Preparation of Court Charts Through Digital Imaging

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In order to demonstrate their findings in a court of law, Forensic Document Examiners frequently prepare enlargements of the signatures or other handwriting that has been examined. This can be a very time-consuming process if photography is used. The authors present an alternative to this method that uses digital imaging with a computer to more quickly prepare professional-looking charts. In addition to the handwriting images, the charts can be supplemented with annotations such as arrows and text, both of which can be colorized if needed.

Introduction

The majority of a Forensic Document Examiner's time is spent in the actual examination of the evidence, formulation of the opinions, and preparation of the report. However, the responsibilities of the examiner do not end here. If called on to do so, the examiner must be prepared to present his or her findings in Court. Frequently, the examiner will find it useful to utilize some type of charts to illustrate the bases for the opinions being testified about. There are many methods for preparing court charts and they each have advantages and disadvantages (Vastrick, 1995). Usually, the choice of which chart method to use will depend on several factors, including the nature of the evidence, available time to prepare the charts, equipment available to the examiner, and the type of setting (deposition, bench trial, jury trial, etc.). One method of chart preparation now available to Forensic Document Examiners is that of digital imaging. The same imaging software that can be used to aide examiners in their examinations (Hicks, 1995) can also be used to prepare charts to demonstrate the examiner's findings (Nelson, 1994). Many computer imaging software packages can be used for this purpose, but this paper will focus specifically on the use of Adobe Photoshop® 5.0.

Methods and Materials

There are several factors the Forensic Document Examiner must be aware of when preparing enlargements for a demonstration chart using a scanner, computer and printer. First, the capabilities of the printer which will be used to output the image must be considered. Most desktop computer printers can't handle paper larger than 8.5 × 14 inches. Further, printers usually are not capable of printing from edge to edge on the paper. For purposes of this discussion, it will be assumed that the printer leaves a void area of ¼ inch on each side. This means an 8.5 × 14 inch sheet of paper will only print an image of 8.0 × 13.5 inches.

Second, the printed image on the chart should have a resolution as close to 100 dots per inch (DPI) as possible. Printed images of more than 100DPI are not noticeably sharper than those of 100DPI because the eye can't readily detect the difference at the higher resolution, but an image of less than 100DPI will be noticeably less sharp. Since higher resolution images require more computer processing and more time for the printer to process, the closer to 100DPI the image is, the easier and faster the entire process will be. Also, to print in the correct size, the resolution of the image should not exceed the maximum resolution of the printer.

Third, scanners generally have the capability of scanning in three modes: black-and-white, color, and grayscale. Black-and-white images have no shades of gray and are seldom useful in chart preparation. Color images offer much more enhancement options, but the image files are very big, sometimes three times the size of the same image in grayscale. This requires the computer to work much harder to process any commands given it concerning the image and the printer requires much longer to print the image. Also, unless color correction features are available with the imaging software and the highest quality color printer is available, the final may not reflect the same tonal qualities as the original image. As a result, it is usually advisable to scan images in grayscale. Some specific uses for color will be discussed later. Also, scanners usually publish two different resolution capa-

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bilities, optical resolution and interpolated resolution. The optical resolution will be the lower of the two numbers and this is the maximum resolution that should be used when scanning images into the computer.

Since the writing on the chart has a target size, no longer than 13.5 inches or wider than 8.0 inches on an 8.5 × 14 inch sheet of paper, and a target resolution, no less than 100DPI, the examiner must select, prior to conducting any scanning, the scanning resolution which will result in a finished product with these desired qualities. There are two methods for doing this. The first one is trial-and-error. While this will certainly work, it can be very frustrating at times. An easier and more certain method is to use the table in Figure 1 to determine the necessary scanning resolution. To use the Scanning Resolution Conversion (SRC) Chart,the examiner must determine the length of the "scale" image. The scale image is the longest single image which will appear on the chart. When preparing a chart of multiple signatures, the scale image is determined by measuring the length of the signatures to find the longest one. On the SRC Chart, in the left column of figures, find the number which most closely corresponds to the length of this longest image. The first number to the right of this length is the conversion resolution, or the resolution of the final image. The number at the top of this column, in the line labeled "Scan DPI," is the resolution at which the original image should be scanned.

Results

Charting a single signature

These instructions will address making a chart of a single signature on a sheet of 8.5 × 14 inch paper. If

SCANNING RESOLUTION CONVERSION CHART

Scale Image Length in mm — Resample Resolutions to convert to Image Length of: 344 mm (13.5 inches)

Scanner Resolution Setting

in mm	300	400	500	600	700	800	900	1000	1100	1200	1300	1500	1700	2000	2300	2900	3900	5800
141	123	164	205	246	287													
138	120	160	201	241	281													
135	118	157	196	235	275													
132	115	153	192	230	269													
129	113	150	188	225	263	300												
126	110	147	183	220	256	293												
123	107	143	179	215	250	286												
120	105	140	174	209	244	279												
117	102	136	170	204	238	272												
114		133	166	199	232	265	298											
111		129	161	194	226	258	290											
108		126	157	188	220	251	283											
105		122	153	183	214	244	275											
102		119	148	178	208	237	267	297										
99		115	144	173	201	230	259	288										
96		112	140	167	195	223	251	279										
93		108	135	162	189	216	243	270	297									
90		105	131	157	183	209	235	262	288									
87		101	126	152	177	202	228	253	278									
84			122	147	171	195	220	244	269	293								
81			118	141	165	188	212	235	259	283								
78			113	136	159	181	204	227	249	272	295							
75			109	131	153	174	196	218	240	262	283							
72			105	126	147	167	188	209	230	251	272							
69			100	120	140	160	181	201	221	241	261							
66				115	134	153	173	192	211	230	249	288						
63				110	128	147	165	183	201	220	238	275						
60				105	122	140	157	174	192	209	227	262	297					
57					116	133	149	166	182	199	215	249	282					
54					110	126	141	157	173	188	204	235	267					
51					104	119	133	148	163	178	193	222	252	297				
48						112	126	140	153	167	181	209	237	279				
45						105	118	131	144	157	170	196	222	262				
42							110	122	134	147	159	183	208	244	281			
39							102	113	125	136	147	170	193	227	261			
36								105	115	126	136	157	178	209	241			
33									106	115	125	144	163	192	221	278		
30										105	113	131	148	174	201	253		
27											102	118	133	157	181	228		
24												105	119	140	160	202	272	
21													104	122	140	177	238	
18														105	120	152	204	
15															100	126	170	253
12																101	136	202
9																	102	152
6																		101

Figure 1. Measure the scale image in millimeters, then read down the first column to find the measurement which is equal to, or just larger than, the scale image length. Read across to find the conversion resolution, then read up to find the scanning resolution.

a series of signatures are to be enlarged for the chart, it is desirable to enlarge all of them to the same extent. Use the steps that follow on the scale signature first to make sure the conversion resolution obtained from the Scanning Resolution Conversion Chart results in the correct enlargement. Then follow the same steps, using the same conversion resolution, for each image.

First, the signature needs to be scanned at the proper resolution. Then the image should be cropped to remove any image area that is not of interest. This is done with the Cropping Tool, located on the top button on the left column of buttons in the Tool Palette. If this button is pressed and held down, a series of buttons will pop up. The Cropping Tool will be on the right end of this series. When this button has been selected, put the cursor in the image window and it will change from an arrow to the symbol of the cropping tool. Click and drag this tool to draw a rectangle around the area of interest. By grabbing any of the boxes on the dotted cropping line, the size of the rectangle can be adjusted (Figure 2). When the box is the proper size, press the **ENTER** key on the keyboard to perform the crop (Figure 3). After saving this image, make a duplicate and do all remaining processing on this duplicate. To make a duplicate, right-click on the title bar of the image window. This will reveal a drop-down menu. Click on the word **DUPLICATE** and then click **OK** in the Dialogue Box.

Next, enhance the contrast of the image by selecting **IMAGE, ADJUST, LEVELS,** or use the shortcut command **Control-L** (Figure 4). The Levels Dialogue Box contains a graph representing the shades of gray in the image (Figure 5). Immediately below the graph are three arrowheads, while above the graph are three boxes labeled "Input Levels."

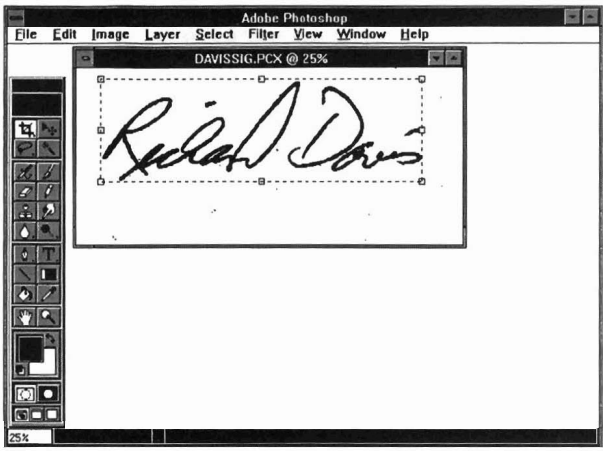

Figure 2.

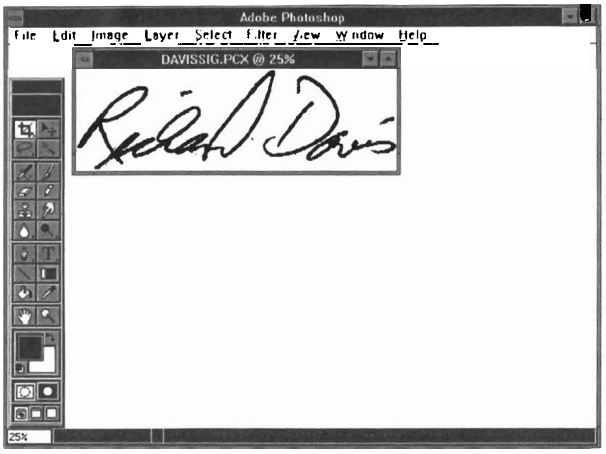

Figure 3.

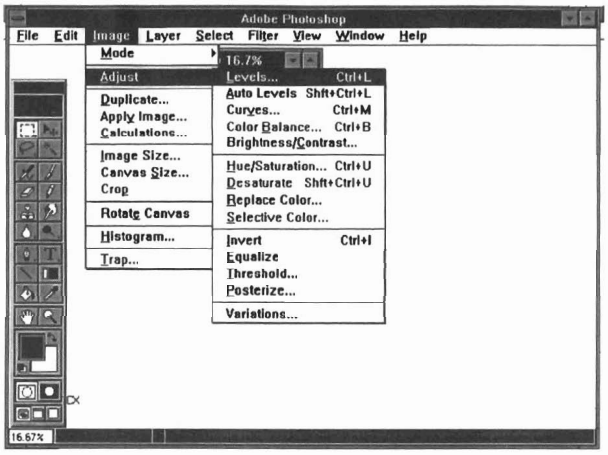

Figure 4.

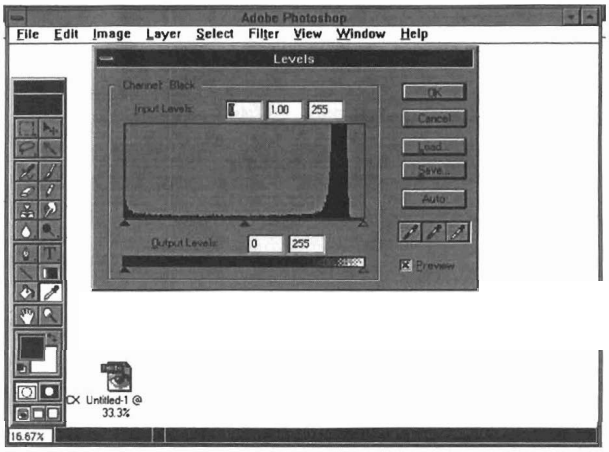

Figure 5.

When the arrowheads are grabbed and moved with the mouse, the numbers in the "Input Levels" boxes change. These numbers can also be changed using the computer keyboard to input the desired numbers. With the use of one or the other of these methods, the left-most Input Level number should be changed to 110 and the right-most number should be changed to 220 (Figure 6). These numbers may not be ideal for every image, but they will be acceptable for the large majority of images. The result will be that the image of the signature will become darker while the background will become whiter. Click on **OK** to apply these changes to the image. (This entire series of commands can be incorporated into an Action and activated with only one or two mouse clicks in the future. Actions are the Photoshop equivalent of the macros used in various word processors. Consult the Photoshop instruction manual for creating Actions.)

The image will now be enlarged by changing the resolution. Select **IMAGE, IMAGE SIZE** from the main menu bar (Figure 7). In the Image Size Dialogue Box, there are three settings for Print Size; width, height and resolution. These three can be locked together by deselecting the Resample Image box in the lower left corner (Figure 8). Now, when the resolution is changed to the conversion resolution, the width and height will be proportionally changed at the same time (Figure 9). The length should be very close to the desired 13.5 inches. In very rare cases, the image may be extremely tall relative to its length and the process described thus far will not result in an image which will fit on the page. If this is the case, adjust the resolution in this dialogue box until the image will fit on the paper being used. Once the proper settings have been entered, click **OK** to apply the changes to the image.

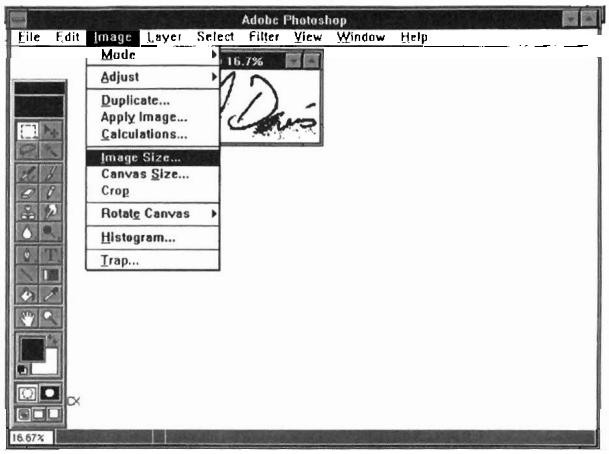

Figure 7

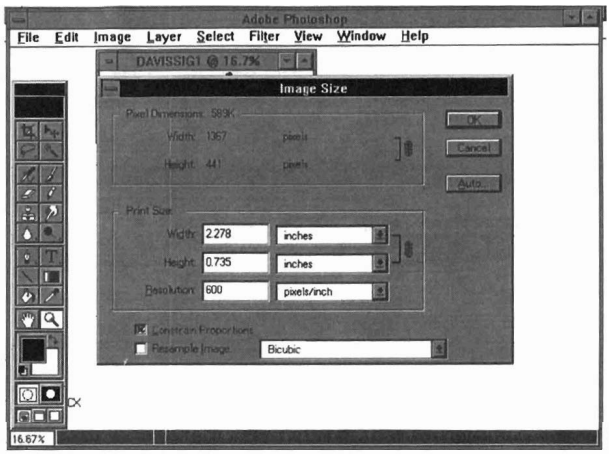

Figure 8.

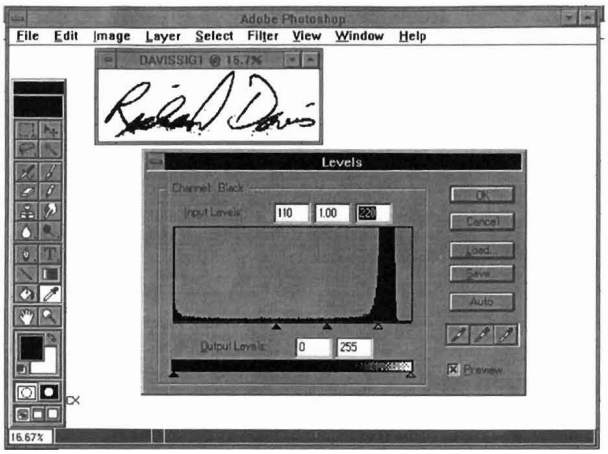

Figure 6.

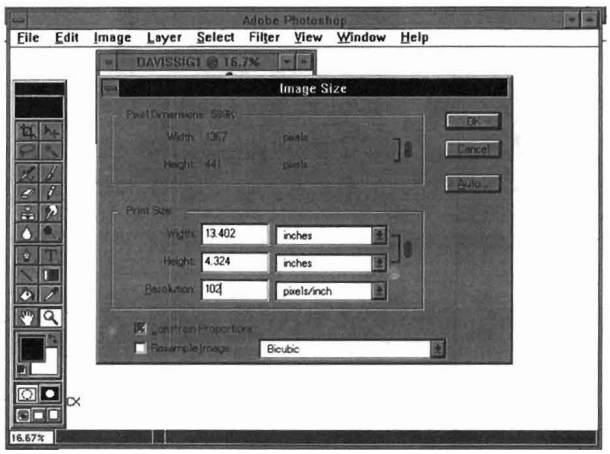

Figure 9.

Note that the size of the image on the screen will not change.

This image can now be printed. Be sure to select the proper paper size and Landscape orientation under **FILE, PAGE SETUP.** The authors often print these images on full-page label material. The backing can be peeled off and the image then applied to chartboard.

Charting multiple signatures

With the Photoshop capabilities, it is also possible to prepare a comparison chart with several signatures. In this method, the signatures are scanned at the appropriate scanning resolution then copied to a blank page created at the conversion resolution. As each image is copied into the blank page, it is automatically enlarged.

To use this process, measure all of the images to be included in the chart and determine the longest image, which will be used as the "scale" image. Refer to the chart in Figure 10 to determine the scanning and conversion resolutions then scan each of the necessary writings that will appear in the chart. Crop the images and save each one. Make duplicates of each image and adjust the levels as described above.

Now, a blank chart page needs to be created. From the main menu, select **FILE, NEW.** In the New Dialogue Box, enter the necessary size for the document. In order to allow for non-printing areas on each edge, set the width for eight inches and the

SCANNING RESOLUTION CONVERSION CHART FOR HANDOUT CHARTS

Scale Image Length in mm — Resample Resolutions to convert to Image Length of: 165 mm (6.5 inches)

Scanner Resolution Setting											
300	400	500	600	700	800	1000	1100	1400	1900	2800
141	256										
138	251										
135	245										
132	240										
129	235										
126	229										
123	224	298									
120	218	291									
117	213	284									
114	207	276									
111	202	269									
108	196	262									
105	191	255									
102	185	247									
99	180	240	300								
96	175	233	291								
93	169	225	282								
90	164	218	273								
87	158	211	264								
84	153	204	255								
81	147	196	245	295							
78	142	189	236	284							
75	136	182	227	273							
72	131	175	218	262							
69	125	167	209	251	293						
66	120	160	200	240	280						
63	115	153	191	229	267						
60	109	145	182	218	255	291					
57	104	138	173	207	242	276					
54		131	164	196	229	262					
51		124	155	185	216	247					
48		116	145	175	204	233	291				
45		109	136	164	191	218	273	300			
42		102	127	153	178	204	255	280			
39			118	142	165	189	236	260			
36			109	131	153	175	218	240			
33			100	120	140	160	200	220	280		
30				109	127	145	182	200	255		
27					115	131	164	180	229		
24					102	116	145	160	204	276	
21						102	127	140	178	242	
18							109	120	153	207	
15								100	127	173	255
12									102	138	204
9										104	153
6											102

Figure 10. Measure the scale image in millimeters, then read down the first column to find the measurement which is equal to, or just larger than, the scale image length. Read across to find the conversion resolution, then read up to find the scanning resolution.

length for either 10.5 or 13.5 inches, depending on the size of the printer paper. The resolution of this chart will be the figure determined from the chart in Figure 10. Set the Mode to "Grayscale" and the Contents to "White." Click **OK** to create this chart.

The next step is to put the writing images into the blank chart. Activate the image which will be placed at the top of the chart. From the main menu, select **SELECT, ALL,** or use the keyboard shortcut **Control-A.** Then, from the main menu, select **EDIT, COPY,** or use the keyboard shortcut **Control-C.** This places the image into the Clipboard. Activate the chart window and, from the Main Menu,select **EDIT, PASTE,** or use the shortcut command **Control-V.** This will place the copied image in the center of the chart. In order to move this image to the desired location in the chart, click on the Move Tool, which is the top button on the right column in the Tool Palette. Now, the mouse can be used to click-and-drag the image to the proper location. Follow this procedure with each of the images. These images are placed into the chart in sequential layers. These layers can be tracked by looking at the layers Palette, which is activated by selecting **WINDOWS, SHOW LAYERS** (Figure 11). To go back and move an earlier image, select the layer in which the image resides and use the Move Tool.

Labeling the chart

Text labels can be added to the chart at this time. Click on the Text Tool button, which is in the right column in the Tool Palette and has a "T" on it. Place the cursor in the chart where the text is needed and click the mouse button. This will activate the Type Tool Dialogue Box (Figure 12). In this box, a number of settings can be made, including the Font, Size, and Justification. The Size needed will depend on what label is being placed in the chart and the resolution of the chart. Enter the desired text in the window at the bottom of the dialogue box, then click **OK.** The text will be placed in the chart at the location selected earlier. This text also occupies a layer in the image and can be moved with the Move Tool. If the text is not correct, simply go to **EDIT, UNDO.** Layers can also be deleted by clicking on the correct layer in the Layers Palette and dragging this layer to the garbage can icon at the bottom of the palette.

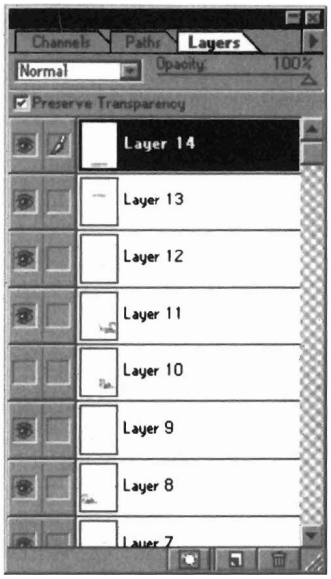

Figure 11.

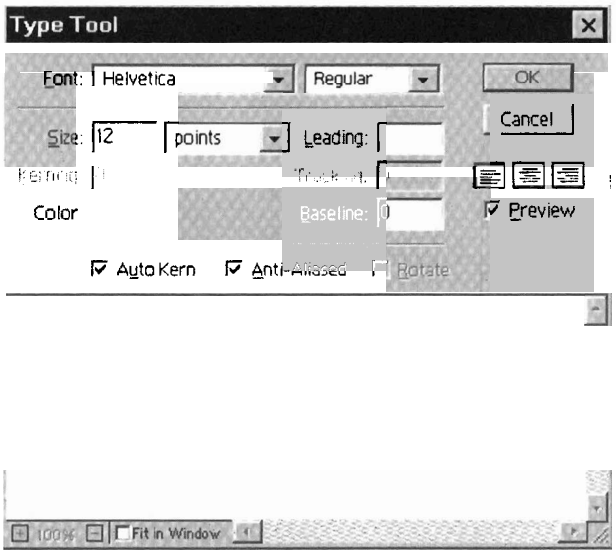

Figure 12.

It is also possible to insert arrows in the chart to point out certain characteristics which may be of interest. Double-click on the Line Tool button, which is in the left column of the Tools Palette. The button has a diagonal line on it. Double-clicking on this button opens the Line Tools Options palette (Figure 13). In this palette, the width and opacity of the line is selected. The necessary line width depends on the resolution of the chart, but a width of six to twelve pixels will usually be satisfactory. The end of the line on which the arrowhead will appear is also selected here. Clicking on the Shape button opens the Arrowhead Shape Dialogue Box. Experimentation with these values will reveal the shape that most appeals to the operator, but Width and Length values of 200% and a Concavity of 0% will usually be acceptable. Click **OK** in this box. The arrow drawn in the chart will

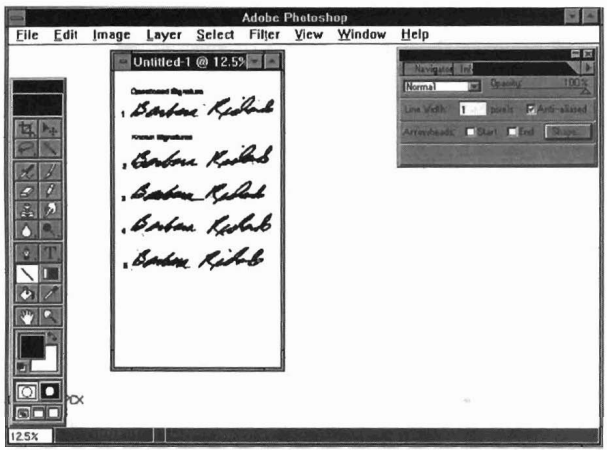

Figure 13.

take on the gray value of the Foreground color, so the Foreground Color box near the bottom of the Tool Palette needs to be black. Be sure the layer of the image on which the arrows are to be drawn is active. Using the mouse, place the cursor near where the tip of the arrow is desired and drag away from this point. As long as the mouse button is not released, the arrow can be rotated around the starting point. When the button is released, the black arrow appears on the document. This can be repeated as often as necessary. Text can be added at the end of the arrows if desired.

The size of the chart image can be seen in the lower left corner of the screen. This file size, particularly if the chart is in color, can readily exceed 2 megabytes. This size is somewhat cumbersome to deal with and may take quite a while to print. It is a good idea to reduce this size prior to printing. First, save the chart image as it is. Next, do a Save As and give this second image a slightly different name. With the Save As image active on the screen, click on the arrow to the right of the word Layers in the Layers Palette (refer to Figure 11). This is a triangular-shaped arrow that points to the right. In the drop-down menu, click on Flatten Image. All of the layers will now be combined into one layer called Background. Depending on the nature of the chart, this will usually reduce the file size by 50% to as much as 75% from its original size. The main limitation of this process is that the various images that had been placed in the chart can no longer be independently moved. If this becomes necessary, just reopen the original image with all of its layers.

Highlighting techniques

There are two other techniques which may be used to highlight certain sections of the chart if this is needed. Both of these processes may be done in color to add some excitement to the chart, but they can also be done on the grayscale image. To convert a grayscale chart to a color chart, select **IMAGE, MODE, RGB COLOR** (Figure 14). Keep in mind that a color image is a great deal larger than a grayscale image and this will slow down every command given the computer.

If the need is to draw attention to a certain limited area of the chart, whether a letter, word or sentence, this area must first be selected and separated from the rest of the chart. This selection can be done with the Marquee Tool, the top button on the left column in the Tool Palette. This Marquee Tool can be used either to draw a rectangular or a circular marquee. Holding down the button will reveal the options. When the needed type of marquee tool has been selected, the marquee is drawn by clicking and dragging in the image area.

At this point, two options are available for further processing of the image. The first option that will be addressed is to partially obscure all of the image except for the area inside the marquee. If the chart has multiple layers, the image should be flattened first. Next, select **SELECT, INVERSE,** then **EDIT, FILL.** In the Fill Dialogue Box (Figure 15), select whether the marquee area will be filled with the foreground color or the background color. These foreground and background colors are found in the large squares near the bottom of the Tool Palette. (If the chart has been converted to RGB Color, the marquee area can be made any color the user wishes, but this color has to be selected prior to this second step. Double-clicking on the foreground color box will open the Color Picker Dialogue Box, from which a color can be selected for this box.) Third, select the opacity of the fill that

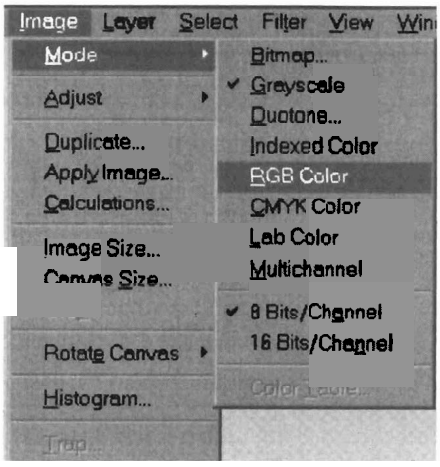

Figure 14.

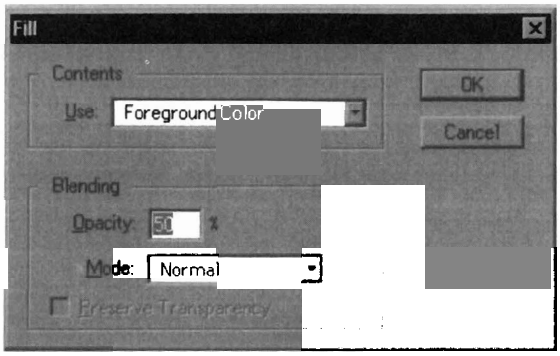

Figure 15.

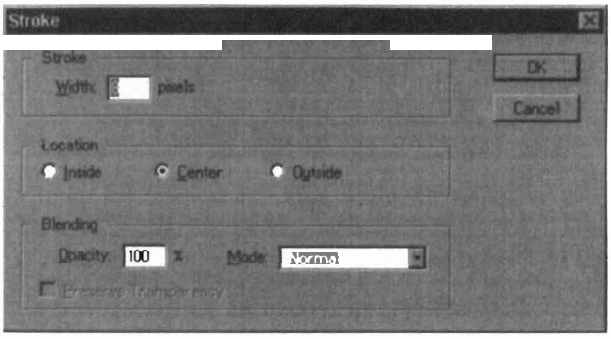

Figure 17.

will be applied. Click the **OK** button and the fill will be applied (Figure 16).

The other option is to color the marquee that was drawn earlier. To do this, select **EDIT, STROKE.** This opens the Stroke Dialogue Box (Figure 17). Select the width of the colored line to be applied. The appropriate width will depend on the resolution of the chart and how noticeable the examiner wants the marquee to be. A width of between 4 and 8 pixels will usually be sufficient. The Location settings allow the user to determine whether the colored line will be inside of, outside of or centered on the marquee that was drawn. Finally, set the Opacity value and click the **OK** button. The color applied will be that in the Foreground box. Now, click anywhere in the image and the marquee will be removed, leaving only the colored line (Figure 18). This process can be repeated to create additional boxes or circles in as many colors as desired. It should be noted that the text and arrows described earlier can also be colorized. This might be particularly useful in having one color of arrows for one category of characteristics and another color for a second category.

DISCUSSION

The processes described in this paper provide the Forensic Document Examiner with another method for preparing demonstration charts. This method is fairly quick to carry out and results in an attractive, easy-to-use chart. While it is not ex-

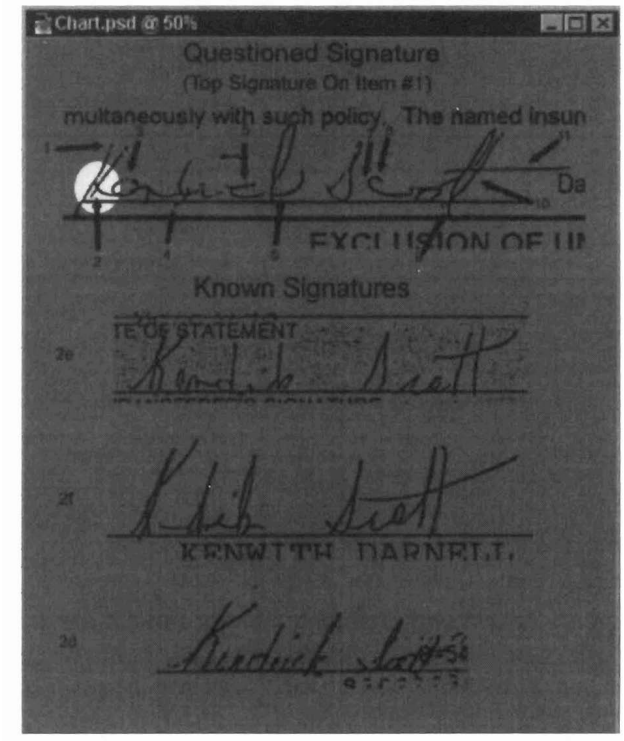

Figure 16.

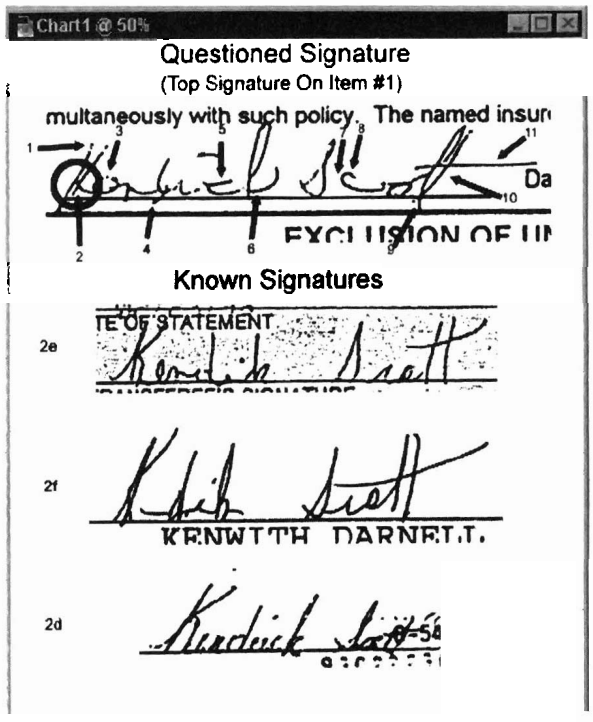

Figure 18.

pected that this method will totally replace photography in the preparation of court charts, it does give the examiner another option for including charts along with his or her report.

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