Here's the Missing Piece!

Ps

This version of this tutorial uses Adobe Photoshop. For those who don't have Photoshop, here's tutorial which uses the GIMP software which is free.

http://brucephilpott.com/tutorials/missing-piece-gimp.pdf

Your puzzle is finished! It's beautiful except it's missing a piece or maybe a few. You've looked everywhere and it's nowhere to be found.

Not only is this disappointing, you don't want to pass this puzzle along to others if it's missing pieces. This tutorial is about the steps I take to create a replacement piece.

First, realize the replacement pieces won't have exactly the same gloss or matte finish or texture as the rest of the puzzle, and the edges won't be rounded down by the cutting die. They might not even match perfectly in color, having come from your inkjet printer. The replacement piece(s) will be far better than a hole, and much better than attempting to guess and draw the image with colored pens and pencils.

Here's what you'll need in addition to a computer:

- **Two broad, thin, stiff pieces of card stock for lifting an area of the puzzle intact and flipping it so it will slide onto a...**
- **Flatbed scanner (all-in-one printers have them)**
- **A printer and white paper**
- **Non-corrugated cardboard similar to the thick stock of your original puzzle pieces. You can sand it to match the thickness.**
- **Spray adhesive or glue. Do not use water-based glues such as Elmer's or YES. They can saturate the paper, causing it to warp. I prefer spray adhesive, but sometimes use UHU petroleum-based glue in a tube.**
- **An X-Acto knife and maybe an 1/8" round chainsaw file**
- **A cutting board**
- **Dremel (electric grinding tool) with a fine burr and eye protection**
- **and maybe a piece of black or other very contrasting paper (as you'll see)**

The puzzle used in this demonstration is Amsterdam, Netherlands *by Websana Games.*

I'll speak as if you're working with one missing puzzle piece (the one with the left of those three X windows). Do the same for each missing piece as we move along. You'll scan the clusters of pieces all at once (if possible), print the new pieces on the same sheet, etc. for the sake of efficiency.

The two distinctive alignment points I've chosen are circled in green above.

We're going to make a replacement puzzle piece in six stages:

1. **Scanning part of the puzzle surrounding the vacant space**
2. **Scanning the poster of the puzzle or the image on the box**
3. **Precisely selecting the shape of the missing piece**
4. **Accurately aligning the poster image on your puzzle image**
5. **Testing and correcting the color of the replacement piece**
6. **Printing, mounting and cutting out your replacement piece.**

Scanning the surrounding puzzle pieces

Before you begin to scan, look at the area around your missing piece. *Find two easily recognizable points* a couple of inches away from the empty space *which you can use to align your image patch*. Notice the places I circled in green, above. I want to be sure to include those distinctive parts of the image in the puzzle pieces I scan *and* in the section of the poster I scan.


As you see at the left-bottom of this page, slide one piece of your stiff card stock under the puzzle pieces surrounding the missing piece area (like a spatula), and place another piece of card stock on top. Hold top and bottom card stock pieces against each other to keep this "sandwich" intact, and gently flip the image side to face downward. You want the image side of the puzzle to be face downward and slide, intact, onto the glass of your flatbed scanner.

Surrounding pieces face-down on the scanner

Before you scan, consider the color content of those puzzle pieces. If the scene on that area of the puzzle is all dark grass and dark earth, the light cover of your scanner will contrast beautifully with those puzzle pieces. If the pieces have a bright, snowy scene or anything resembling the scanner cover, you'll need to lay a contrasting, solid color paper on top of those pieces. For example, if my missing puzzle piece is surrounded by snow, I can put a piece of red or dark blue, etc. construction paper atop my pieces, and the scan will show a clearly defined area in the shape of the piece I want to create.

Scan the puzzle pieces at the 300 dpi (dots per inch) setting. Carefully follow the spatula/sandwich procedure
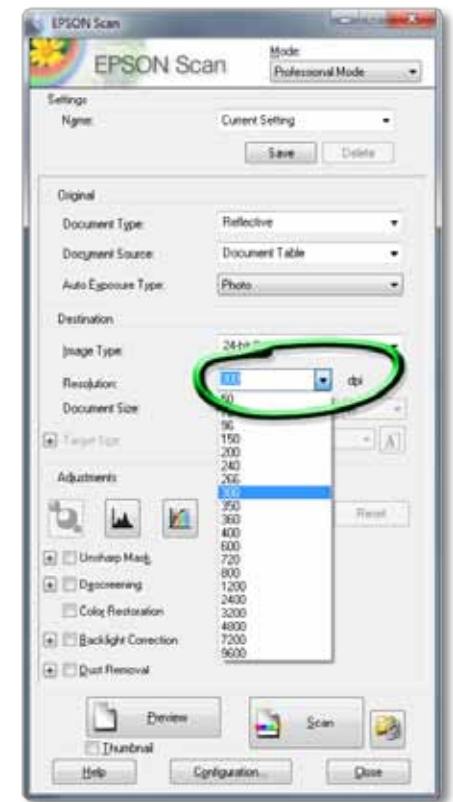
Scan the puzzle pieces at 300 dpi.

to remove those puzzle pieces from the scanner glass and put them back in the assembled puzzle.

Scanning the poster of the puzzle

Measure the long edge of the puzzle and compare it to that measurement on your puzzle poster (or box top image). Divide the puzzle measurement by the poster measurement.

This particular puzzle is 28 inches wide and the poster is 16.5 inches wide. That means the puzzle is 1.7 times as big.
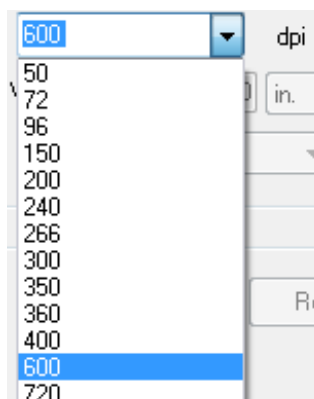
I scanned the puzzle pieces at 300 dpi and my puzzle is 1.7 times as large as the poster image, so I multiply that 300 dpi by 1.7 and get 510 dpi to equal the pixels of my puzzle pieces scan. This increase of pixel setting will prevent the replacement piece from being "pixelated" (having overly large, jaggy dots). My scanner won't let me type in a dpi, so I select the next higher adjustment offered: 600 dpi.

My wife, Susandra, suggested it would be a good idea to scan the poster before even building the puzzle and possibly finding a piece was missing. This would prevent damaging the poster during puzzle assembly before it can be scanned.

Precisely selecting the shape of the missing piece

Puzzle width ÷ poster width x 300 dpi = poster scan dpi (round upward)

Open Photoshop and press **Cont/Cmd-o** (or go up to the **File** menu and select **Open**) and navigate to the scan of the puzzle pieces to open it. I like to sharpen this puzzle-part layer a bit to help me see edges better, so I copy the Background layer (**Cont-Cmd-j**) and go up to **Filter** and select **Sharpen>Unsharp Mask** click Enter to accept the default values. You won't print this Sharpened layer (or the *Background*) - it's just to help you select the very edges of the puzzle shape). If you are missing adjoining pieces, treat them as one piece.

Make a new, empty layer (click the dog-eared paper icon at the bottom of the Layers Panel). This new layer is where where you'll define the shape of

your replacement piece. You'll notice I name my layers. You don't have to, but my having done so might make this demonstration easier to understand. Press **Cont/Cmd-s** each step of the way, to **Save** your work.

Select the Zoom Tool (magnifying glass icon or **z**), then double-click on the Zoom Tool (to go to 100% magnification) and click twice on the vacant space you want to fill (to Zoom in to 300%).

You'll use just three tools to define the shape of the missing part. The first tool is the Polygon Lasso Tool. Select it and very, very carefully click around the exact edge of the image-printed area of those puzzle pieces that surround the missing piece. Do not include the edges of the puzzle pieces or their shadows. Keep in mind that you're selecting the space which will be occupied by the new replacement piece.

I do this a bit at a time, as shown on the next page, closing a small area by pressing Enter, then starting a new, connecting area. When you mis-click where you hadn't intended, press **Delete/Backspace** to "un-click." When you've selected the entire space, examine your dashed line selection carefully. You can add areas you missed. By holding **Alt/Option**, before you begin an additional selection area, you'll notice the Lasso icon will have a minus sign
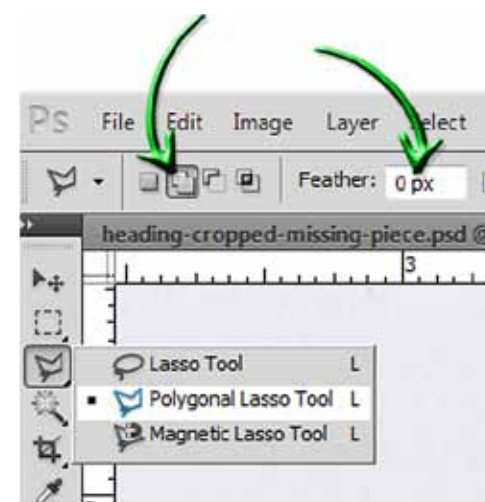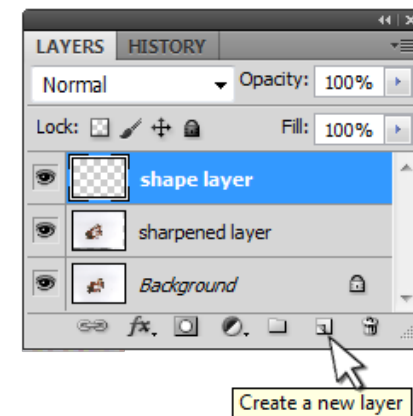
Polygon Lasso Tool with "add to" button selected, and zero Feather.

attached to it. Click and begin a selection which will subtract from your carefully made selection.

Fill the selection with black or another easily recognized color (by pressing **Cont/Cmd-backspace**). De-select (**Cont/Cmd-d**). Take a careful look at your shape.
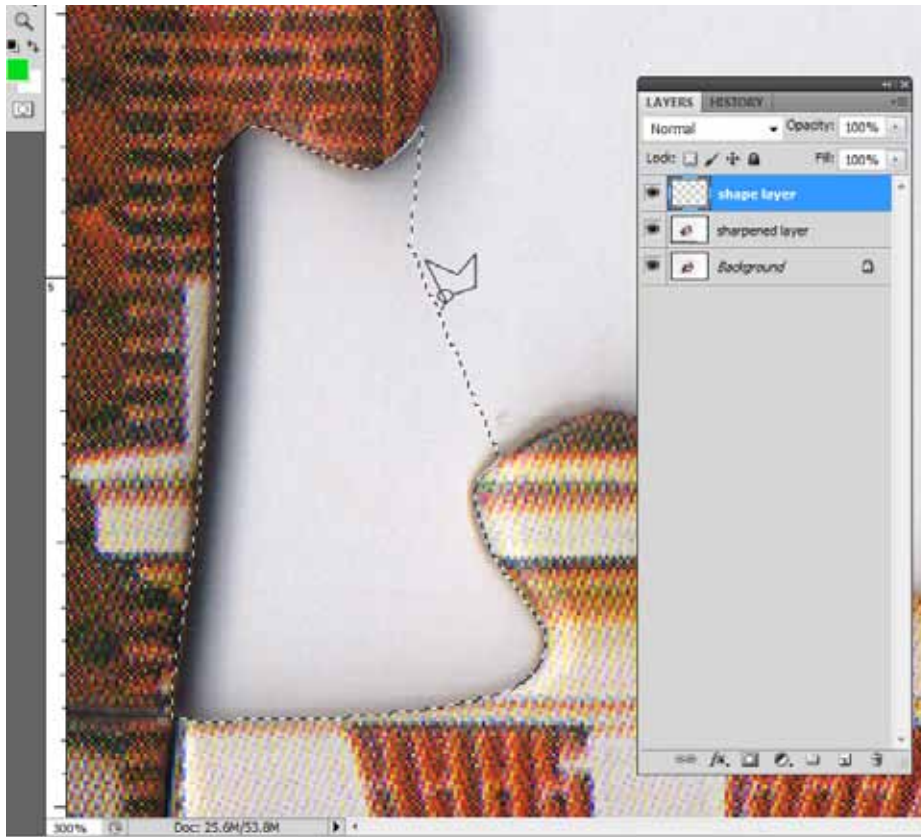

The two other tools you might want to use in adding to or subtracting from this shape are the Pencil Tool and the Eraser tool. You'll find the Pencil Tool under the Brush Tool (**b**). When it's selected, you can use the bracket keys ([and]) to increase and decrease its diameter. The round shape can be very helpful in defining puzzle knobs. You'll want to select the Pencil option when using the Eraser Tool (**e**) to subtract from the shape on your shape layer, for the same reason.
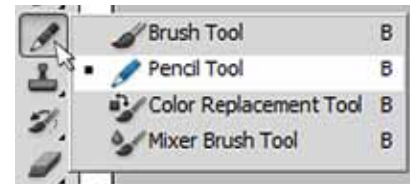
On your new layer, by itself, you should have a solid shape precisely the shape of that puzzle piece! Do any trimming necessary to make this shape exactly the shape of the missing piece.

By clicking on the eye icon of your shape layer, you can turn off and on the visibility of that layer to carefully examine the accuracy of your shape. If you want to double-check before you continue, you can click
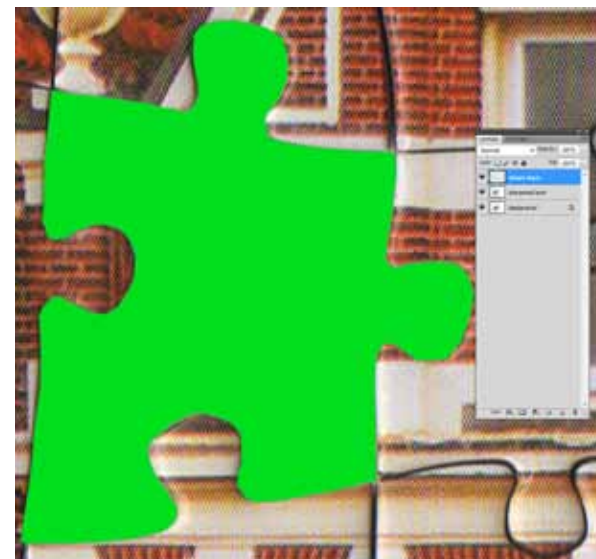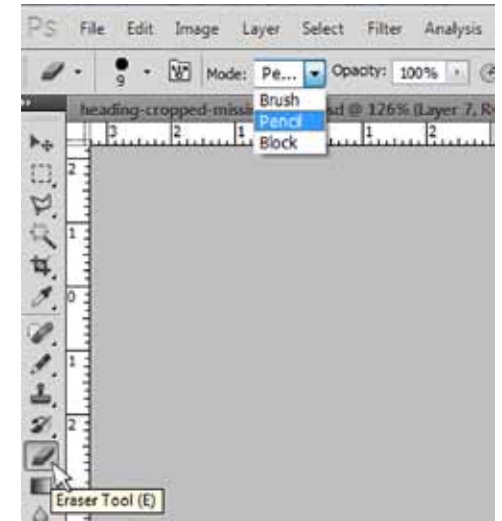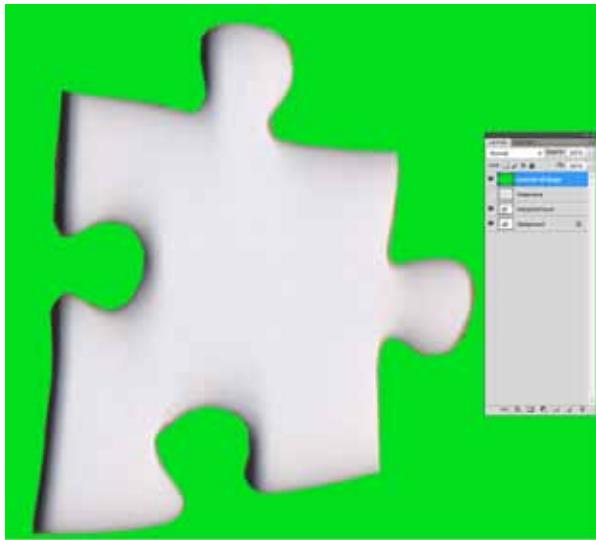

Selection filled with solid color on its own layer

again on that dog-eared page icon at the bottom of the Layers Panel to create another new, empty layer. I've named this layer "inverse of shape." With this new layer highlighted as shown, click on the thumbnail of the shape layer. This will give you a selection of that shape. Now press **shift-Cont/Cmd-i** to change your selection to the inverse (inside-out) of the previous selection, and press **Cont/Cmd-backspace** to fill this new area on the newest area. Click on the eye icon of the actual shape layer to temporarily turn off its visibility, and you can see the empty space and hopefully no bits of puzzle image area. When looking at this on my full screen,

I can see thin areas of the surrounding pieces. I'll cover those precisely using the tools I mentioned until I've covered them entirely.

The non-puzzle piece area filled with solid color on its own layer, as a test of how well I selected.
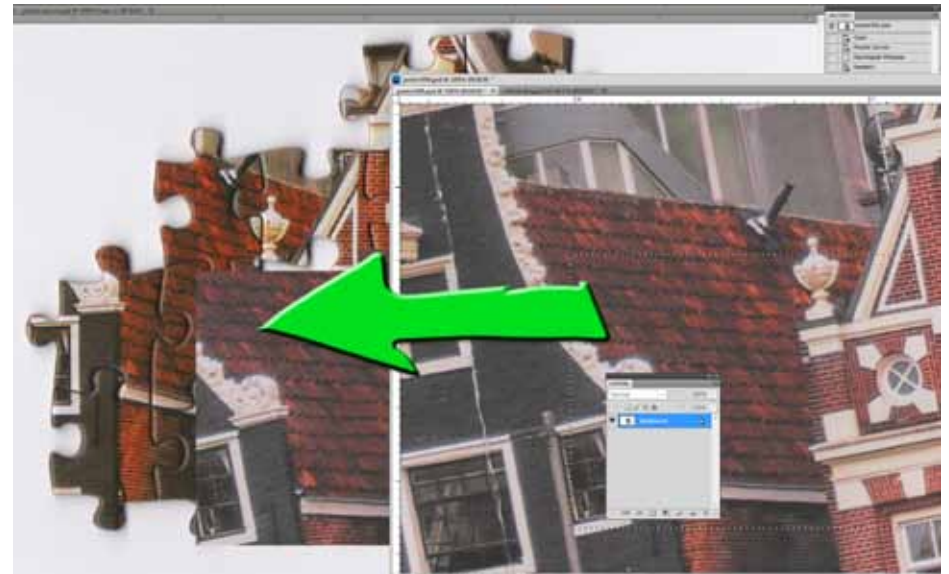
Then I'll go through the same procedure again, creating yet another new layer (which could be called "improved shape layer"), **Cont/Cmd-clicking** on the thumbnail image of the "inverse" layer (making a selection of the green area, above), doing **Cont/Cmd-i** again to turn that selection inside-out, then pressing **Cont/Cmd-backspace** again while addressed to my "improved shape layer" to fill that space with the closer-to-perfect shape. Whew! A lot of steps, but we have a pretty accurate shape for our replacement puzzle piece. Deselect (**Cont/Cmd-d**). Again, **Save** your document.

Accurately aligning the poster image on your puzzle pieces

Now, with this puzzle piece Photoshop document still open, go back up to **File** and **Open** the scan you made of the poster or box top. It will open as its own Photoshop document. Click on the name tab at the top of this frame and drag this document off your puzzle piece document, so both are visible. Use the **M**arquee tool (or Polygon **L**asso tool) to roughly select the area on the poster surrounding the missing piece (including those alignment points you chose) and use the **black arrow Move tool** to drag that area of the image from this document onto the document of your puzzle pieces we've been working on.

You'll have to reduce and rotate this image area to exactly match the image on the surrounding puzzle parts. If your missing piece is just


Dragging the selected poster area onto the puzzle piece document.

undistinguished sky, leaves, etc., you my want to skip this part. (If it has any important details, continue.)

Here's how: First, click on the eye icon on the layer that shows the shape of the piece. That will turn off the visibility of the shape layer we made. Then at the top of the Layers Panel, reduce the opacity of the image layer you just dragged in making it translucent, just enough that you can see *through* it, seeing that image and the puzzle parts beneath it on the Background layer.

In a moment, you're going to Transform this translucent layer of the image. I'll have you hold down two keys while Transforming in addition to using your mouse, plus a helpful trick. Holding the **Shift** key while Transforming by click-dragging a corner will keep the height/width proportions the same as you enlarge/reduce and rotate. Holding the **Alt/Option** key *while* holding **Shift** will make these Transformations happen centered on the crosshairs at the center of your Transformation.

*Eye (visibility) icons*

Thumbnails
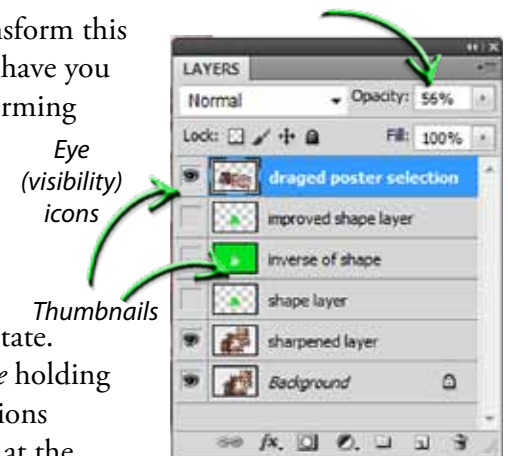
Drag that now translucent poster image layer so one of your target spots (the corner of that white window trim in this case) is precisely over that exact spot on the puzzle pieces. Press **cont/cmd-t** to Transform.

Now here's the trick: with the Transformation frame active, carefully click on that center axis crosshair at the center of the transformation and **drag** it (as shown below - that long green arrow) from the center of the transformation rectangle (where it normally lives) to that first target spot...
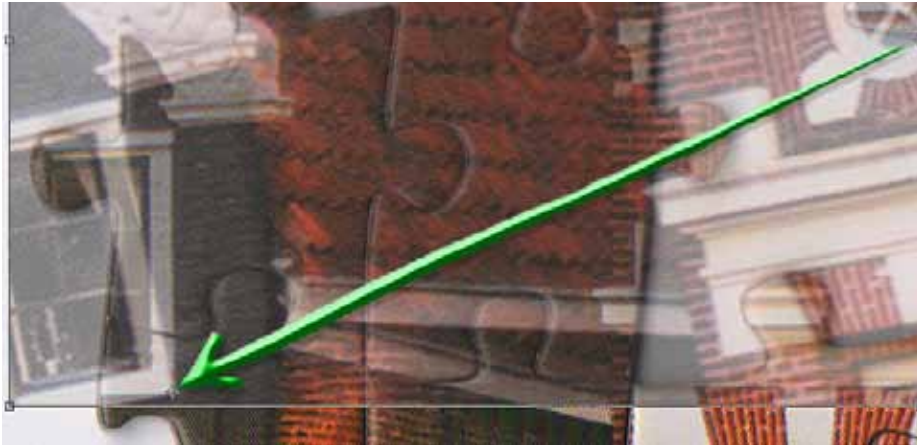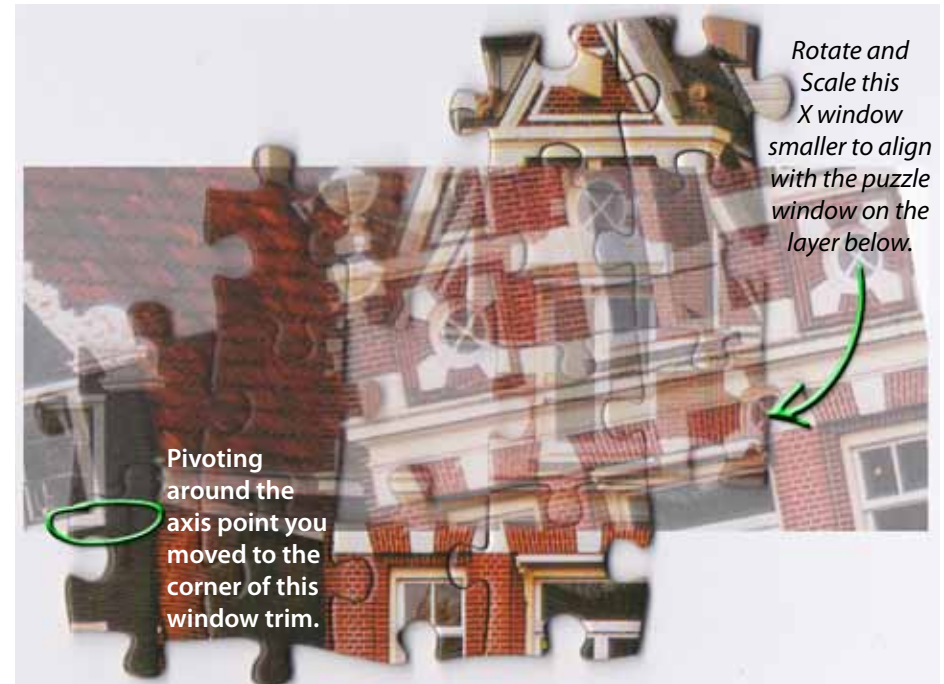

You'll have to magnify this image as much as you can to be able to see the center axis crosshair I'm speaking of, which you'll move to one of your alignment points.

the one where you just aligned the image spot with the corresponding puzzle spot (in this case, the corner of the white wood trim. Release your drag and bring your cursor to a far corner handle of the transformation. Then, while HOLDING **Shift** (to keep the proportions equal), and **Alt/Option** (to make the Transformation happen relative to your first target spot), drag the corners to enlarge/reduce/rotate the image (don't let go of **Shift** and **Alt/Opt**) rotating as needed, until the second target point lines up with its puzzle target point exactly, as shown below, and click to accept the Transformation. *Whew!*

Center axis crosshair
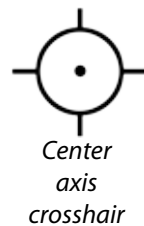
You've successfully lined up the image for your new piece! Bring the opacity of that poster section layer back to 100%. While still addressed to that poster layer, **Cont/Cmd-click** on the thumbnail image of the turned-off puzzle piece shape layer; this will select that shape.

Press **shift-cont/cmd-i** to invert this selection (selecting everything BUT the puzzle shape) and press your **Delete/Backspace** key. This will remove everything on the poster layer except for the puzzle part image area.

Rotate and Scale this X window smaller to align with the puzzle window on the layer below.

Pivoting around the axis point you moved to the corner of this window trim.

Place your cursor outside the upper right corner in this case, to rotate (around that moved Center point) and scale by dragging the corner handle to (in this case) align the X of the window on the poster with the X on the puzzle piece.

Many people would be happy to leave it at this, but I like to add one more brief step to make it easier for myself later on. I'm going to show you how to easily put a narrow border around your puzzle part image, which will make it easier to trim the piece after you've printed it and mounted it.

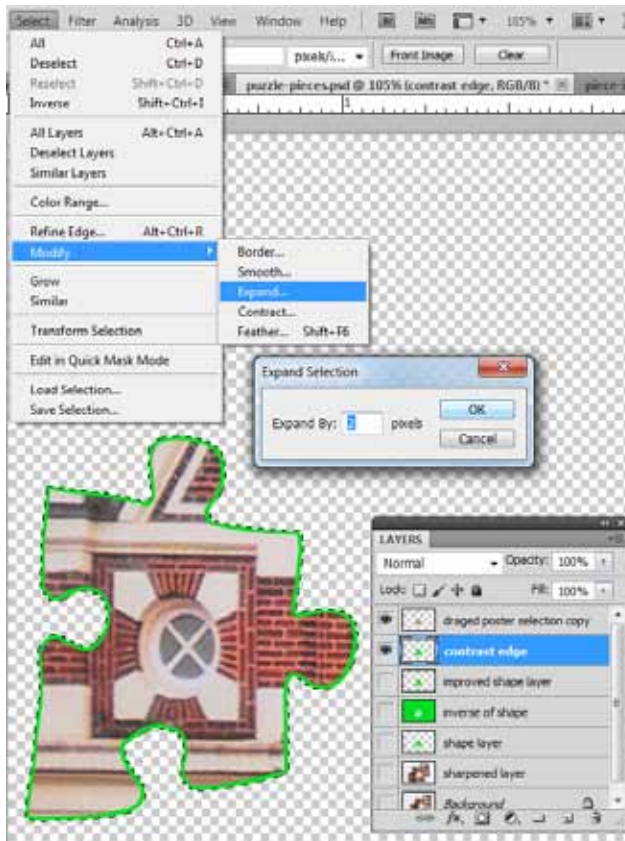*The missing left X window (translucent here). Puzzle piece image aligned in place!*

It's simple: Select a color which is distinctly different from those on the puzzle piece. Make another new layer. **Cont/Cmd-click** on that previous shape layer to get that shape as a selection again. Go up to the

The replacement puzzle shape with its image in place.

top of your computer screen and click on **Select**, drag down and click on **Modify>Expand**; enter "2" for the number of pixels you want to enlarge this selection in every direction. Then fill that enlarged selection with your chosen color on your new layer (**Cont/Cmd-backspace)**. Deselect. Now

Cont/Cmd-click on the previous image shape layer again, making a selection of the image shape. You're still on your latest enlarged image shape layer; click **Delete/Backspace** to remove this actual image shape from what's now a contrasting border surrounding the image on the new piece. (Repeat all these steps for each missing piece. If there are contiguous missing pieces, treat that whole area as one piece.

Testing and correcting the color of the replacement piece, printing

Your poster or the image on the box was probably made on a different press using different inks than the actual puzzle, so it would be unlikely for them to be a very accurate color match. Add to this the variables of your scanner, your computer, and printer, and it's not surprising that your first version of a replacement piece will look different from the original puzzle pieces.

We'll print a test sheet to see what changes have to be made in order to get the replacement piece to match as well as we can. If this were easy, everyone would have be doing it long ago. Hang in there, you'll master this!

At the right, you can see my test print is darker and more blue than the the original puzzle pieces.

We can fix that using a Curves Adjustment Layer. It's a powerful tool, but I'm only going to explain how to manually change contrast and color for our purposes. On the image you made of the outlined puzzle piece, at the bottom of the Layers Panel (shown on the following page), click on the black/white disc to see the **Adjustment layer options** and click on **Curves**.

The test print shows us what we need to change to match the puzzle.

The left part of that grid describes the darker parts of the image; the right part the lighter areas. The diagonal line represents how those light, medium and dark areas will appear. The bottom/left part of the line affects the darker parts of the image; the upper/right part of the line affects the lighter parts of the image. If you click on the far upper right of the diagonal line and pull it down a bit, you'll notice the brightest areas in the image will be reduced in brightness. Play with that diagonal line a bit and watch how your image changes.
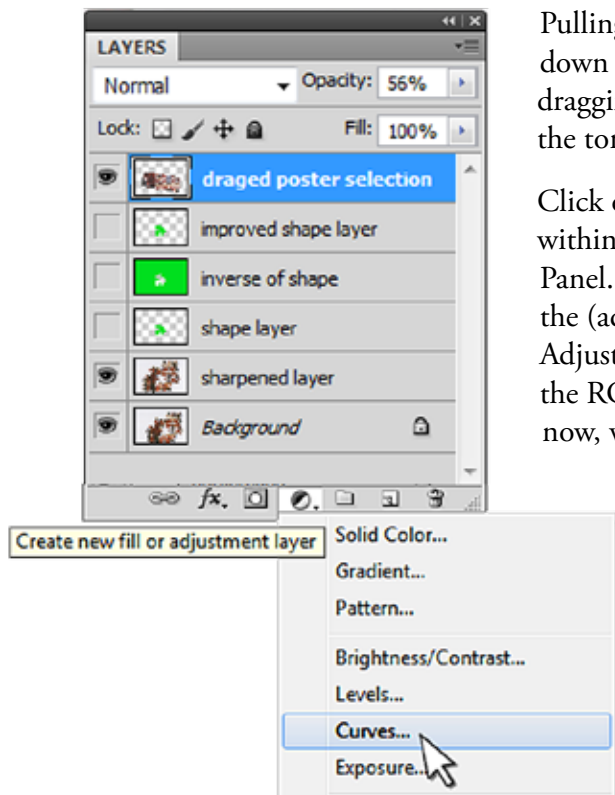
Pulling the center of the line down darkens the mid-tones; dragging the line upward lightens the tones you're controlling.

Click on the Channels box within this Curves Adjustment Panel. Red, green and blue are the (additive) primary colors. Adjusting that diagonal line in the RGB mode, as you did just now, varies them all at once. By selecting one of these channels at a time, you can, for instance, reduce the amount of blue in the lighter (or darker) parts of the image.

Let's say you see your new puzzle piece is too blue, like mine. Go to the Blue channel of the curves adjustment dialog box and pull that curve downward a bit in the middle. Does that decrease the amount of blue in the (light, medium, dark) area that needed a change? It looked fine on the computer before and the printout was too blue, so we want less blue, so reduce it.

When you have the color and contrast right, while still addressed to that (highlighted)
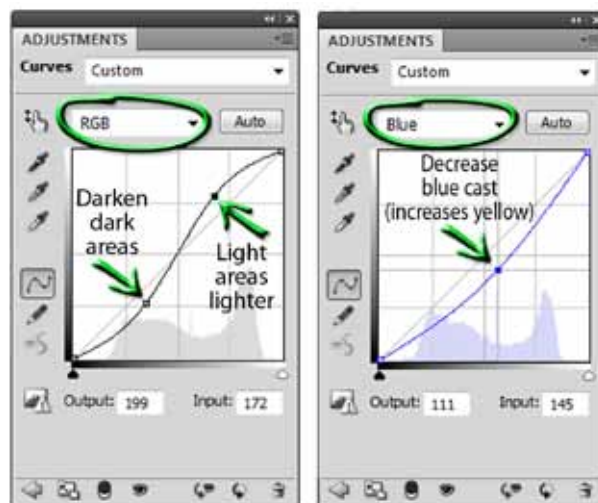
Curves layer, turn off the sharpened and *Background* layers and press shift-Cont/Cmd-alt/option and E. This will copy everything to a new layer. Using the black-arrow Move Tool, drag it into its own space. Holding alt/option, drag (duplicate) this layer a couple of more times. Now you have four outlined, color-corrected puzzle pieces to work with (in case you don't achieve perfection on the first try). Print your puzzle pieces.
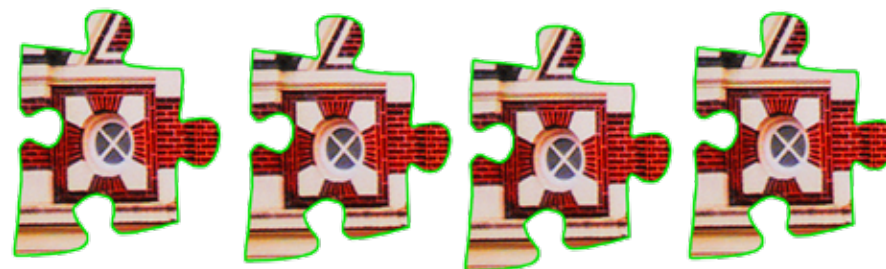
Mounting and cutting out your replacement piece

I found the thickness of the cardboard backing of a writing tablet I had plus the thickness of some white card stock, added to the piece of printer paper matched the thickness of this puzzle closely enough. That extra layer of white behind my printed paper prevented the dark cardboard from showing through. Glue your layers together following the directions on the container, clamping or weighting as needed. You might attempt to match the puzzle finish with matte or gloss spray after the adhesive has dried very well.

Use the X-Acto or craft knife in excellent light (with reading glasses if you wear them) to cut the border precisely from the puzzle piece. After carefully cutting triangular pieces out of concave round areas, you can gently grind away at them with the Dremel tool

Cutting a triangle out of an inside loop.

*The Dremel grinder with an abrasive burr grinding
that triangular hole into a round notch.*

There really wasn't a missing piece.

I was delighted with this puzzle by **Websana Games**, and all of the pieces were in the sealed plastic bag in the box. (They even included a zip-lock bag for later storage.) Since no pieces were missing, I had to temporarily remove this one to demonstrate my method of making a replacement piece.

and a burr or grinding stone plus an 1/8" round chainsaw file. Continue cutting and sanding, being careful to remove the entire border but not anything else. Try the fit of your new piece and trim as needed.

Again, this replacement piece won't be perfect, but it will match very closely and minor imperfections won't be noticed.

Piece missing

Our replacement installed