Here's the Missing Piece!

This version of the tutorial uses the GIMP program which is a free download. If you have Photoshop, you'll want my other tutorial instead:

http://brucephilpott.com/tutorials/missing-piece-photoshop.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.

You can download the GIMP image editing software for your computer for free here: https://www.gimp.org/downloads/

There's no hidden subscription or payment fee. Here's a video I found about installing GIMP on a Mac: https://youtu.be/OrCXp1MJLac

The gimp.org web page will detect which operating system your computer has and offer the appropriate version of GIMP. Be careful not to click on anything you don't want. When you've downloaded and installed the GIMP, you can continue.

This is very powerful, useful software. I'm just going to explain how to use it to make puzzle parts. If you want to learn more to harness this power, I suggest this book:
Beginning GIMP; From Novice to Professional by Akkana Peck.
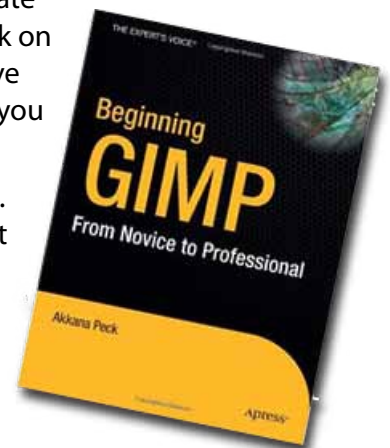
Here's what you'll need in addition to a computer and GIMP:

- **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**
- **A cutting board**
- **Dremel (electric grinding tool) with a fine burr and eye protection, and maybe an 1/8" round chainsaw file**
- **and maybe a piece of black or other very contrasting paper (as you'll see)**

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.

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

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

empty space *which you can use to align your image patch*. Notice the places I circled in green, here. 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 below, 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.
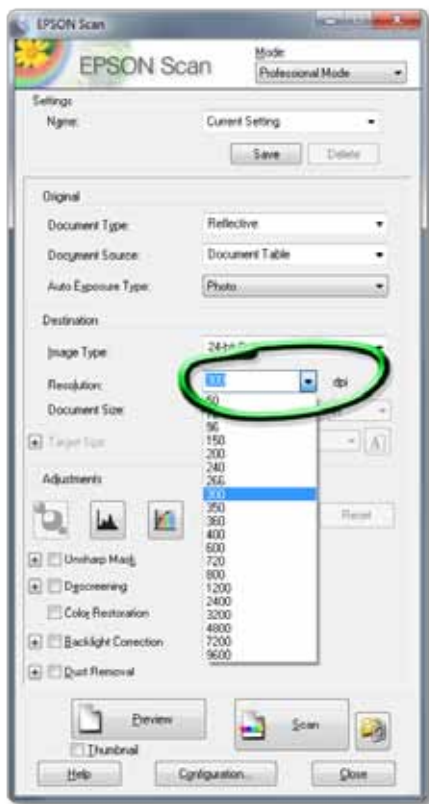

Before you scan, consider the color content of those puzzle pieces. If the scene on that area of the puzzle is all dark grass and dark earth, the light cover of your scanner will contrast beautifully with those puzzle

Scan the puzzle pieces at 300 dpi.

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 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

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

higher adjustment offered: 600 dpi. I'd rather reduce this later than have to try to enlarge it then.

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

Open GIMP 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 scan layer (right/Cont-click in the Layers Panel and click on Duplicate layer) and go up to **Filters** and select **Enhance>Sharpen (unsharp Mask).** Click **OK** or change 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.
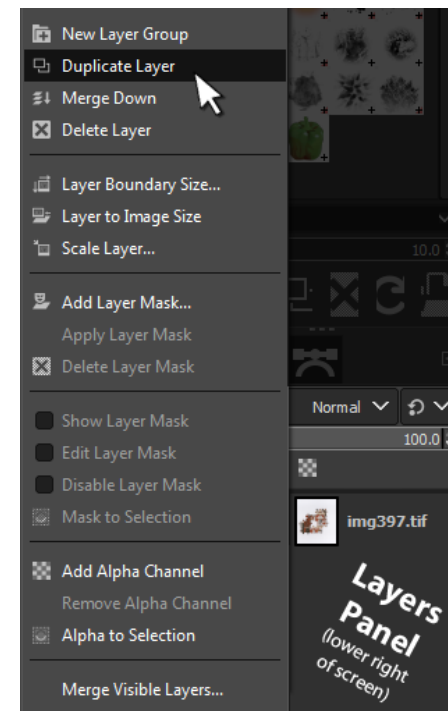

Access options by right-(Cont.)-clicking in the Layers panel at the lower right
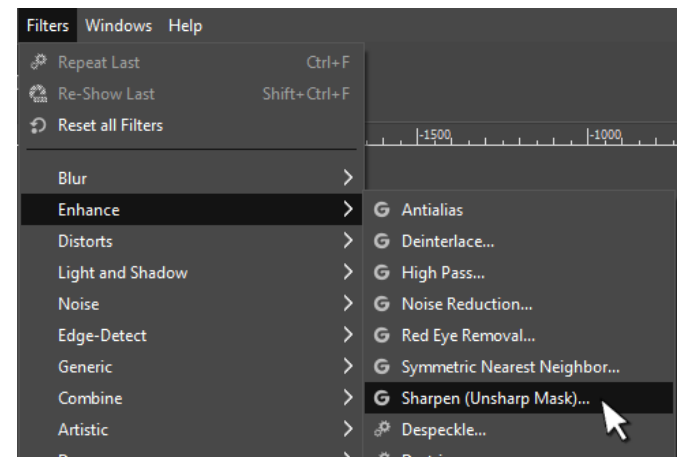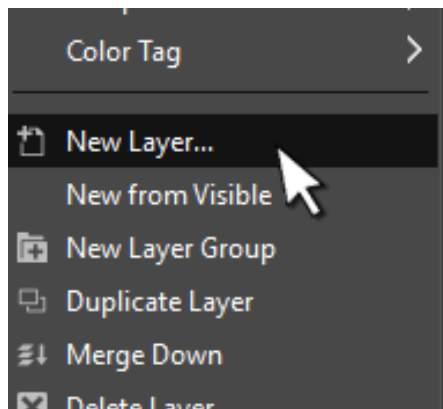
Make a new, empty layer (right/Cont-click on the Layers Panel and choose **New Layer**. This new layer is where you'll define the shape of your replacement piece. You'll notice I name my layers. You don't have to, but my having done so might make this demonstration easier to understand. Press **Cont/Cmd-s** each step of the way, to **Save** your work.

Select the **Zoom Tool** (magnifying glass icon or **z**), then click several times on the vacant space you want to fill until that area nearly fills your screen.
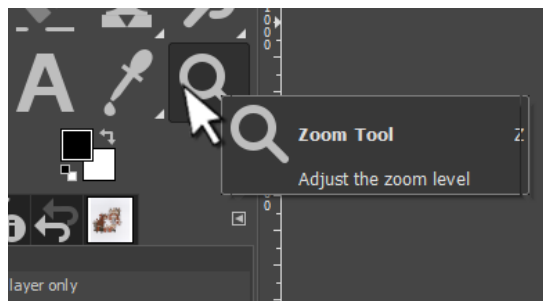
You'll use just three tools to define the shape of the missing part. The first tool is the **Free Selection Tool** (**f**). Select it and very, very carefully click
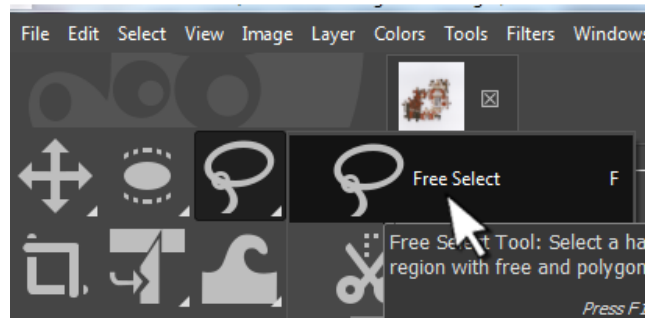
around the exact edge of the image-printed area of those puzzle pieces that surround the missing piece. The crosshair will be where the selection goes. Do not include the edges of the puzzle pieces or their shadows. Keep in mind that you're selecting the space which will be occupied by the new replacement 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 while holding **Shift**. When you mis-click where you hadn't intended, press **Delete/Backspace**
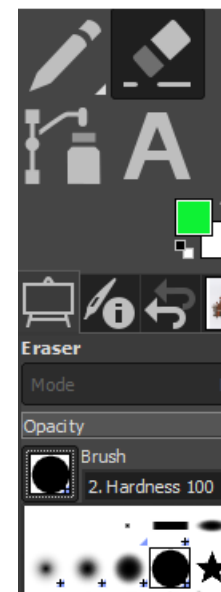
to "un-click." When you've selected the entire space, examine your dashed line selection carefully. You can add areas you missed. By holding **Cmd/Cont** before you begin an additional selection area, you'll notice the Lasso icon will have a minus sign attached to it. Click and begin a selection which will subtract from your carefully made selection.

Fill the selection with black or another easily recognized color using the Bucket Fill Tool (shift-B)and clicking on your selection. De-select (**Shift-Cont/Cmd-A**). Take a careful look at your shape.
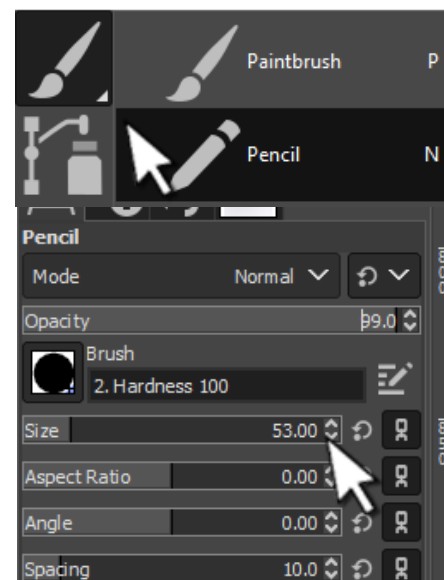
The two other tools you might want to use in adding to or subtracting from this shape are the Pencil Tool and the Eraser tool. You'll find the Pencil Tool (**n**) under the Brush Tool. When it's selected, you can increase and decrease the Pencil diameter (size) in the menu below. The round shape can be very helpful in defining puzzle knobs. Similarly, you'll want to select the Eraser

Hardness of 100 when using the Eraser Tool (**Shift-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 create another new, empty

Selection filled with color on its own layer
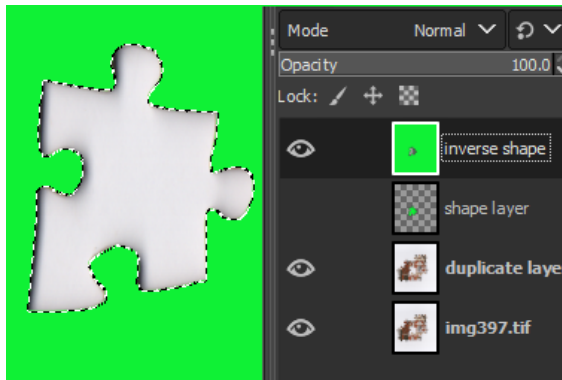
The non-puzzle piece area filled with solid color on its own layer, as a test of how well I selected.

layer. I've named this layer "inverse shape." With this new layer highlighted as shown, clicking on the colored area of this Inverse Shape layer with the **Fuzzy Select Tool** to create a selection of that colored shape.

Now press **Cont/Cmd-i** to change your selection to the inverse (inside-out) of the previous selection, and use the **Bucket Fill Tool** 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


I need to improve this selection.

precisely using the tools I mentioned until I've covered them entirely.

Then I'll go through the same procedure again, clicking on the colored area of this Inverse Shape layer with the **Fuzzy Select Tool** to create a selection of that color and creating yet another new layer (which could be called "improved shape layer"), doing **Cont/Cmd-i** again to turn that selection inside-out, then (on my "improved shape" layer) using the Bucket Fill Tool 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.
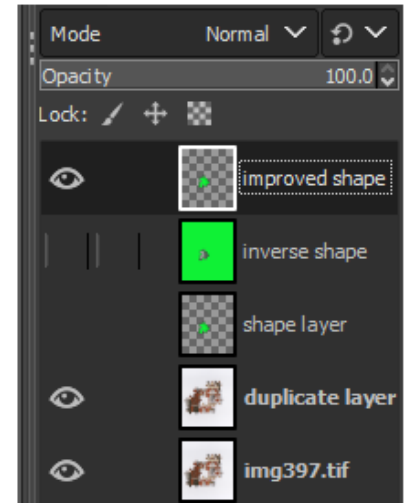

Accurately aligning the poster image on your puzzle pieces

Now, with this puzzle piece GIMP document still open, go back up to **File** and **Open** the scan you made of the poster or box top. Use the **Crop Tool** to eliminate the parts you don't need, keeping anything that might be on your missing puzzle piece and keeping the two alignment points mentioned before.
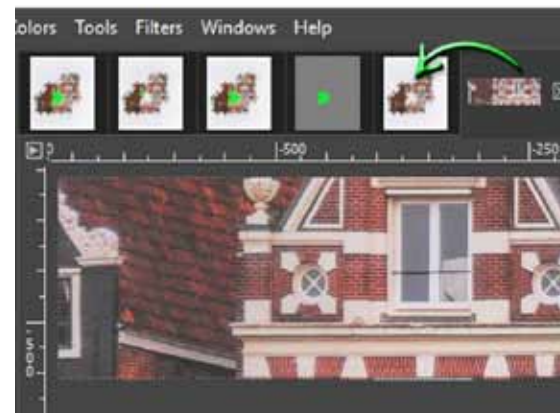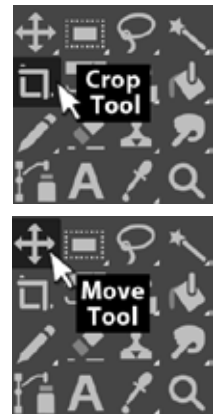

Using the **Move Tool**, click on the image tab above this cropped poster and drag and drag that tab to hover over the other image tab until it becomes active but don't release the tab yet. Drag your poster image tab down onto the canvas itself and release. *Whew!*
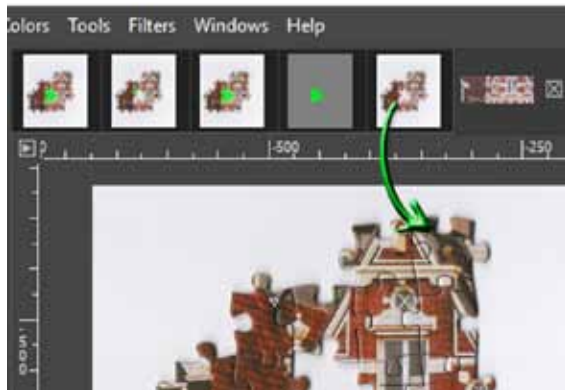
Dragging the selected poster area onto the puzzle piece document.

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

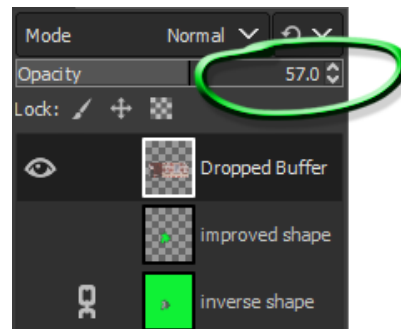Here's how: First, click on the eye icon on the layer that shows the shape of the piece. That will turn off the visibility of the shape layer we made. Then at the top of the Layers Panel, reduce the opacity of the image layer you just dragged in making it translucent, just enough that you can see *through* it, seeing that image and the puzzle parts beneath it on the Background layer.
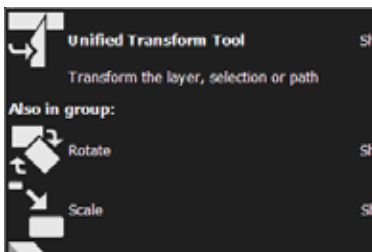
Use the Move Tool to drag that now translucent poster image layer so one of your target spots (the corner of that white window trim in this case) is precisely over that exact spot on the puzzle pieces. Use the Transform Tools to


Scale/Rotate the translucent layer until both of your alignment points on the poster line up with those same places on the puzzle pieces.

You've successfully lined up the image for your new piece! Bring the opacity of that poster section layer back to 100%. In the Layers Panel, **right-(Cont)-click** on the improved shape layer and choose **Alpha to Selection** to make a selection of that layer. Click on the poster layer (here GIMP has named it Dropped Buffer). Press **Cont/Cmd-i** to invert this selection (selecting everything *BUT* the puzzle shape) and go up to **Edit** and click on **Clear**. This will remove everything on the poster layer except for the puzzle part image area.
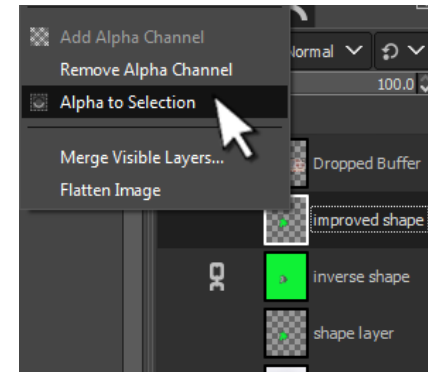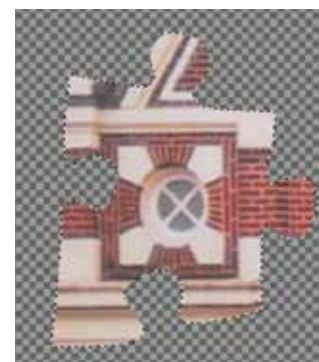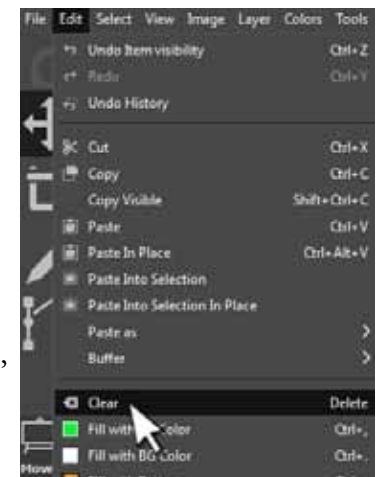

Right- click on the improved shape layer to make it a selection.
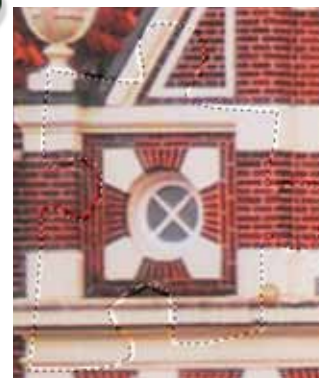
The puzzle piece area selected.

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.

It's simple: Select a color which is distinctly different from those on the puzzle piece. Make another new layer *beneath* this one.

Everything else removed.
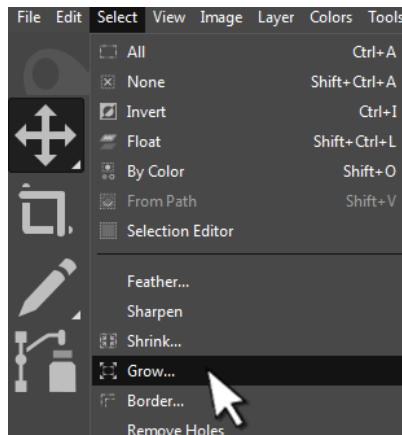
Again go to that "improved shape" layer and **Right-(Cont)-click** and select **Alpha to Selection** to get that shape as a selection again. Go up to the top of your computer screen and click on **Select**, drag down and click on **Grow**.

Enter "6" 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 (beneath the puzzle image layer) using the **Bucket Fill Tool**. **Select>None** to de-select. (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.

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

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 left, below, 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. Go up to **Color** and click on **Curves**.

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 Channel 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.
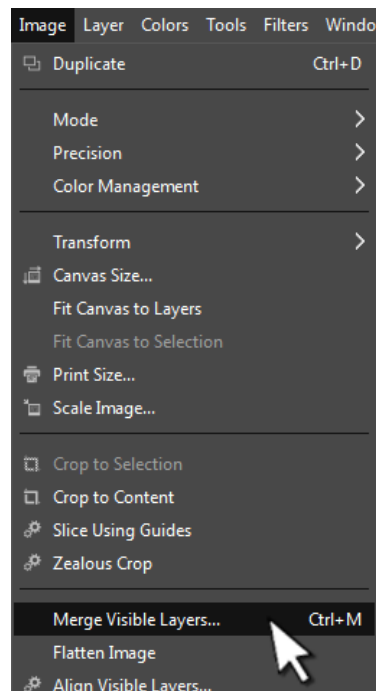
When you have made a test print that has the color and contrast right, be sure you have only the outlining layer and the puzzle image layer visible and go up to Image and select Merge Visible Layers (**Cmd/Cont-m**). In that **Imag**e menu, select **Duplicate Layer** (**Shift-Cont/Cmd-D**).In your Layers Panel, move these four outlined puzzle images into a row. 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.
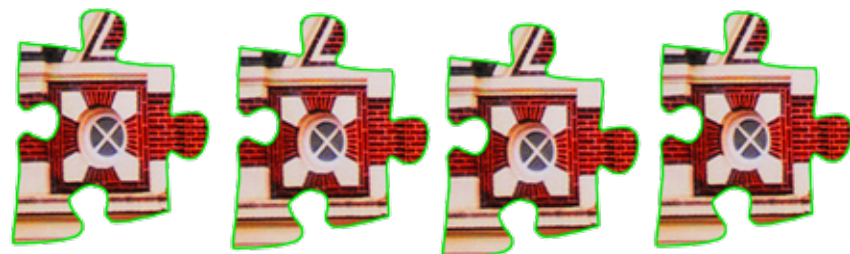
Mounting and cutting out your replacement piece

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

Cutting a triangle out of an inside loop.

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

round areas, you can gently grind away at them with the Dremel tool 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.

Feel free to write your initials on the back of your new pieces. You've done a service for those who build the puzzle after you.

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.

Piece missing

Our replacement installed