

Computer Imaging for Questioned Document Examiners I: The Benefits

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ABSTRACT: Computers are touching every aspect of our lives. Many computer software programs are beneficial to Forensic Document Examiners. These include word processing programs and databases for typewriter reference files. A new area of interest is the use of digital imaging programs to address some document problems. Many imaging packages, such as Adobe Photoshop 3.0, allow the examiner to quickly and easily tackle problems that, otherwise, would require some very expensive instrumentation and/or a great deal of time and trouble. This software can also be of benefit in preparing demonstrative exhibits of the examiner's findings. Illustrations and step-by-step instructions will assist examiners in putting this technology to work for them.

KEYWORDS: forensic science, questioned documents, computer imaging, document examiners

Technology, particularly in the area of computers, has had a profound effect on all of us. Some of these effects are beneficial for Forensic Document Examiners, such as the Typewriter Database program by Bouffard. Some things, like word processors, make our paper work simpler. The new computerized image processing software which is now available for personal computers can simplify some of the examinations conducted by Document Examiners.

There are a number of computer imaging products which can be of assistance to Document Examiners. These include Aldus Photostyler, Micrografx Picture Publisher and the subject of this paper, Adobe Photoshop 3.0. The usefulness of imaging software in the Forensic Document field has already been described by Nelson [1] and Hart [2].

Adobe Photoshop is a digital image processing program that operates in the Microsoft Windows environment. It allows the user to retouch, enhance, correct, edit, compose and apply various special effects to either grayscale or color images. The images in this paper were all input with a color flat-bed scanner, but other input devices, such as video and digital cameras, could also be used. If no input device is available, an image which has been stored on a diskette or a tape can be accessed and edited.

The computer used to accomplish the procedures that follow is a 90 megahertz Pentium with 40 megs (megabytes) of RAM (Random Access Memory). A system this powerful is certainly not required to run this software, but Photoshop 3.0 does need a

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minimum of 10 megs of RAM. The monitor is a Nanao FlexScan F760i.W with a twenty-one inch screen. The scanner is a Microtek ScanMaker III capable of reproducing images in grayscale, color, halftones and line art. The images were printed with a Hewlett Packard Laser Jet 4 Plus with 6 megs of memory. The computer has a Colorado Jumbo 250 tape back-up system, which is useful for archiving images. For those who don't speak these "computerese" terms, Waggoner's 1992 paper [3] might prove useful.

For the benefit of anyone who has or will be getting Adobe Photoshop 3.0, the steps necessary to carry out each of the image editing processes below will be given. These instructions will vary somewhat between different software programs, but it shouldn't be too difficult to take these instructions and relate them to similar instructions in other programs.

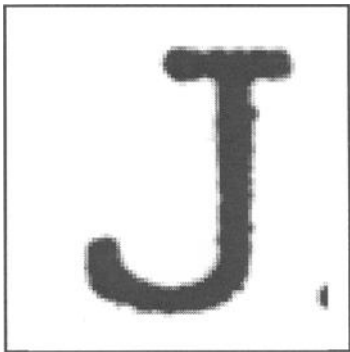
Typewriter Overlays

When comparing two typewritten samples to determine if the type styles are the same, it would sometimes be useful to be able to overlay a character from one sample on the same character from the second sample. This would allow the examiner to determine with certainty if the characters are shaped the same. Also, it might be useful to be able to prepare a demonstrative exhibit of this overlay to demonstrate similarities or differences to an officer, attorney or jury. All of this can be done with Photoshop.

Step 1—Scan words from the two documents (or two words from the same document) that contain the letters to be overlaid. A grayscale image will be sufficient.

Step 2—Select the Cropping Tool from the Tool Ribbon. Use the mouse to place the image of the cropping tool to the upper left of the target character in one of the words. Click and hold the mouse button down and drag the cropping tool to the lower right of the target letter. Release the mouse button and a moving dotted line will appear around the character. Place the cursor inside the box formed by the dotted line and the cursor will change to a pair of scissors. Click the left mouse button and the image inside the box will be cut out of the larger image window and the single letter will appear in a window of its own (Fig. 1). Follow this same procedure on the target letter in the second word (Fig. 2).

Step 3—This step is important in any imaging. Make duplicates of both images. To make a duplicate, go to IMAGE, DUPLICATE. In the Duplicate Image Dialog Box, click on OK. Carry out all editing on the duplicates so that if a grievous error is made on an image, a new duplicate can quickly be made from the original.

FIG. 1—*Questioned "J."*FIG. 2—*Known "J."*

Step 4—Sharpen both images by going to FILTER, SHARPEN, SHARPEN. Keep in mind that any commands will be carried out only on the image in the active image window. To activate a window place the cursor on the title bar of a window and click.

Step 5—Since the images are rather small, they will be easier to work with if they are enlarged. Click on the Zoom Tool (it looks like a magnifying glass) on the Tool Ribbon. Now place the magnifying glass cursor inside one of the windows with a letter and click the left mouse button. Do this to both images. This only enlarges the size of the image on the monitor, not its size when printed.

Step 6—Next, the "J" from Fig. 1 will be overlaid on the "J" in Fig. 2. Double-click the Magic Wand button on the Tool Ribbon. This will change the cursor to a magic wand and open the Options Palette. Place the cursor inside the letter in Fig. 1. Click the left mouse button and the letter, without any of the background, will be selected. If the moving dotted line does not completely surround the letter, go to EDIT, UNDO MAGIC WAND. In the Options Palette, click on the words Magic Wand Options. Raise the figure for Tolerance. This will be necessary for very weak images. Go to EDIT, COPY. This places this letter in the Photoshop Notebook.

Step 7—Click the title bar on the second image then go to EDIT, PASTE. This will place the image from Fig. 1 on top of that in Fig. 2. The image from Fig. 1 is called the "floating image." To make this floating image semi-transparent, activate the Layers Palette by pressing the F7 key. There is an Opacity slider in the upper right corner of this box. Put the cursor on the triangle which

is below this slider, click and hold the mouse button and pull it to the left until the opacity value is reduced to about 50%. To move the floating image around in the window, place the cursor inside this image then click and hold the mouse button while moving the character around. When the floating image is properly aligned, click the cursor in another area of the window and this image will be fixed (made permanent) in the window. If the two images do not precisely overlay, the difference will be obvious by the grey image appearing outside the borders of the black image (Fig. 3). There are two additional options for the floating image. To get just the outline of this image, click on the down arrow next to the word NORMAL in the Layers Palette. In the drop down menu, click on the word DIFFERENCE. This will leave a light outline of the floating image's border. Choose the word LIGHTEN and all of the floating image will disappear except for the moving dotted line. It's a good idea to reverse this process and put the Fig. 2 image on top of the Fig. 1 image.

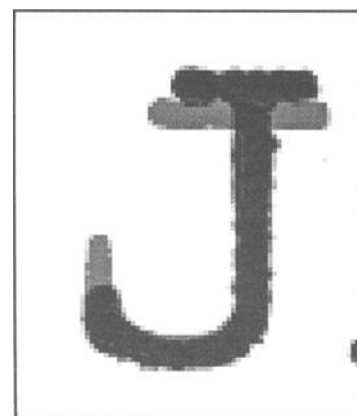
It is possible to print the overlaid image for presentation purposes. Because of the very small size of this image, it will be necessary to enlarge it. Go to IMAGE, IMAGE SIZE. This brings up the Image Size Dialog Box. The top portion of this box gives information on the current dimensions of the image—file size, width, height, resolution. The size of the new image appears on the lower half of the box and these values will begin identical to those above. At the very bottom of the dialog box, be sure there is an X in the box next to Proportions. Now, if either the width or height measurement is changed, the other measurement will be changed automatically and proportionally. An enlargement of more than roughly 5X for a typewritten character may not be suitable, because the individual pixels show up and deteriorate the image quality. To print the image, go to FILE, PRINT.

It is also possible to photograph the image from the monitor. The author uses a 35 mm camera on a tripod. With 200ASA Ektachrome film, an exposure of one second gives excellent results.

The presentation can be spruced up if the images to be overlaid are scanned in color. Then a letter can be selected, colorized and overlaid.

Step 1—If not already visible, activate the Picker and Options Palettes by pressing the F6 and F5 keys, respectively.

Step 2—On the Picker Palette, click on the word Scratch. Now click the Eyedropper Tool on the Tool Ribbon and place the eye-

FIG. 3—*Overlay of "Js."*

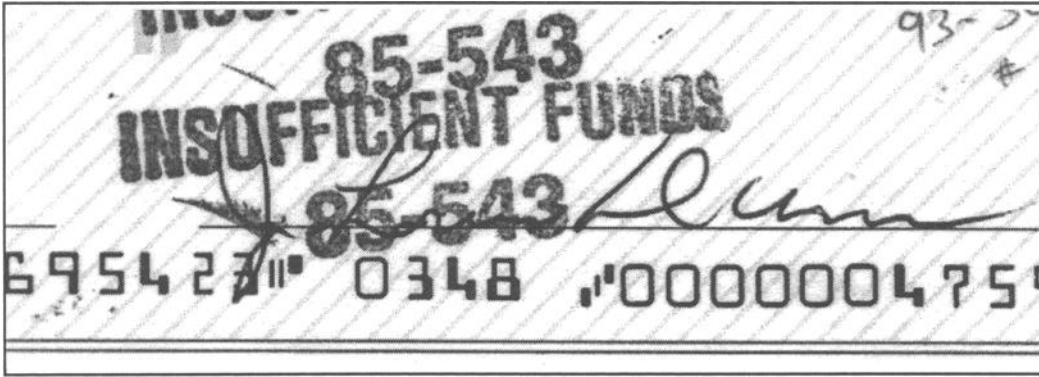


FIG. 4—Black ink signature, vivid blue rubber stamp impression, light blue paper with slightly darker blue diagonal lines.

dropper cursor over any color on the scratch pad and click the left mouse button. This will designate that color as the foreground color.

Step 3—Click on the Paint Bucket Tool. Place the paint bucket cursor inside a target letter and click. The black color of the letter will be replaced by the foreground color. The other letter to be used in the overlay can be colorized or left black.

Step 4—The overlay procedure now continues in the same manner as that described earlier.

Obliterations

Obliterations come in a variety of forms. Some cause problems with the examination while others are nothing more than a minor inconvenience. Still other obliterations have no effect at all on the examination but are a distraction on a court chart. Photoshop offers several methods for removing obliterating marks.

Rubber Stamp Impressions

Figure 4 represents a very common problem in handwriting examinations. This is the payer signature on a personal check. The signature, written in black ink, is partially obscured by a vivid blue bank stamp. The paper is very light blue with slightly darker blue diagonal stripes. While the stamp impression does not interfere with the examination of the signature, it does interfere with any court chart. Several methods exist to remove all or part of this stamp.

Method 1

This is the quickest method. Depending on the exact color of the stamp impression, this method may not entirely remove the impression, but complete removal may not be desirable.

Step 1—Display the Channels Palette by pressing the F7 key (or use the cursor to go to WINDOW, PALETTES, SHOW CHANNELS). When the Channels tab is activated in this palette, four channels are displayed for a color image—Red, Green, Blue and RGB, which is the full color image. Since the offending image is blue, the cursor should be placed on the word BLUE (the cursor will change to a hand pointing up) in the palette and the left mouse button clicked. This will change the image to its blue channel. The effect is equivalent to putting a blue filter over a camera lens and photographing the signature with black-and-white film (Fig.

5). Since the stamp impression is not a true blue, it's not entirely removed, but that may be preferable. The stamp impression no longer interferes with the ability to see the signature, but it is clear that this is the same signature as that in Fig. 4.

Step 2—If complete removal of the stamp impression is desired, further processing of the blue channel image can be carried out. Click on the Eyedropper Tool. Now place the cursor, which looks like an eyedropper, over a blank area of the check paper. Click the left mouse button to select this gray level as the foreground color.

Step 3—Double click on the Paint Bucket Tool and the Brushes Palette will appear. To the right of the word Tolerance in this palette, there is a small box with a number in it. This number defines how similar a pixel must be to be filled by the paint bucket. The values can range from 0 to 255. A low tolerance only fills pixels that have gray values very similar to the selected pixel. With this image, a Tolerance setting of 65 worked well, but some experimentation may be necessary here. Be sure an X appears in the box next to the word ANTI-ALIASSED. This will smooth the edges of the area to be painted.

Step 4—Place the cursor, which looks like a paint bucket being emptied, over an area of the stamp impression and click. All of the stamp, plus the background pattern on the check paper, will be removed (Fig. 6). This painting will not cross darker solid lines, so additional painting will have to be done inside enclosures, such as the upper loop of the "J."

Method 2

This method gives results very similar to those in Method 1 and is only covered here to provide an option for the user, since the effectiveness of any method is dependant on the colors that are present.

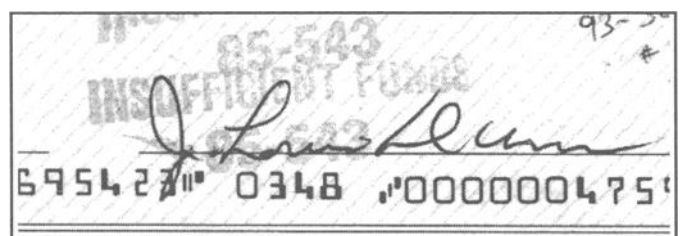


FIG. 5—The blue channel image of Fig. 4.

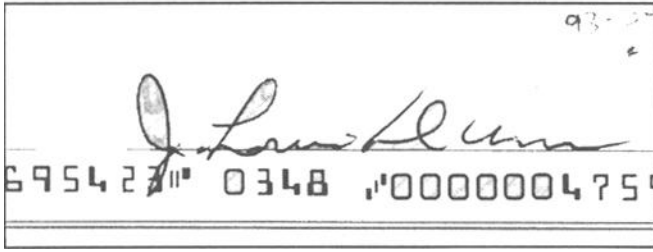


FIG. 6—The image from Fig. 5 after the complete removal of the rubber stamp impression.

With the full color image opened, go to IMAGE, ADJUST, HUE/SATURATION. This brings up the Hue/Saturation Dialog Box. On the left side of this box are six color swatches. Since the stamp impression is blue, click the cursor in the circle to the left of the darker blue swatch. In the center of the dialog box are three bars for Hue, Saturation and Lightness. Place the cursor in the triangle beneath the Lightness bar, click and hold the mouse button and drag the triangle all the way to the right. If there is an X in the Preview box, immediate results will be seen on the image. The changes become permanent when the OK button is clicked (Fig. 7). This method offers one clear advantage over the first method. The six color swatches in this dialog box offer greater flexibility to the operator than the three channels of Red, Green and Blue.

Method 3

If the operator wishes to leave the image in color and only remove the stamp impression where it surrounds the signature lines, this can also be accomplished.

Step 1—With the Eyedropper Tool, select the Foreground color to be the same as a blank area on the paper. Double click on the Paint Bucket Tool and make the necessary tolerance settings. Again, a tolerance setting between 60 and 70 is a good starting point. Click the cursor over individual letters in the stamp impression. This will remove the stamp color, leaving only an outline of the original letter or numeral (Fig. 8).

Step 2—To completely remove the outlines of the stamp impressions, double-click on Paintbrush Tool on the Tool Ribbon. To select the size of the brush tip to be used in the painting, click on the word Brushes in the Brushes Palette and then click on the appropriate size circle. Place the tip of the paintbrush cursor over the area to be painted, hold the left mouse button down and drag the cursor. The image will be replaced by the chosen foreground

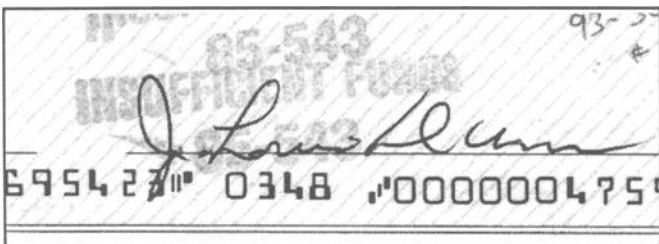


FIG. 7—Partial removal of the bank stamp through the adjustment of the lightness setting in the hue/saturation dialog box.



FIG. 8—Painting out the bank stamp images with the paint bucket tool.

color. If a mistake is made in this painting process, the last area to be painted over can be immediately restored by going to EDIT, UNDO PAINTBRUSH.

In some instances, a round paintbrush may not be the preferred shape. A differently shaped brush can be chosen by clicking on the arrow in the upper right corner of the Brushes Palette. This opens a drop-down menu. Click on Brush Options and this will open a dialog box. In this box, the graphic at the lower left can be used to alter the shape and angle of the brush. With the Diameter slider at the top of this box, the exact pixel size of the brush can be selected. Click the OK button and this new brush size will be selected. Figure 9 shows the image from Fig. 8 with the images around the "J" painted out.

Random Pattern Obliterations

Figure 10 is a blue carbon image of a signature which is obscured by a random pattern of black marks. This type of obliterating area is seen in some check ledgers, medical records, invoices and other types of documents where a carbon copy is prepared but some of the information needs to be protected from view. Photoshop offers a method which may help to make the carbon image more legible.

Step 1—Scan the image area in color. Make a duplicate of the image and use this duplicate for all subsequent processing.

Step 2—Go to IMAGE, ADJUST, HUE/SATURATION. This



FIG. 9—The image from Fig. 8 after painting over the images surrounding the J.

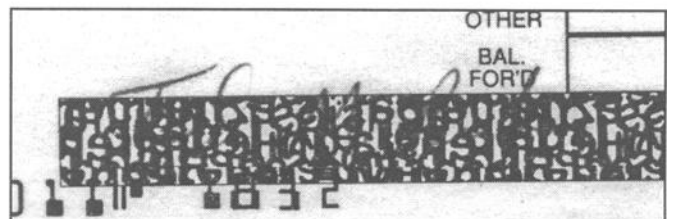


FIG. 10—Blue carbon image obscured by a random pattern of black marks.

brings up the Hue/Saturation Dialog Box. Click the cursor in the circle next to the "B." This allows the blue color to be adjusted independently of the other colors. Slide the pointer beneath the Saturation bar all the way to the right. If the Preview box is checked, the results will show in the selected image. Move the pointer beneath the Lightness bar to the left end. This makes the carbon image as dark as possible.

Step 3—In the Hue/Saturation Dialog Box, click the cursor in the circle to the left of MASTER. Drag the pointer under the Lightness bar slowly to the right. This will lighten the black obliteration areas. Don't go too far with this or the entire image will be washed out. The results are found in Fig. 11 (the visual appearance on the computer monitor is much more dramatic than that in this reproduction). The name present is "Ted M. Burkes." This technique can be very effective in some cases, but not in every instance.

Two further procedures may bring out a weak image a little more.

Step 4—Go to IMAGE, ADJUST, REPLACE COLOR. This brings up the Replace Color Dialog Box. Place the eyedropper cursor over a part of the black obliteration and click. In the dialog box, grab the pointer under the Lightness bar and move it slowly to the right. This will lighten the black obliterations and may make the carbon image stand out some.

Step 5—Repeat step 4, but click the eyedropper cursor on a part of the carbon image. Hopefully, a piece of this image will be outside the obliteration area. In the dialog box, drag the pointer under the Lightness bar slowly to the left and the carbon image will darken.

Same-Ink Obliterations

One of the most frustrating kinds of obliterations is where the overwriting is done with the same type of ink as that used for the original writing. A very effective method for this type of examination is that described by Waggoner and Spradlin [4]. Their method involves preparing enlarged photographs of the obliterated area. When a line on the original is identified as part of the overwriting, this line is painted out on the enlargement using a removable paint. With Photoshop, this painting can be done electronically. Figure 12 is the payee information from a personal check. It was suspected that there might be a name beneath the obliteration. Since the same inks were used for the original writing and the obliteration, the Video Spectral Comparitor was of no help. Through examination of the original writing under magnification, it was very clear in most areas which lines were a part of the overwriting. These lines were then removed in Photoshop, resulting in the image in Fig. 13. It should be emphasized that the examination *must* be carried out on the original document, not on the

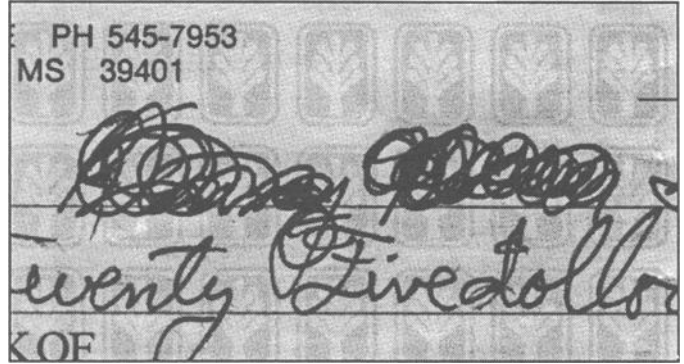


FIG. 12—Same ink obliteration of a payee name.

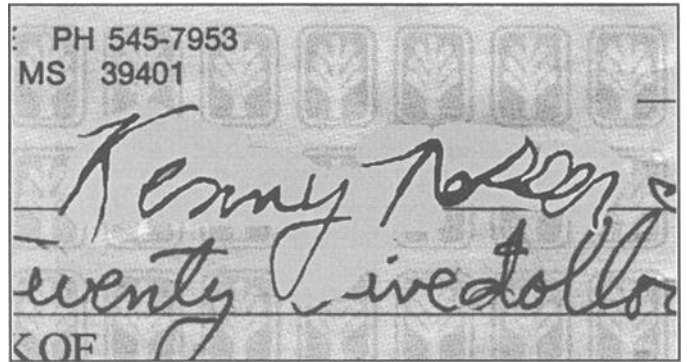


FIG. 13—Payee name after removal of obliterating marks.

computer's monitor or on a photocopy. Before any line is removed, this removal must be warranted through the microscopic examination of the original material. The following steps describe how to accomplish this.

Step 1—Scan the obliterated area in grayscale and make a duplicate image.

Step 2—Any part of the image which is removed has to be replaced with something, so a foreground color must be designated. As described earlier, this is done with the Eyedropper Tool. Choose an un-imaged area of the document's paper to be the foreground color. A background should also be selected at this time. This should be the same as the foreground color. This is selected in the same manner as the foreground color, but hold the **Alt** key down while clicking the mouse button.

Step 3—To remove large areas quickly, click on the Lasso Tool on the Tool Ribbon. Place the loose end of the lasso cursor (any of the picture-type cursors can be converted to a bull's-eye cursor by depressing the **Caps Lock** key on the keyboard) on the border of an area that is to be deleted. Hold the left mouse button down while drawing a line around the area to be deleted. When the line is back at its starting point, release the mouse button and a moving dotted line will surround the selected image area. Depress the **Delete** key on the keyboard and the image inside the dotted line will be replaced by the background color. With the cursor still in the image area, click the mouse button again and the moving dotted line will be removed.

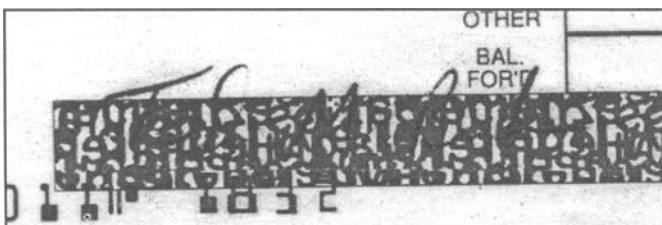


FIG. 11—The results of the hue/saturation adjustments.

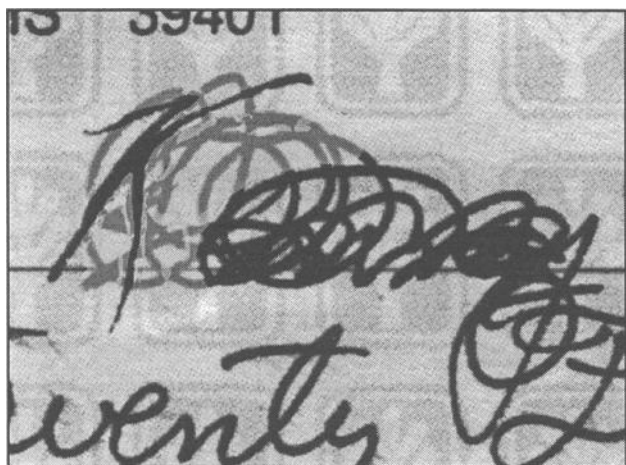


FIG. 14—"Ghosting" of the obscuring marks.

Step 4—The Paint Brush Tool will have to be used to remove the obliterations in the narrow, confined area close to the lines that are to be left in the image. This will be easier if the image is enlarged. Click on the Magnifying Glass Tool. Now place the magnifying glass cursor over the target area and click the left mouse button. Double click on the Paint Brush Tool and select a brush size in the Brushes Palette. With this type of work, the ability to precisely shape the brush size (described earlier) is very helpful. Place the tip of the brush over the area to be painted, hold the left mouse button down and drag the cursor. The image will be replaced by the chosen foreground color. If a mistake is made in this process, the last area to be painted over can be immediately restored by going to EDIT, UNDO PAINTBRUSH.

It may be preferable to not completely paint over the obscuring lines, but to leave a "ghost" image of these lines. This makes it easy to demonstrate that the end result was achieved not by adding anything to the image, but by removing the obscuring lines. This is accomplished by reducing the Opacity setting in the Brushes Palette to make the painting semi-transparent instead of opaque. The image in Fig. 14 shows the result of a 50% opacity setting used to partially cover the lines around the "K" in the first name.

ESDA Images

Weak ESDA (IMEDD, etc.) images can be very frustrating. A number of procedures can be carried out on these images with Photoshop which may be of some help. Keep in mind that nothing is going to bring up details that simply don't exist on the original image. The only thing these procedures can do is to make the weak images more prominent. Grayscale images are entirely sufficient for this procedure. Figure 15 is an ESDA image developed from a sheet of paper in a legal pad. Several methods can be used to try to make the images more legible.

Method 1

Go to IMAGE, MAP, EQUALIZE. Photoshop will make the darkest value in the image black, the brightest value white, and



FIG. 15—ESDA image.

average everything between these extremes. This will increase the contrast of the image (Fig. 16).

Method 2

The contrast of the image can be directly adjusted by going to IMAGE, ADJUST, BRIGHTNESS/CONTRAST. This brings up the Brightness/Contrast Dialog Box. Drag the pointer under the Contrast bar to the right and view the results in the image. The change to the image will become fixed when the OK button is clicked. Figure 17 shows the ESDA image with a +60 contrast setting.

Method 3

The contrast of the edge detail in particular can be adjusted by going to FILTER, SHARPEN, UNSHARP MASK. This will reveal the Unsharp Mask Dialog Box. Adjustments can be made in three areas. The Amount can vary from 1 to 500, with the higher number having a stronger effect. The Radius setting designates how many pixels surrounding the edge pixels will be sharpened. This value can be adjusted from 0.1 to 250, with the higher number causing more pixels to be sharpened. The Threshold value of 1 to 255 determines how profound an effect will be seen on the image. The most profound effect is achieved with a Threshold of 0. Figure 18 is the ESDA image with an Amount setting of 100%, a Radius of 50 pixels and a Threshold of 0 levels.

Method 4

Go to IMAGE, ADJUST, CURVES. This brings up the Curves Dialog Box. The line in the square graph area allows the user to adjust the tonal range of any point along the gray scale. Fixed points can be arranged to up to 15 locations on the line. This line can be moved by placing the cursor on it at any location and moving the mouse while holding the mouse button down. This process is very case dependant and no specific instructions can be applied to every situation. Experimentation is the key to this process. The effect of any changes can be viewed immediately on the selected image but won't be made permanent until the OK button is clicked (Fig. 19).



FIG. 16—Equalized ESDA image.



FIG. 17—ESDA image with a +60 contrast.

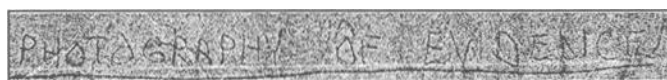


FIG. 18—ESDA image after unsharp mask commands.



FIG. 19—ESDA image after adjusting curves.

Method 5

This process is somewhat more involved than the previous four, but may provide some additional detail that the other methods don't.

Step 1—Make two duplicates of the original grayscale image. Make one of the duplicates an active window by clicking on the title bar. Go to IMAGE, MAP, INVERT and the image will become a negative.

Step 2—Click on the Rectangular Selection Tool and use the cursor to draw a box around some or all of the negative image. Go to EDIT, COPY.

Step 3—Activate the second duplicate image by clicking on its title bar. Go to EDIT, PASTE. This places a copy of the negative image, now called a "floating image," into the other image window.

Step 4—In the Channels Palette (F6), click on the word Layers. Decreasing the opacity value to roughly 50% will make the floating image semi-transparent.

Step 5—The floating selection, which is surrounded by a moving dotted line, can be moved with the cursor (arrow) keys. If the images are overlaid with the floating image slightly offset, the lines will have a three-dimensional appearance which may bring out some detail (Fig. 20).

As in any overlay procedure, it is a good idea to reverse this process and put the normal image on top of the inverted image to see if any more detail is revealed.

Discussion

These uses of computer imaging technology can be of great benefit to Forensic Document Examiners, both in the examination of casework and in the preparation of demonstrative exhibits. It is expected that this will just be the beginning of the use of computer imaging to address document problems. New software programs and computer capabilities will expand even further the use of computers in this field.

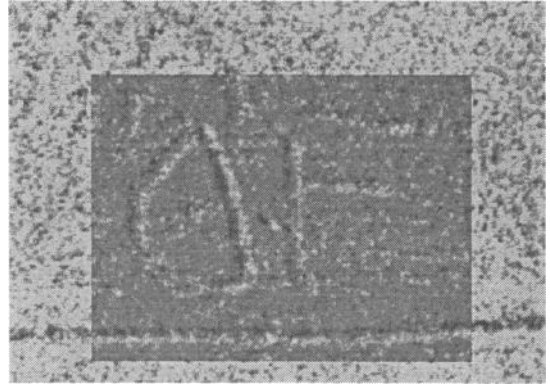


FIG. 20—ESDA image after overlay of the word "of."

In the second part of this paper, possible abuses of this imaging software to alter documents or create fraudulent documents will be discussed. It is imperative that Forensic Document Examiners be aware of these abuses so that we can exercise the appropriate caution when examining documents that have toner-powder images.

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