see Figure 1). We'll start off focusing on the four sides of the box. We'll be making a box with a ½" thick wall and exterior dimensions of 9" x 12" x 3". This means you will need the following pieces:

2 pieces	9" Long × 3" Wide × .5" Thick	*(For the left and right sides)*
2 pieces	12" Long × 3" Wide × .5" Thick	*(For the front and back sides)*
1 piece	11.5" Long × 8.5" Wide × .25" Thick	*(For box base)*

Sourcing material

You have many choices on how to obtain this material. The simplest route is to purchase it pre-milled to the correct cross-sectional dimensions (3” x .5”) from your local hardware store or specialty woodworking outlet. If you go this route, you’ll simply cut a board to the correct lengths. However, if you have access to a jointer and planer, you’ll have even more flexibility as to the species of wood and cross-sectional dimensions of your material. For this type of “fine woodworking”, we usually work with solid hardwood (two examples being maple and walnut). Alternatively, you can purchase some ½” thick plywood and cut the pieces to size using Origin’s built-in rectangle tool.

Whatever material you use, make sure that the resulting pieces are of a consistent width and thickness, and that the lengths of each set match. Please note that although we are using specific dimensions for the purposes of this example, Box Joint Basic allows you the flexibility of using practically any size stock you want.

Pro Tip:

One neat trick is to get the grain of the wood to continuously wrap around the box. An easy way to accomplish this is to start with a single board that has been milled to the correct cross-sectional dimension, and then to cut pieces in the order they will “wrap” around the box. So you might cut a long piece, then a short piece, followed by a long and then a short piece (rather than cutting two long pieces first, and then two short pieces).

Step 2: Laying Out Your Box

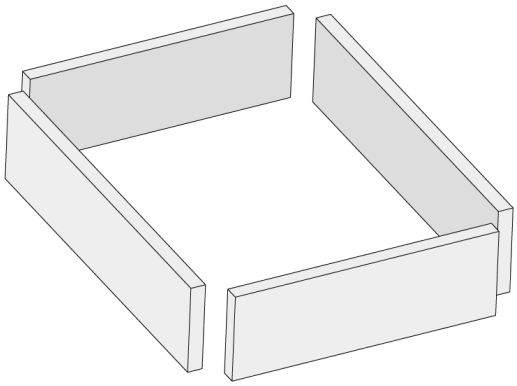


Figure 2

Once the four sides of your box have the correct dimensions, the next step is to decide which piece goes where. Carefully examine your stock, and decide which faces should be on the outside, and which edges should be on the top or bottom of the box. A few factors you might consider include:

- Keeping blemishes on the inside and bottom of the box
- Making the grain continuous (see our “pro tip” in the prior section)

Place the pieces on a workbench as they will be arranged in your box, as shown in Figure 2. In the next step, you will mark them so you can keep track of them throughout the process. The up-facing edges of the stock are going to become your “reference datum”: these edges are most likely to be flat relative to each other in the finished box. You should take this into account when laying out the parts on the table.

Step 3: Marking Your Pieces

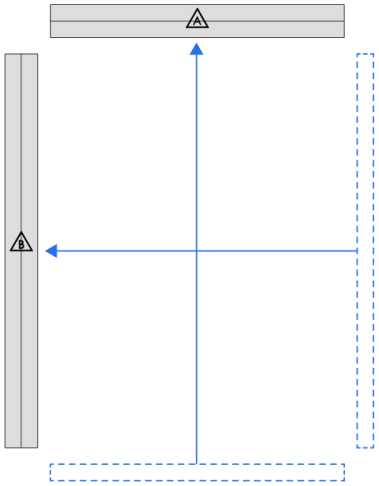


Figure 3

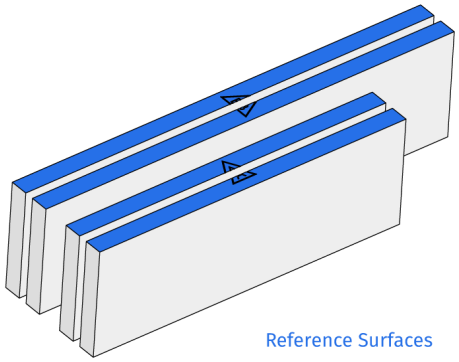


Figure 4

In order to keep track of the exact position of each piece in the box, you'll want to mark the pieces during this layout step. Looking at your arranged pieces from above, slide the right board so that it is touching the left board, and the bottom board so that it is touching the top board (as shown in figure 3).

Using a pencil, draw a triangle across each set of two boards. Write "A" in the triangle that spans the top and bottom pieces, and "B" in the triangle that spans the left and right pieces. Both the triangles and the letters should have the same orientation, as pictured above.

> The top point of the triangle will always be facing away from your body. This marking system will indicate the orientation and location of each piece throughout this build.

Figure 4 emphasizes the point that the marked surfaces are now your datum reference. This will become very important throughout the remaining process.

Step 4: Fixture Your First Piece

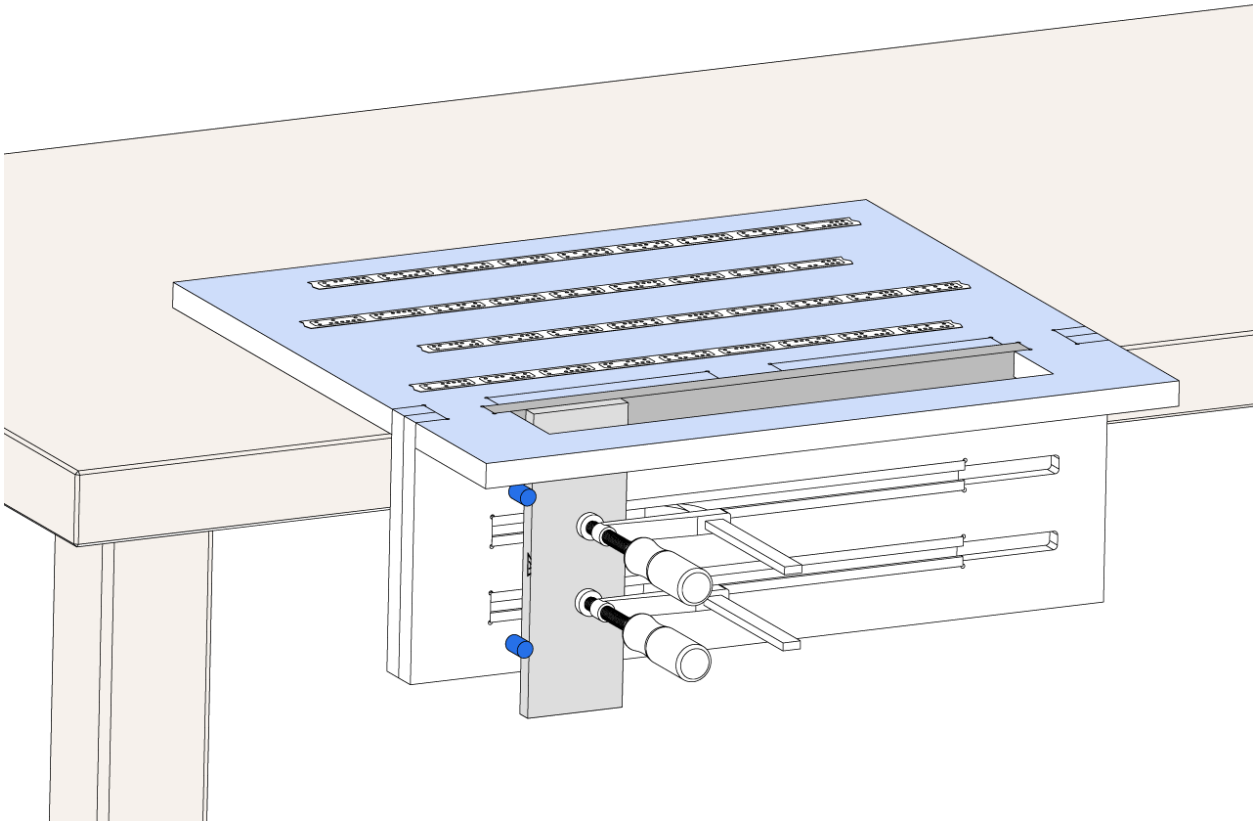


Figure 5

In order to properly cut the pins of each box joint, you need to hold your stock vertically so that the cutting tool has access to the end of the board. The Shaper Vertical Workstation (shown in Figure 5) is ideal for this task. Plans for building your own Vertical Workstation are available on ShaperHub (shapertools.com/r/vws). This is the method we will be showing throughout this guide, but there are many other methods and fixturing options.

First, you'll need to securely mount the Vertical Workstation to your workbench. There are many techniques for this, including F-style clamps through dog holes in the top surface of the workbench (esp. If you are using the Festool MFT-3 or Paulk Bench systems).

Next, ensure that you have a clean spoilboard installed in the Vertical Workstation. This is shown in dark gray in Figure 5, and spans the working area of the fixture. A spoilboard is simply a strip of material that supports the piece to be cut. It provides a sacrificial layer you can cut into without damaging the fixture, while also preventing tear-out. Tear-out is a tendency for chunks of material to peel from your stock when a router bit exits a cut. The spoilboard supports the stock behind the cut, helping to prevent tear-out.

Finally, mount the lower box piece into the Vertical Workstation. You can identify this piece because it has the bottom of the letter “A” marked on it. The reference edge of the stock (which bears this marking) needs to be in contact with **both** datum pins (highlighted in bright blue in Figure 5) located on the left side of the Vertical Workstation. These pins provide a repeatable index for taking stock in and out. If you use them effectively, you’ll only need to create a grid once with Origin! In fact, this method is so repeatable that it’s possible to re-install a piece you’ve already cut, and shave a bit of additional material off to loosen the fit.

Besides aligning the piece’s reference edge to the datum pins, you also need to align the top-facing (3” wide) edge of the piece to the top surface of the Vertical Workstation (highlighted in light blue above). This will ensure that Origin will be able to cut into your board at the correct depth, which is referenced off of the top surface of the vertical workstation during zeroing. This can be done by placing something flat across the top of the workstation (like another piece of flat wood), so that it overhangs above your stock. Then, gently bring your stock up until it makes contact, and secure the stock using clamps. It takes some care to accomplish this without accidentally pulling the stock away from the datum pins during clamping.

Step 5: Scanning Your Vertical Workstation

These instructions assume that you’ve already used Origin at least once, and thus know how to perform a scan. If this isn’t the case, check out our detailed tutorial videos. (shapertools.com/tutorials) Once your workpiece is in the fixture, create a new workspace by creating a scan of the entire setup.

Step 6: Creating a Grid

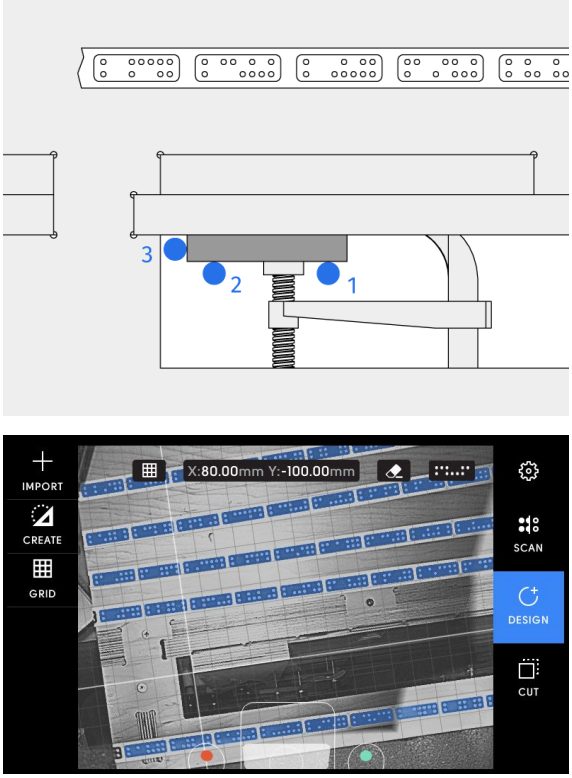


Figure 6

Set up a “virtual grid” on top of your workpiece, with its origin (X and Y = 0) at the front left corner of your stock as shown in Figure 6. This will allow you to accurately place the digital template generated by the Box Joint Basic Extension.

In order to create a grid, Origin is going to ask you to probe your workpiece in three places with a round shaft placed in the spindle. The first two probes on the south (near-to-you) edge of your stock will establish the grid orientation as well as Y = 0. The final probe on the left edge of the stock establishes X = 0.

First, enter Design Mode by selecting “Design” on the right-hand side of the screen. Select “Grid” on the left. Here you will see a few options, including the grid spacing increments and your probe diameter. We’re going to choose the default ½” grid spacing. Because you’ll be placing the box joint template at (0,0), the grid spacing doesn’t really matter (and in any event, it can be changed later). The bit diameter setting should match the diameter of whatever will be in the spindle when you probe your stock.

To probe accurately, we recommend that you put a smooth precision-ground dowel in the spindle. You can also approximate this by inserting the engraving bit in the spindle point-first. Don’t clamp the spindle collet onto the sharp edges of a standard router bit.

Alternatively, it is possible (but not recommended) to use the sharp flutes of a router bit while probing. This will save you time changing tools, at the possible expense of accuracy and also scratching your work surface. If you choose to do this, make sure to rotate the flutes of the bit so that the diameter of the tool (rather than a gap between flutes) is what makes contact with the edges of your board when probing.

Once you have the probe in your spindle, press the “New Grid” button on the left of the screen. Directions on the tool will guide you through the rest of the process. We’ve included the recommended probe points in Figure 6 (above).

Designing with Box Joint Basic

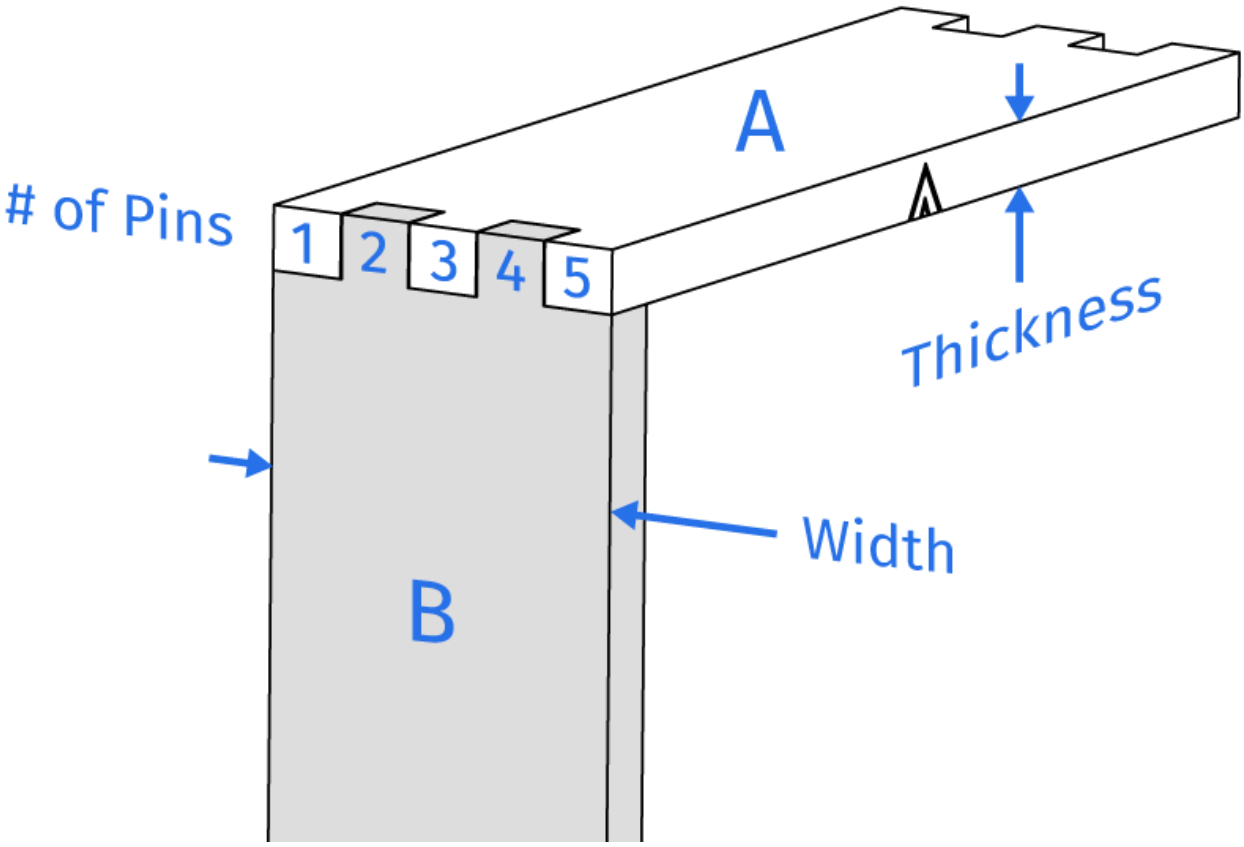


Figure 7

You are now ready to start designing the joinery for your box! Box Joint Basic lets you customize your joint, and then generates the digital templates needed to accurately route pins that match your design.

There are a few key parameters that you will need to define:

Pin Count

This is the *total* number of pins in the joint, including those found on both joined pieces. In Figure 7, the total pin count is 5, with three pins belonging to Side A, and two belonging to Side B. Note that we define Side A as the board with the greater number of pins. For an odd-numbered total pin count, this means that Side A will always have pins on the outside edges. An even-numbered pin count will result in the same number of pins on both Side A and Side B, and each side will have one pin on an outside edge.

Tool Diameter

This is the diameter of the cutting bit you intend to use while cutting. With this information, the extension is able to generate a digital template that will allow enough room for the tool between pins, and that extends far enough beyond the top and bottom of the stock to ensure the tool fully exits the cut before starting on the next. A ¼" diameter bit is used in this example.

Thickness

This is the actual thickness of the board. We recommend measuring with calipers. The board thickness in this example is 0.5".

Width

This is the actual width of the board. This will be used to determine the width of each pin, so it is important to get it correct. We recommend measuring with calipers. The board width for this example is 3.0"

Figure 9

Glue Gap

The glue gap adjustment allows you to specify a designated clearance between pins. This number represents the **total** clearance at each interface (i.e at each blue line in Figure 9). You should strive for a fit that allows the boxes to glide together, rather than a tight fit that requires force to assemble. A gliding fit will provide room for glue; this becomes especially important when you are fitting all four joints together simultaneously during assembly and gluing. The default setting of 0.005" should provide an adequate starting point. We recommend doing a test cut on two pieces of scrap material. Keep in mind that you can always use the onboard Cut Offset function to further adjust the fit after making the digital template.

Pro Tip:

The better your cut quality, the lower the gap that is required to achieve a gliding fit. You can achieve higher quality cuts by moving Origin smoothly and steadily, and by using a finish pass at your final depth (which is described in more detail later on).

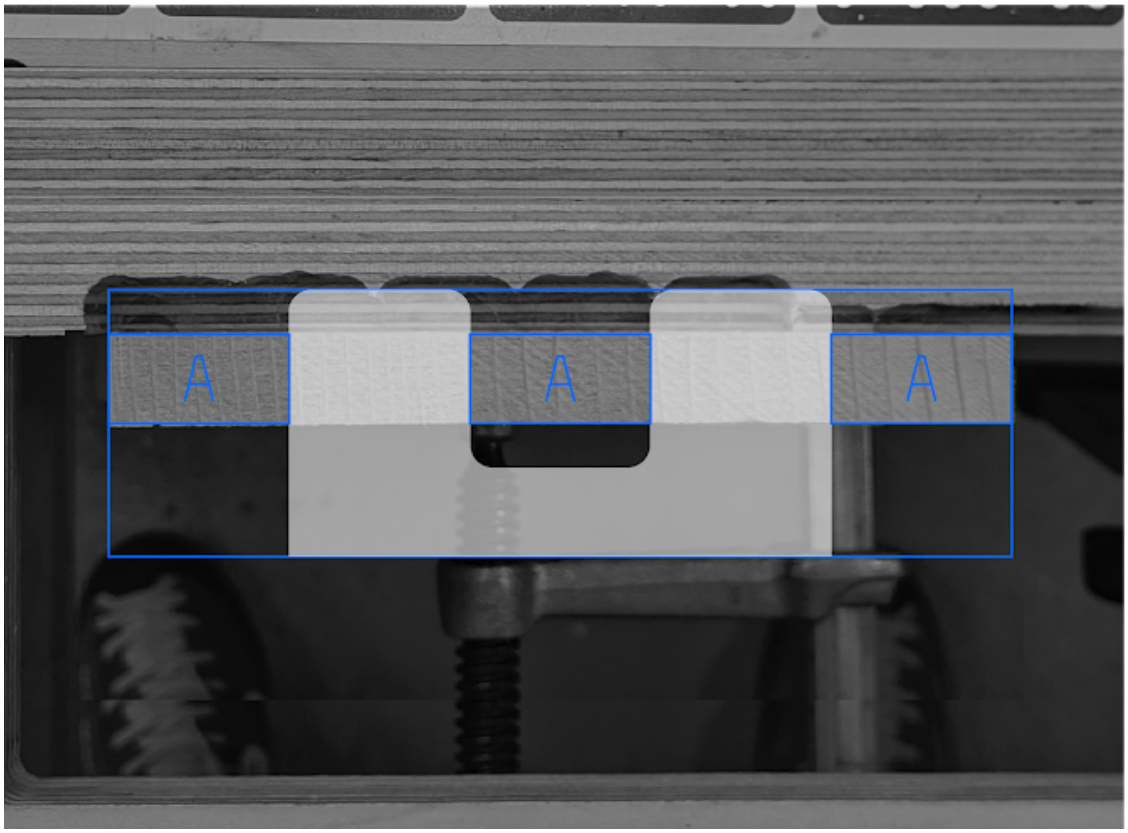


Figure 10

Side

The “swap” button, located at the bottom center of the screen, lets you flip between Side A and Side B. Remember: for a joint with an *odd* total number of pins, Side A will have the greater number of pins, with pins on both outside edges.

Note: *You can swap between sides once the digital template has been placed, so you won’t need to go back into the Extension to create Side B after you cut Side A.*

As you input the joint parameters, the digital template shown in the center of the screen (Figure 10) will update. There are a few key elements of the template that are worth pointing out.

First, you will notice blue boxes labelled either “A” or “B”, which represent the pins that will remain after you are done cutting. These are a reference to give you a better picture of the end result. The grey area that looks like a comb is the cutting template itself. By routing along the inside of this path, you will generate the pins of the joint. This is quite similar to the “old-fashioned” router templates you might have used with a follower or bearing bit

Step 7: Place Your Box Joint Template

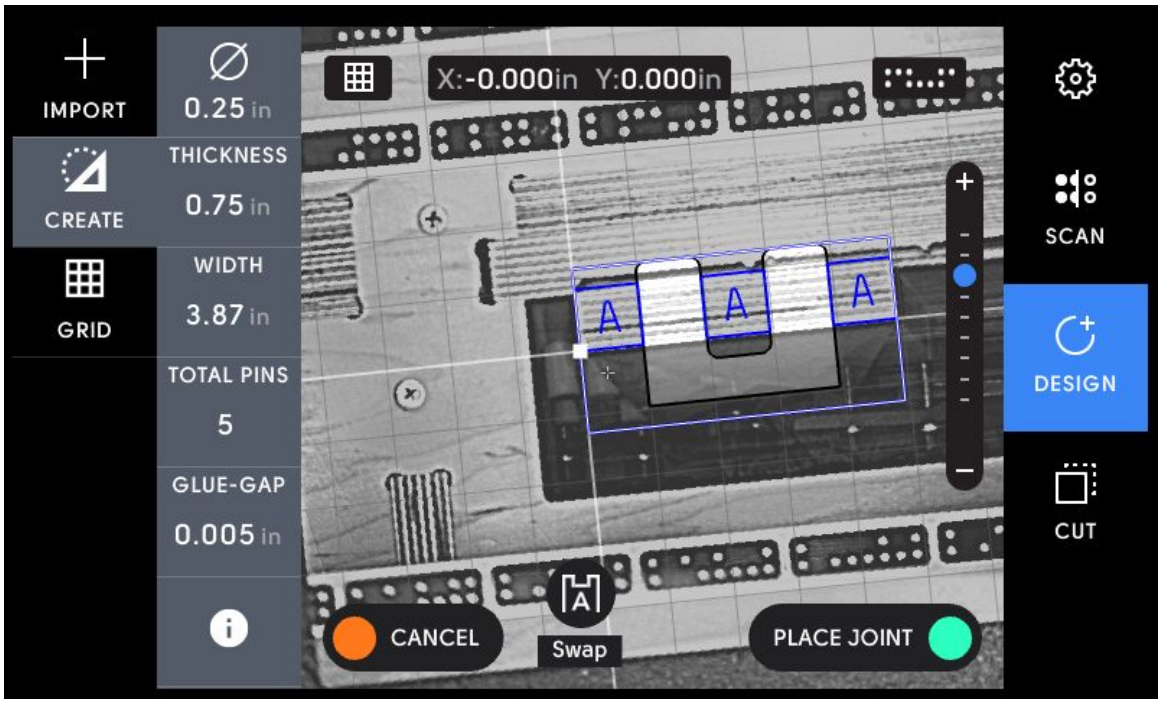


Figure 11

Once you've entered your joint parameters, move Origin so that the anchor point of the digital template is approximately over the lower left corner of your board. Because you created a grid earlier in the process, the template will automatically "snap" to the nearest grid point, which in this case will be (0,0). Confirm that the position of the tool reads "X:0.000, Y:0.000" at the top of the screen, and then either select "PLACE JOINT" or press the green handle button. The digital template for cutting pins into your board should now be perfectly aligned, and you are ready to start making some sawdust!

Cutting Your Box Joint

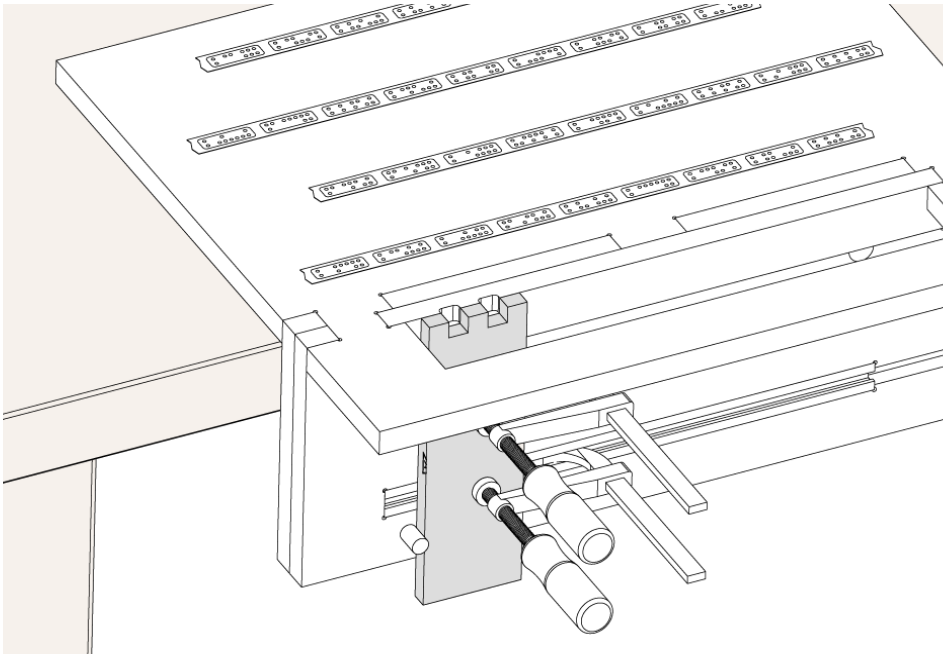


Figure 12

You are now ready to cut! Go into Cut Mode by clicking “Cut” on the right of the screen. Next, confirm that your router bit is installed, that the diameter is entered correctly on the left of the screen, and that you have zeroed your bit by performing a Z touch. Make an Aircut (cut depth of -0.05”) to ensure that you will not be cutting into any material other than your spoilboard and stock.

Now move the tool so that the center cross-hairs are located just inside the bottom left corner of the grey comb. This starting point will place you off the edge of your board, which will help you achieve a more consistent cut by plunging to depth in the air rather than plunging into your stock. You will see the cut path highlight as you move over it.

Option A

If you are using a hardwood and are unfamiliar with using Origin on end grain, you can use a more cautious cutting sequence. Cut the pins in several passes with offsets, followed by a finish pass:

Pass	Depth	Offset
First	0.25”	0.055”
Second	0.50”	0.055”
Finish	0.50”	0”

The distance between pins in this example is 0.6” (3” / 5 pins), so by cutting with a ¼” cutter and an offset of 0.055”, no material is left in the middle between the pins. If the distance between your pins is greater than the sum of the cutter diameter and the offset, you may want to use a larger offset (with multiple offset passes).

Option B

If your stock is a softer wood and you are familiar with operating Origin in end grain, you can take a more efficient, aggressive approach to speed things along. Make a first pass at full depth with a smaller offset and clear out the remaining material between pins with a pocket cut. Use a sequence of passes like this:

Pass	Depth	Offset
First	0.50”	0.01”
Finish	0.50”	0”
Pocket	0.50”	Removes the material left behind

Once you have all the parameters (bit diameter, cutting depth, offset) entered, you can begin cutting. Ensure your dust collector is attached and turned on. Then, turn on the spindle, tap the green button, and wait for the tool to plunge to your initial depth. Follow the dotted toolpath. Try to move as smoothly as possible for the highest possible cut quality. After you’ve made it around the entire toolpath to where you started, tap the red button to retract, and turn off the spindle.

Step 8: Cut the Mating Piece

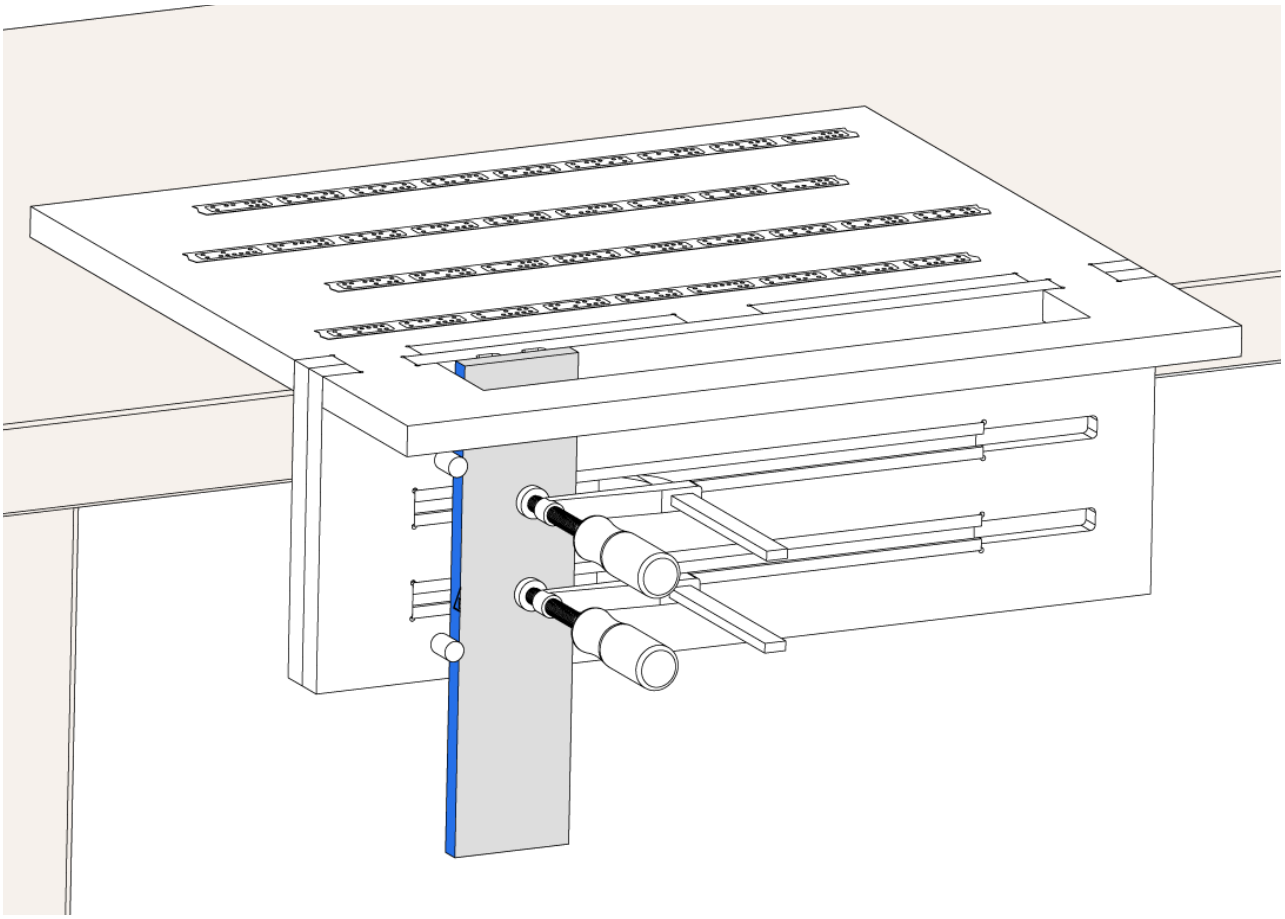


Figure 13

Next, cut pins into a mating B-Side board so that you are able to check the fit of your joint early in the process.

Install a mating B-Side board into the vertical workstation, being mindful to follow the fixturing instructions of Step 4 as pertains to the reference surfaces. To recap, the board's reference surface (bearing your marking) must be in contact with both fixture datum pins, and the top edge of the board must be coplanar with the top surface of the fixture.

Move Origin over the A-Side digital template, and press the "Swap" button that appears at the bottom of the screen. You are now ready to begin cutting the mating joint. Follow the same procedure as in Step 9.

Step 9: Test-Fit the Joint

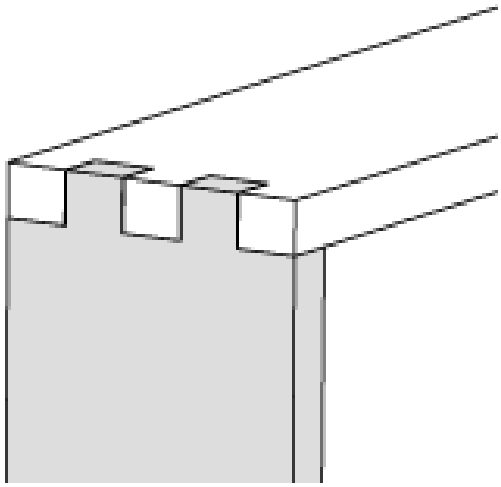


Figure 14

Before cutting the remainder of the joints, it is worth checking the fit early. Try to assemble your two pieces as shown in Figure 14. Ideally they will require no force to slide together, but won't have excessive free play or big visible gaps. If the fit is too tight, you can simply adjust the glue gap in your template and cut the joint again.

Make sure that the tips of the pins are either flush with the outside face of the mating part, or that they extend slightly. If they extend, you'll need to sand or trim the pins to be flush, but this will be much easier to correct than pins that are too short. To adjust the pin length, simply change the cut depth value on your finish pass. Note that any changes you make to your template file will result in a new file that will need to be placed again in your workspace prior to cutting.

Step 10: Cut the remaining joints

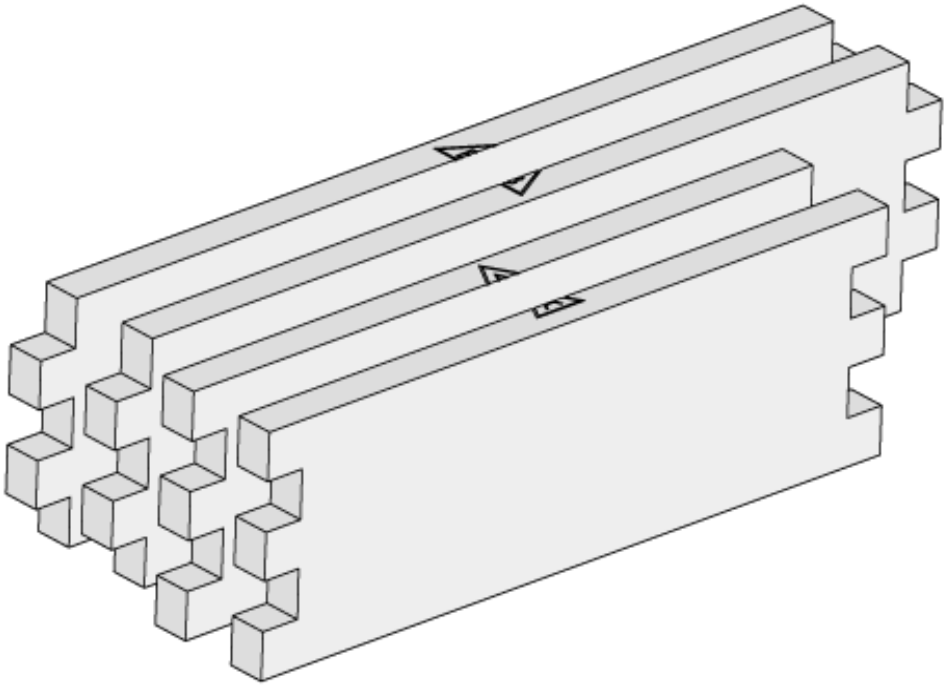


Figure 15

Now that you've confirmed your fit, you can make the remaining cuts. Flip over the piece that is in the fixture, being careful to maintain the same marked reference surface against the fixture datum pins, and cut the pins. Repeat the process for the remaining pieces, always minding the datum surface, and making sure you are using the correct side template for the type of piece (Side A or Side B) you are cutting.

Step 11: Route Dado for Bottom Panel

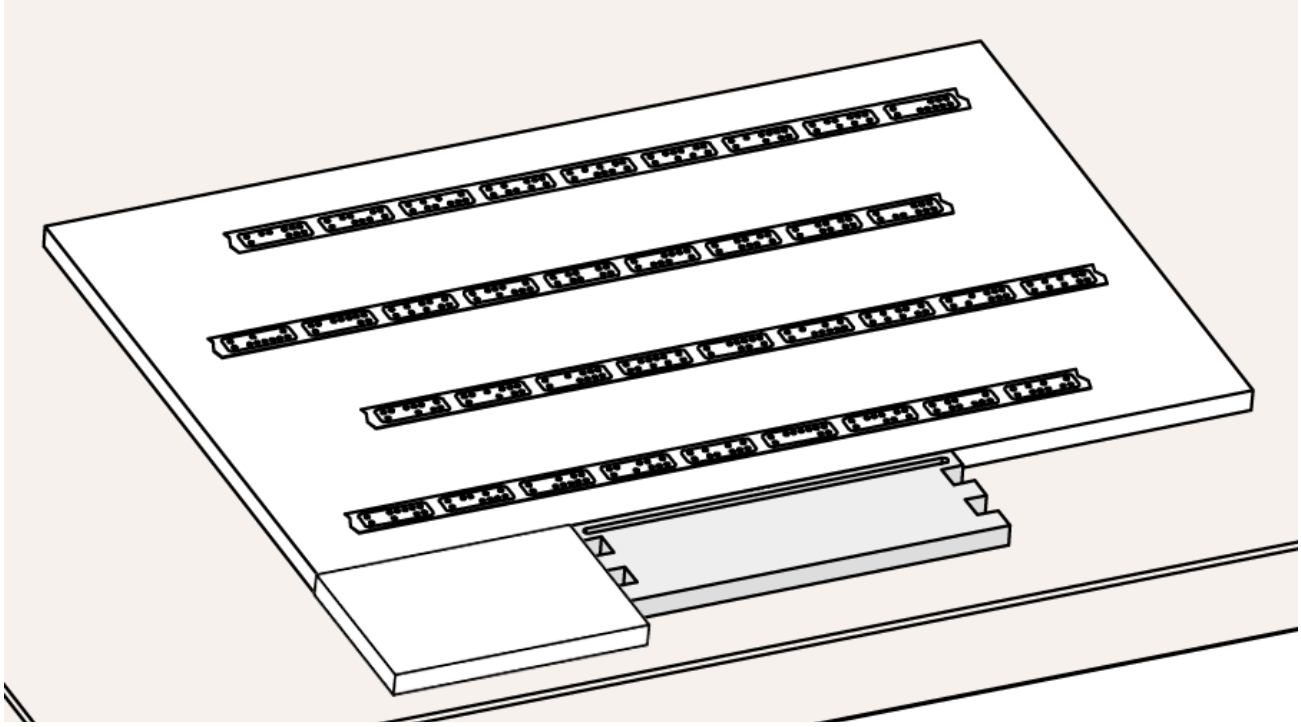


Figure 16

Most boxes need a bottom, and in this step we will quickly show you a method for using Origin to route dado grooves to hold the bottom panel in place. You can use a table saw to cut this dado, but using Origin makes it easy to cut a blind dado in just a few steps.

Secure a tape board to your bench and place ShaperTape on it. Make sure that your tape board is the same thickness as your stock. Secure an additional piece of ½" thick material on the left side of the south edge of the tape board (see Figure 16). You'll be placing all four pieces of stock in the corner created by this index piece and your tape board and this will make it easy to insert each piece of stock and use the same grid each time.

Secure your first A piece so that it is flush both to the tape board and to the indexing piece. You'll be cutting on the side nearest the tape board. Scan your tape board. Note that the area your stock will occupy doesn't need to be visible on the scan.
Create a grid like you did in Step 6. Probe twice along the south edge of your stock for your x axis, but this time, probe once against the right side of your indexing piece for your y axis. Note that this will place your y axis ¼" (the diameter of your probe) inset from the left edge of your stock. Make your grid increments ¼".

Use the Pen Tool to create the cut path for your dado. Place your first point at (x=0, y=-.25"). Place your second point at (x=8.00", y=-.25") and tap the green button again to complete the cut path. This will give you a blind dado that ends ¼" from each edge of your A piece.

Insert a ¼" cutter and move Origin to one end of the cut path. Make an aircut (cut depth of -.05") along the entire dado to make sure that you have good tape visibility throughout your intended cut. Make your first pass at ⅛" depth and insert your box bottom to check its fit. Make a second pass at .3" depth. This will allow for a little room during assembly while still ensuring a snug fit.

Remove your stock and replace it with the other A piece. Keep track of your alignment so that you will still be cutting the side of the stock that will be the inside of the box after assembly. Secure your second A piece against your tape board and indexing material. Erase your cut history and make the same cut again. Make your first pass at ⅛" and your second pass at .3".

Remove your stock and replace it with one of your B pieces. Align and secure it so the edge where you will cut your dado is flush with your tape board. Erase your cut history and erase the cut path of your previously-cut dado by switching to Design Mode and selecting Erase.

Use the Pen tool to create a dado the full length of your B piece. Make your first pass at ⅛" and a second pass at .3". Remove your B piece and place your second B piece flush with the tape board and indexing piece. Check your orientation to make sure that the dado will be on the correct side of the inside face. Erase your previous cuts and make a cut the full length of the piece again. Make one pass at ⅛" and a second pass at .3"

Step 12: Dry Fit

Press-fit all five pieces of your box together to check fitment.

Step 13: Glue Everything Together!

Disassemble your box, glue all four mating joints and clamp your box together. You can leave your box bottom to float free as it will be secured by your clean, precise joints.

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