PhotoGraV

The **Power Tool** for Laser Engraving Photographs

PhotoGraV
User Guide

Version 3.0

PhotoGrav

PhotoGrav©

Version 3.0

User Guide

Revision 3.0.1

PhotoGrav

Copyright Information

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Introduction

PhotoGrav has been designed specifically for Laser Engravers. The objective of the program is to efficiently process digitized photographs so they can be engraved on a variety of common engraving materials with a high degree of confidence that the engraved photographs will be acceptable products.

Traditionally, the engraving of photographs has been difficult and has been a hit or miss endeavor resulting in many discarded objects. The process has been so difficult and costly, in fact, that many Engraving shops simply do not offer engraved photographs as one of their standard products. **PhotoGrav** has been designed to address this problem and does so in three ways:

1. It provides a set of powerful tools that have been found effective in processing photos for engraving.
2. It provides an **automated** application of these tools to the subject photo.
3. It provides a **simulation** of the engraving process for many common materials so the "engraved product" can be inspected before it is actually engraved.

Currently, **PhotoGrav** simulates more than 25 engraving materials including: cherry and walnut wood; clear and black-painted acrylic; black laser brass and anodized aluminum; a variety of generic leather materials; and many plastics with either a white or black core and with a variety of caps including brushed gold and most solid colors. **PhotoGrav**'s processing functions have been tuned and optimized for each of these materials and the appropriate optimized parameters are automatically loaded whenever a new material is selected. Further, **PhotoGrav** automatically compensates for the engraving peculiarities of each material in the process of creating the "engraver-ready" processed image. For example, photos to be engraved on clear acrylic are automatically mirror-imaged and produced at a "negative" polarity. Of course, you can override these automatic features at any time to produce special effects if so desired.

The **PhotoGrav** process is very simple: (1) You select the digitized image that you want to engrave, (2) You select the engraving material, and (3) You choose the Final Processing option within **PhotoGrav**. The next thing you see on your computer monitor is a simulation of what the image will look like when it is actually engraved on the material you have chosen. You can then save the image on disk and use your favorite image processing program, e.g., CorelDraw, to send the image to the engraver.

Of course, the simulated engraving might not look quite like you wanted so instead of saving the image on disk you can reprocess the image by "tweaking" the parameters that **PhotoGrav** had

originally chosen for the image. Most of the time, however, the automated processing in **PhotoGrav** is so good that you won't be able to improve on the automated rendition no matter how long you tweak.

Using an energy and lens model, **PhotoGrav** has been calibrated for many laser engravers from the major manufacturers. However, **PhotoGrav** goes one step further in that it provides the capability that allows you to customize and automate **PhotoGrav**'s processing for your particular machine and for the particular materials that you use.

As a final note, we would like to point out that **PhotoGrav** has NOT been designed in a vacuum by computer scientists who have merely a passing acquaintance with a laser engraver. Rather, it has been designed by a team of engravers, physicists, and computer scientists who have pooled their experience, knowledge, and talents to result in a truly unique and remarkable product for the laser engraving community. This team wishes you all possible success in using **PhotoGrav** and welcomes your comments for improvements to future **PhotoGrav** versions.

Chapter 1
Getting Started

1.0 Using this Document

This document has two objectives: (1) To acquaint you with **PhotoGrav** so you can be productively using the program as rapidly as possible and (2) To serve as a complete reference source for all of **PhotoGrav**'s components and operational characteristics.

To satisfy the first objective, chapters 1 and 2 have been written to present essential information and concepts in as concise a manner as possible. Chapter 1 provides the information necessary to install **PhotoGrav** and to begin using it almost immediately. A series of logically-connected scenarios, with screen shots, provides immediate hands-on experience and should give you a good idea of **PhotoGrav**'s basic operational characteristics. Chapter 2 presents an overview of the flow of events within **PhotoGrav**, discusses some basic **PhotoGrav** concepts and rationale, and presents a summary of important information that you should know about the program.

The remainder of the chapters, especially chapters 3 and 4, provides a detailed reference source for all of **PhotoGrav**'s features. Chapters 3 and 4 present detailed descriptions of **PhotoGrav**'s Primary and Support windows, respectively. Chapter 5 describes how to use the program's Help capability and Chapter 6 explains what to do if you have any difficulties in using **PhotoGrav**. The Appendices present supplemental information in specialized areas.

At a minimum, after installing the program, you should read Sec. 1.4 and step through the scenario presented in that section. You should also definitely read Sec. 2.3, **Important PhotoGrav Information**. Preferably, to really understand and fully use **PhotoGrav**'s extensive capabilities, you should read Chapters 1 and 2 in their entirety.

1.1 System Requirements

To use **PhotoGrav**, you need the following hardware and software:

Hardware

Minimum Configuration

       500 MHz Intel or AMD processor or better
       128 megabytes (MB) of RAM
       CD-ROM or DVD-ROM drive
       Hard disk with at least 50 MB of free space (see *Notes* below)
       Keyboard & Mouse
       1024 x 768 SVGA Video Card

Recommended Configuration

       2 GHz multicore or faster Intel or AMD processor
       At least 1 to 2 GB of RAM
       CD-ROM/DVD-ROM drive
       Hard disk with 100 MB of free space (see *Notes* below)
       Keyboard & Mouse
       At least 32 MB SVGA Video card

Software

       Windows 2000, Windows XP, Windows Vista

Notes on Hardware Requirements:

    PhotoGrav itself requires less than 30 MB of hard disk space for program and data files. However, several temporary disk files are created during **PhotoGrav** execution on the disk where you installed **PhotoGrav**. These files are used as temporary storage for some of the images which are generated during execution. The sizes of these temporary files are proportional to the size of the digitized photo which is to be engraved and thus the required hard disk space is a "soft" number which depends on your operational scenario. All **PhotoGrav** temporary files are deleted when **PhotoGrav** terminates execution.

1.2 Preliminaries

    PhotoGrav *requires* that your computer monitor be set up to display a pixel depth of at least 32 bits per pixel. It is also desirable that the display resolution (desktop area) be set to at least 1024 x 768, but it is recommended to be set at a larger size.

1.3 Installation / Setup

1. Log in to Windows if you have not already done so.

2. Insert the CD into your CD-ROM drive.

3. If Autorun is enabled on your system, installation will start automatically. Otherwise, click **Start**, then **Run** and enter *X:\setup.exe* where X is your CD-ROM drive.

4. Click **OK**.

5. Follow the instructions on the screen.

   Note: During installation you will be asked to enter your **PhotoGrav** serial number. It is located on page *i* (first page) of this document, printed directly on the **PhotoGrav** CD, and in **Help→About PhotoGrav…** menu item.

6. After Installation and until **PhotoGrav** is activated a **Product Activation Screen** will give the remaining days left to activate the **PhotoGrav** product. **PhotoGrav** allows up to 15 days to activate the software. For further information refer to Sec 1.4 on **Activation**.

7. After Installation and on the first time **PhotoGrav** is launched a **Select Machine Type** window will appear. Select the appropriate laser machine type from the list of available laser machine manufacturers and model types. For further information refer to Sec 3.6 on **Machine Properties**.

The installation process will create an icon for **PhotoGrav** and place that on your desktop as a shortcut and will also create a new Program Group under **"*PhotoGrav*"**. In all cases, the installation process will also create an **Uninstall** icon that allows you to easily remove **PhotoGrav** from your system. You may also use the "**Add/Remove Programs**" capability in the **Control Panel** to uninstall the program.

1.4 PhotoGrav Activation System and Licensing

When **PhotoGrav** is launched it checks to see if the software has been activated and authenticated for full use. **PhotoGrav** will permit full usage with an activation reminder up to 15 days from initial installation in order to give adequate time for the user to activate the software. No registration is required to activate the software and no personal information is transmitted across the internet.
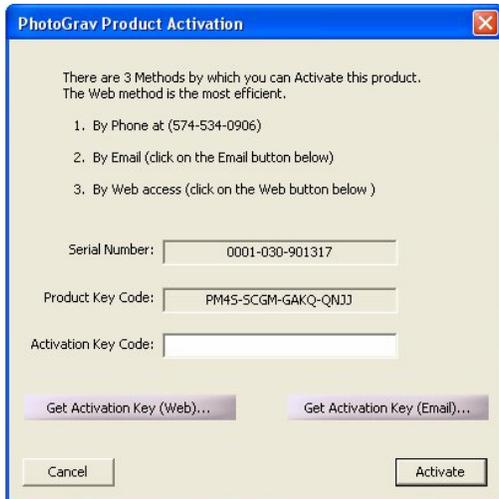
Fig. 1.4.1

Fig. 1.4.2

PhotoGrav Licensing and Activation System permits activations on two separate computer machines and reactivation as many times as needed. This policy allows **PhotoGrav** to be installed on any combination of two computers such as office/laptop, home/office, machine/office, etc.

There are four different methods of activation provided to conveniently assist in activating the **PhotoGrav** software product. These four methods of activation are via the Web, Email, Postal Mail, and Phone (see Fig. 1.4.1). The quickest method to activate the **PhotoGrav** software, assuming efficient internet capabilities, is to use the online **PhotoGrav Activation System** (see Fig. 1.4.2).

To activate the software and display the activation screen in Fig 1.4.1, open **PhotoGrav** and click **Help→Activate PhotoGrav** on the main menu bar. If an active internet connection is available then it is suggested to click the **Get Activation Key (Web)…** button for the quickest way to activate the software. If you prefer to use email then simply click on the **Get Activation Key (Email)…** button and on most computers your default email client will pop up and be filled in with the appropriate information. If the computer system is configured in such a way that the relevant information is already filled in then just click the **Send** button to send an activation request email and allow 24 hours for the Activation Key to be emailed back to the sending email address. The third method is to call ImageLaz Sales Dept and we will be happy to provide an **Activation Key**. The fourth and most inefficient method of activation is to send an activation request via postal mail to ImageLaz with the appropriate information and wait for the **Activation Key** to be sent back.

1.5 Quick Start Scenarios

This section provides a "Quick Start" to using **PhotoGrav** by presenting a simple, but typical, engraving scenario. It introduces **PhotoGrav**'s major features and controls and how they are used within the context of an actual engraving scenario. To successfully use this section you should have a basic understanding of Windows features and techniques. If you're anxious to try **PhotoGrav** and you don't like to read, then this section is for you. However, even if you consider yourself a **PhotoGrav** expert after completing this section, it is highly recommended that you step through the additional scenarios in Section 1.6 and then read Chapter 2 for a more complete understanding of how **PhotoGrav** works.

There are several definitions that one should have firmly in mind before tackling the **Quick Start** scenario. These definitions are listed below:

Original Image (Gray or Color)	The image, in jpg, tif, png or bmp format, that is the input image to **PhotoGrav**. This image is the digitized photograph (either in color or grayscale) that you want to engrave.
Engraved Image (Binary)	This is the processed image that **PhotoGrav** produces that should be sent to your laser engraver. This image is a binary image (black & white) and can be saved in either tif, png, or bmp format.
Simulation Image	This is a simulation, produced by **PhotoGrav**, of what the engraved image will look like when engraved on the selected engraving material. This image is a 24-bit, true color image and can be saved in either jpg, tif, png or bmp format. This image is useful for customer proofs and for reference BUT is NOT the image to be sent to the laser engraver.

Scenario 1: _Engrave a man's photograph on cherry wood._

It is assumed that the man's photograph has been previously digitized and stored as either a color or grayshaded image (in one of the supported image formats) on disk. This scenario will use the image "Image250.bmp" which has been furnished with **PhotoGrav**. This image should reside in the directory **C:\[PhotoGrav Installation Directory]\SAMPLES**.

Note: The image "Image250.bmp" has a dpi of 250. In general, the ratio of engraver dpi to image dpi should be an integer factor. So if your engraver has dpi's like 150, 300, 600, . . , then in the following scenario you should use the image "Image300.dpi" which has a dpi of 300.

1. Start **PhotoGrav** by double clicking its icon or by choosing it from the **Start** menu. The opening "Splash" screen appears.

2. Click anywhere at any time on the opening screen or press any key to continue with **PhotoGrav** execution which always begins with a blank **Session Window**.

3. However, the very first time you run **PhotoGrav**, a **"Select Machine Type" Window** is automatically displayed. In that window, select your engraver type by clicking one of the option buttons. If you cannot find your engraver in the list of machines just Select **"User Defined→Custom"** and type in the relevant information. Then click **OK** to close the window.

4. Click **Open Image** and use the standard Windows dialog box to choose the image "Image250.bmp" which resides in the \SAMPLES subdirectory of the directory in which you installed **PhotoGrav**. The image should be displayed.

5. Click **Select Material**. (A list of engraving materials appears).

6. Scroll down the list and select "Cherry with light vertical grain" and click **OK**. ("Cherry with light vertical grain" shows up in the status bar pane at the bottom of the **PhotoGrav** application window).

7. Click **Final Process**. (A status message informs you of **PhotoGrav**'s progress permitting you to CANCEL the operation if needed at the first available point in the processing algorithm).

8. When processing is complete, a simulation of the engraving is displayed while permitting one to cycle through the various images by clicking on the appropriate buttons:

      O = Original, **G** = Grayscale, **E** = Engraved, **S** = Simulated

9. Click on the **Save Image** button. At this point, if you wished to save the engraved image to disk in order to later send it to your engraver, you would select the **"Engraved"** option in the **Export Image** window that appears. A standard Windows dialog box would then appear in which you could specify the file name of the engraved (binary) image in the usual manner.

10. That's all there is to it! You have created an image, the engraved image, which is ready to be sent to your laser engraver via your print software such as CorelDraw or your laser driver. You may now save the **PhotoGrav** Session if desired which will save the original image and all the appropriate material, machine, and session parameters in one **PhotoGrav** Session File (.pgs) .

    At this point, either continue with scenario 2 (in Section 1.6) or click **Exit** to exit the **PhotoGrav** program.

1.6 Additional Tutorial Scenarios

This section presents five additional scenarios which further illustrate **PhotoGrav**'s features. Each scenario is a logical follow-on to **Scenario 1** presented in the preceding section.

Scenario 2: Compare the original, grayscale, engraved, & simulated images.

This scenario will demonstrate how easy it is to evaluate the engraved (binary) image by comparing it and the simulated engraving to the original (input) or grayscale image. The scenario will also demonstrate some of **PhotoGrav**'s supporting features. **PhotoGrav** has a **"Split Screen"** feature which can be used to more efficiently compare the various images (i.e. grayscale vs. simulated).

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1. If you are continuing here from Scenario 1, then go to the next step. Otherwise, repeat the first eight steps of Scenario 1.

2. Left click on the **Split Window** button. This will provide two separate viewing windows to facilitate in the comparison of results.

3. Now click the **Cycle Images** button in either viewing pane to successively display the original, grayscale, engraved, and simulated images. Note that the four images have been enlarged by the same amount and are in synchronization to facilitate comparisons among the images.

4. Left click at a position between the man's eyes on whichever image is displayed. The image will be magnified. Left click again at approximately the same point. The image will be enlarged more. (Note the scale factor in the lower right corner of the window).

5. Click with either mouse button anywhere on the gray area surrounding the displayed image. The display should now show the entire image. (The image can also be de-magnified in steps by clicking on the image with the right mouse button).

6. "Click and drag" on the image to define a rectangular area that you want magnified. After releasing the mouse button, the selected portion of the image will be magnified to fill the image area.

7. The simulation image and the ability to magnify and to cycle among the original, grayscale, engraved, and simulated images has been designed to help you decide whether or not the engraved image is a good representation of the original (input) or grayscale image on the engraving material you have chosen (cherry wood in this scenario).

At this point, either continue with scenario 3 or click **Exit** to exit the **PhotoGrav** program.

Scenario 3: _Generating a PhotoGrav Session Information Report_

This scenario will demonstrate how to generate a **PhotoGrav** Session Information Report that completely describes the current engraving session. The scenario will also demonstrate several other **PhotoGrav** features.

1. If you are continuing here from Scenario 1 or Scenario 2, then go to the next step. Otherwise, repeat the first eight steps of Scenario 1.

2. Click the **Display Info** button located on the **Primary Functions Toolbar**. The **Session Info Report** window should open and display all the relevant session information including an estimate of engraving time.

3. Click on the lightest-gray box titled **Engraver's Comments**.   Type in a comment such as: _This session used the standard parameters for cherry wood._

4. Click the **Print Report** button near the bottom of the window. A standard Windows dialog box should appear allowing you to select a printer (if you have more than one) and to set the options for the selected printer. Your report should be printed after clicking **OK** in the standard dialog box.

5. Click the **Close** button next to the **Engraver's Comments** button and the **PhotoGrav Session Info Report** window should disappear.

6. Refer to Figure 1.6.1 on the next page for the entire display of the **PhotoGrav Session Info Report** screen.

    At this point, either continue with Scenario 4 or click **Exit** to exit the **PhotoGrav** program.

Notes:

Fig. 1.6.1

Scenario 4: *Adjusting Parameters in the* **"Interactive Mode"** *Panel.*

This scenario will demonstrate how to adjust the parameters used in creating the engraved and simulation images. The **Interactive Mode** panel is extremely powerful, but also a little complicated so this scenario will just demonstrate some, not all, of the features available when **Interactive Mode** is selected. This scenario will also demonstrate how to export the **Parameters**.

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1. If you are continuing here from Scenario 1, 2, or 3, then go to the next step. Otherwise, repeat the first eight steps of Scenario 1.

2. Click the **Interactive Mode** ![Interactive Mode button] button located on the **Primary Functions Toolbar**. The **Interactive Mode** button should change to indicate that it is selected and the Parameter Adjustment view is displayed in the lower panel of the Session Window (see Fig. 1.6.2).

3. Components of the **Interactive Mode** panel:

    If **Split Window** ![Split Window button] is selected (two viewing windows) and the input image is displayed in the left image pane and the output image (usually the simulated image) is displayed in the right image pane.

    The seven green/red ON/OFF buttons represent the various processing functions that are applied to the input image. If a button is green, that function is "ON". If the button is red, that function is "OFF".   There are also 8 sliders with corresponding text boxes for manual entry of the various parameters along with slider controls that adjust the histogram clipping region and the viewing range.

4. Within the "Simulate Engraving" panel, click the "**Power**" scroll bar (in the light gray area under the scroll box) until its value is 20%. Now click the ![Preview] button (also on the session toolbar see Fig 1.6.3) and note that the simulated image has gotten much lighter reflecting the lower power setting for the engraving.

5. In a similar fashion, click the "**Speed**" scroll bar until its value is 30% followed by the ![Preview] button. Again note that the simulation image is now about the same darkness as was the case when **Power** was 70% and **Speed** was 100%.

6. Now, uncheck the ![Progress On] check box and click the **Reset** ![reset icon] button next to the **Power** control then click the ![Preview] button. Note how much faster the simulated image is displayed. If it is significantly faster then you may want to consider leaving this unchecked unless you are working with a rather large image.

7. You may have noticed that every change you make requires you to click one of the Preview buttons to view the changes. To see the changes in almost real time after every change ensure that the ☑ Auto Preview checkbox is checked and the ☐ Progress On checkbox is unchecked. Now change the **Power** back to 20% by either typing "20" into the textbox for the **Power** parameter followed by pressing the [**Enter**] key or move the slider bar until the textbox reads 20% followed by releasing the mouse button. Note in either case how the simulated image is changed almost instantly. These options are included to provide some flexibility in previewing efficiency based on the speed of your computer and the size of the image.

8. Once you have adjusted the parameters to your satisfaction press the [Final Process] button to hold the parameter changes and process the image in its entirety. The engraved/binary image is now ready to be saved for engraving.

9. There are many other functions and features available when in **Interactive Mode**. See Section 3.2 of this **PhotoGrav User Guide** for a complete description of each of these functions.

At this point you can click **Exit** to exit the **PhotoGrav** program if you so choose.
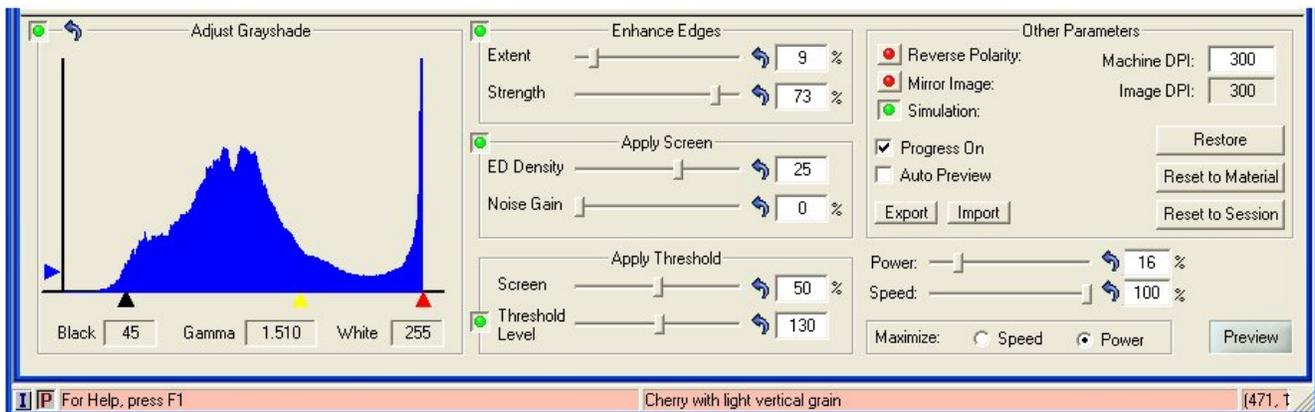
Fig. 1.6.2

Fig. 1.6.3

Notes:

Chapter 2
Operational Overview

2.0 Introduction

The objective of this chapter is to present the essential information that you need to know in order to effectively use **PhotoGrav**. Section 2.1 briefly describes **PhotoGrav**'s primary functions and flow of events that those functions support during a typical **PhotoGrav** session. Beginning with **PhotoGrav** version 3.0 multiple simultaneous **PhotoGrav** sessions can be opened, modified, and independently saved. Section 2.2 provides a concise, high-level description of the program's concepts and the rationale for those concepts. Finally, section 2.3 presents a list of items that summarize the important information about **PhotoGrav**.

2.1 Functional Flow of Events

PhotoGrav employs a small number of primary toolbar buttons to functionally organize the major steps involved in engraving a photograph. Each functional button has one or more major functions to accomplish and, upon completion of those functions, control passes back to the main session window. Figure 2.1.1 illustrates the normal flow of events in **PhotoGrav** processing.
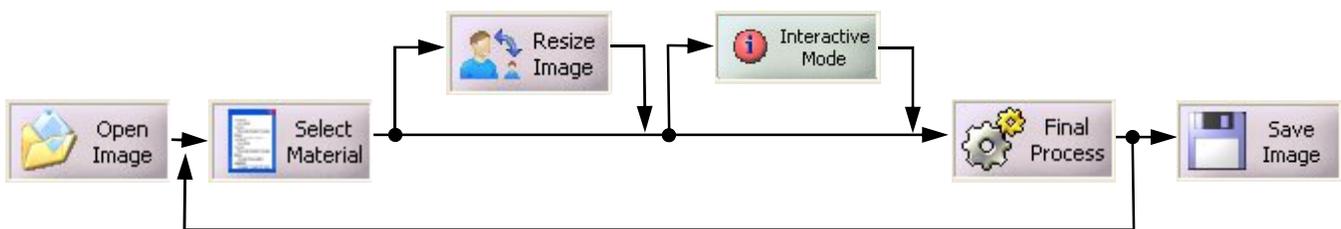
Fig. 2.1.1: PhotoGrav Functional Flow

The **Open Image Button** provides the capability to select the image that you want to engrave while the **Select Material Button** selects the engraving material that you want to use. **PhotoGrav** stores a set of processing parameters with each material that it models. These processing parameters are optimized for each particular material to ensure excellent engraving results without any user intervention. These optimized parameters make possible the "**Final Process**" path indicated in Fig 2.1-1.

The **Resize Image Button** provides the capability for you to resize/resample the input image without having to rely on another software application to perform this task. **PhotoGrav** will NOT resize or even modify the original image in any way because **PhotoGrav** makes a working copy of the original file. Also, on every resize/resample operation **PhotoGrav** uses the original image to perform the resize operation in order to maintain the highest degree of quality.

The **Interactive Mode Button** provides the capability to individually specify parameters for all of **PhotoGrav**'s processing functions and to view the result in near real time. Most importantly, one can view a simulation of what the engraving would actually look like on the material that you have selected. Although the **Interactive Mode** provides complete access to **PhotoGrav**'s functions that have been tuned specifically for Laser Engravers, you will probably find that you can seldom do better than **PhotoGrav**'s Automatic **Final Process**ing option.

The **Final Process Button** (Auto Process in previous versions) allows the input image to be processed and finalized in the proper format for the laser engraver. To ensure that the image is processed and finalized with the latest modifications of the parameters _**this operation should ALWAYS be performed whether in Interactive Mode or otherwise prior to saving the image to disk.**_

The **Viewing Panes** (Figure 2.1.2), whether in split mode or otherwise**,** displays the **Original** (Input) image, the **Grayscale** image, the **Engraved** (Binary) image (the image that is to be used for engraving), and the **Simulated** image (what the engraving will look like on the selected material). The images appear on the screen one or two (if in split mode) at a time. One can, however, click a button to rapidly cycle through the various images for comparison purposes or view the images side by side when in split view mode. You can also magnify the images by clicking near the center of the area you want magnified or by defining a rectangular area to be enlarged to fill the screen. All three images are magnified by the same amount so comparisons are still easy to do even after magnification. Once the processed image is acceptable the various images can be save to disk for storing and to transfer to your engraver.

The **Save Image Button** allows the various images (Original, Grayscale, Engraved, Simulated) to be saved to disk (when appropriate) in the supported file formats i.e. jpg, tif, bmp, png. When saving the Engraved image the jpg file format is NOT permitted due to the fact that in most cases it would ruin the engraved image information which would not be suitable for engraving.

Fig. 2.1.2: Viewing Panes
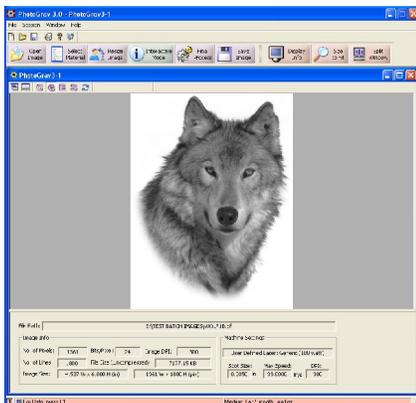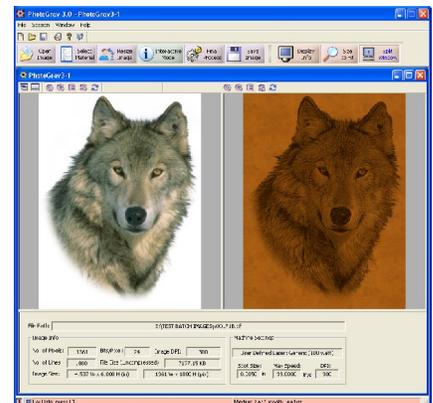
Single Viewing Pane   Split Viewing Pane

2.2 Basic PhotoGrav Concepts

The objective of the **PhotoGrav** program is to efficiently process digitized photographs so they can be engraved on a variety of common engraving materials with a high degree of confidence that the engraved photographs will be acceptable products. This objective is achieved via two basic **PhotoGrav** concepts:

1. Processing operations that are "tuned" for each engraving material, and
2. A simulation of the engraved image

The intent of this section of the user guide is to provide a concise, high-level description of these two concepts and their underlying rationale. A more detailed description can be found in "**Appendix 5: PhotoGrav Concepts and Design**".

PhotoGrav's processing operations were designed and developed specifically to process images for laser engraving and were parameterized so that a wide range of effects could be achieved by adjustment of the parameters. Then the parameters were individually "tuned" for each of the engraving materials supported by the program. This "tuning" was accomplished experimentally, using several test images, by specifying several sets of parameters for each engraving material, actually engraving the images on the material, and evaluating the resulting engravings. This process was repeated until the resultant engravings appeared to be near optimal for the subject material. The parameters that produced the final, "near optimal' engraving were then recorded and a data set was created for the material. These data sets are stored as part of the description of each engraving material and are automatically retrieved whenever a material is selected as the current engraving material within **PhotoGrav**.

Although the tuning process described above results in "near optimal" parameter settings for each engraving material, _engraving results are still often somewhat image dependent_. In other words, the settings that produce an excellent engraving for one image on a specific material might result in an engraving that is less satisfactory for another image using the same engraving material. Further, it is very difficult to view the raw processed image on a computer monitor and to judge from that display whether or not the final engraving will be satisfactory. To overcome these difficulties, **PhotoGrav** provides, optionally, a simulation of what the processed image will look like once it is actually engraved on the selected material and the ability to modify the parameters as needed.

PhotoGrav's simulation capability is intended to provide a **WYSIWYG** (**W**hat **Y**ou **S**ee **I**s **W**hat **Y**ou **G**et) capability. In other words, the appearance of the simulated image on your computer monitor should be close to the appearance of the actual engraving produced from the processed image for most of the included materials. The simulated image is not merely an overlay of "dots" on top of a representation of the engraving material, but rather a convolution of the various parameters and images. In other words, it is a full-fledged simulation wherein a lens-power model, calibrated for each material, is used to calculate an **effective** laser spot size which is then "burned" into a representation of the engraving material. Further details about the simulation and model can be found in Appendix 5.

The Simulation Image produced by **PhotoGrav** should **always** be a representation of the final engraving. For example, for "Black Laser Brass", the Simulation Image should appear with proper polarity even though the processed image, if displayed in its "raw" form, would appear to have a "negative" polarity. There is one special case of this **WYSIWYG** capability that should be noted. For acrylics, which are normally engraved on the "back" of the material, the Simulation Image produced by

PhotoGrav is the view from the "front" of the material, i.e., the normal viewing perspective. So, even in this special case, the Simulation Image produced by **PhotoGrav** is a true **WYSIWYG** representation, i.e., the simulated engraving is presented as it would normally be viewed by your customers as a finished product.   Although the primary utility of the Simulation Image is to help you make fine adjustments to create a more satisfactory engraving, it can also be printed and used for customer proofs or as supplements to file copies of your shop's projects. The prints are especially effective if you have a color printer attached to your computer.

Although the simulation model has been calibrated for a variety of laser engravers and for many common engraving materials, there are bound to be variables that at times cause noticeable differences between **PhotoGrav**'s Simulation Image and the actual engraving. For example, black laser brass from different manufacturers, or even different "batches" from the same manufacturer, will sometimes engrave somewhat differently under identical engraver settings. Also, variables in the laser engraver itself, e.g., dirty lenses or mirrors, can cause variations in the engraving performance. You should try to control these variables to the degree possible and also realize that **PhotoGrav**, like any other tool, requires some practice and skill on your part to adapt its capabilities to your particular environment and requirements. It is also important to remember that, for engraved photographs, "beauty is in the eye of the beholder", i.e., the perceived goodness of an engraving is a very subjective measure. You might therefore find that **PhotoGrav**'s processing parameters for a particular material do not result in engravings that match your tastes. If so, use **PhotoGrav**'s interactive processing capabilities (see Sec. 3.4) and its Named Parameter Sets to define things the way you want them to be.

One other aspect of **PhotoGrav**'s operational characteristics requires some discussion before concluding this section. In the **Image Viewing Panes** (see Fig. 2.1.2), **PhotoGrav** displays the Original Image, the Grayscale Image, the Engraved Image, and the Simulation Image for comparison purposes. The Grayscale Image is the input image and the Engraved Image is the processed binary image that is to be sent to the engraver. The Engraved Image is normally **displayed** in the same polarity and the same left-to-right orientation as the Grayscale Image even though those characteristics might be automatically changed by **PhotoGrav** when the image is saved on disk for transfer to your engraver. The reason for displaying the Engraved Image in this fashion is merely to facilitate the comparison to the input image. If this is a bit confusing, just remember that the Simulated Image **always** represents what will be engraved if you save the processed image (Engraved Image in **PhotoGrav**'s terminology) to disk and transfer it to the engraver with no changes.

2.3 Important PhotoGrav Information

The following is a collection of important things that you should know about **PhotoGrav**. Some of the items have already been discussed in previous sections and some of them will be covered in later sections. However, since much of the information following Chapter 2 is very detailed and is intended as reference material, the essential elements of that information are summarized below so you can begin using **PhotoGrav** with confidence after reading this section. If an item is discussed elsewhere in this document, then a reference to the appropriate section is included below.

1. **PhotoGrav** has been designed for compatibility with a display screen color pixel depth of 32-bit and a resolution of 1024 x 768 or larger.   **(Reference: Sec. 3.3)**

2. The input image ("Original/Grayscale Image") for **PhotoGrav** can be any image type in the following format: **tif, bmp, jpg, png**.   **(Reference: Sec. 3.2.2)**

3. The input image to **PhotoGrav** should be scanned in some image processing program such as CorelDraw or Adobe PhotoShop, so that its size and resolution (dpi) are "correct". If the image is already in a digital format then **PhotoGrav** is able to resample the image to the desired size and resolution (dpi). Most images taken with a digital camera have an arbitrary resolution of either 72 or 96 dpi. In most engraving cases a dpi of 72 or 96 must be altered for best results.

    The dpi (dots per inch) for the image should be the same, or an integer factor or divisor, of the dpi at which you intend to engrave the image. For example, if you intend to engrave at 250 or 500 dpi, then the image should be scanned at 250 dpi. If you intend to engrave at 300 or 600 dpi, then the image should be scanned at 300 dpi. Engraving results can often be very disappointing otherwise. The size of the image, at the scanned resolution (dpi), should be the desired size of the final engraved image.

4. Processed photographs (**PhotoGrav**'s "Engraved Image") should be engraved using the highest resolution lens (smallest spot size) that you have available. If you do not own your manufacturer's "high-resolution lens" and if you intend to engrave a lot of photographs, then you might consider obtaining such a lens.

5. Use **PhotoGrav**'s "Machine Properties" or "Select Machine" dialog window to set the parameters and characteristics for your specific laser engraver. The "Machine Properties" window is accessible from the **File→System Defaults→Select Machine** menu item. The *session* "Machine Properties" can be modified by selecting **Session→Select Machine** from the menu bar.   **(Reference: Sec. 3.6)**

    Although you specified your Laser Engraver model and its maximum power on your very first **PhotoGrav** execution, there are other parameters that further define your specific machine. In particular, within the "Machine Properties" window, you should add and/or delete lenses from the "Lenses" list to match your set of lenses. Similarly, the list of "dpi's" should be edited to reflect the dpi settings available on your machine. Also, if your laser engraver's maximum wattage is not listed under "Watts" then add it to the list as well.

6. **PhotoGrav** is not designed to "Print" directly to laser engravers. To engrave a **PhotoGrav** processed image (the "Engraved Image"), save the "Engraved Image" to disk and use your standard program, e.g., CorelDraw, to send the image to the engraver.

                    (Reference: Sec. 4.1.2.1)

7. <u>**DO NOT RESIZE NOR ROTATE**</u> the "Engraved Image" (the image to be sent to the engraver) in CorelDraw, or any other image processing program, before sending it to your engraver. The "Engraved Image" is a binary image, as it must be for laser engraving, and resizing and rotation operations in general do not work well for binary images.

8. **PhotoGrav**'s "Sessions" provide a powerful mechanism whereby you can customize **PhotoGrav**'s parameters to achieve the results you want and can be assured that those results are repeatable in the future. If **PhotoGrav**'s default parameter settings do not provide a satisfactory result for a specific material after the "Final Process" button is pressed, then select the "**Interactive Mode**" button to create "Engraved Images" at several parameter settings that you suspect might be better. Save the various "Session's" with different names and then actually engrave the images. Choose the engraving you prefer and then delete the "Session's" that do not correspond to that "best" engraving. If satisfied with the "best" engraving, note which session was used and/or rename it so you can readily access it in the future for similar engraving projects. Otherwise, repeat the process until the results are satisfactory. You can now use this "Session" as a template to begin other similar "Session" types.   **(Reference: Sec. 3.1)**

9. The engraving material to be modeled is selected via the "Material Properties" dialog window. The "Material Properties" dialog window can be accessed by selecting the **File→System Defaults→Select Material** menu item. The *session* "Material Properties" can be modified by selecting **Session→Select Material** from the menu bar.
                                                                   (Reference: Sec. 3.2.3)

10. The leather materials included with **PhotoGrav**, unlike most of the other furnished engraving materials, are not standardized materials. Further, the engraving behavior of leather depends very much on the tanning process, whether the leather is oiled or not, etc. therefore, **PhotoGrav**'s Simulation Image for any specific leather material might not be a good representation relative to the specific leather material that you want to use. However, you can use the furnished material as a starting point for your own calibration process wherein you save your final, calibrated parameters as a **PhotoGrav** "Session File" Template.

11. The list of engraving materials includes two plastic materials that are "User-Defined Caps" with white or black cores. These materials can be used to model just about any plastic with a solid-color cap and with either a black or white core. Some calibration and parameter adjustment, as described in item 8 above, might be necessary for certain plastics and colors.   **(Reference: Sec. A1.1, Tip 5)**

12. Two copies of **PhotoGrav** cannot be running at the same time. If **PhotoGrav** refuses to start, there is probably another copy of **PhotoGrav** running in a minimized window.

13. **PhotoGrav** produces temporary image files during its execution that can become quite large if the input image is large. Try to maintain a reasonable quantity of free disk space on the hard disk where you installed **PhotoGrav** (200 MB should be more than adequate for most purposes).

14. **PhotoGrav** is a Windows 32-bit program which runs equally well under 2000, XP, and Vista. A 64-bit version is planned to be released and it is recommended that you call **PhotoGrav** or check online at ***www.photograv.com*** for the latest information.

Chapter 3

PhotoGrav Application

3.0 Introduction

Chapter Two described **PhotoGrav**'s operational overview and how **PhotoGrav** uses these to provide a smooth flow of events within a **PhotoGrav** Session. This chapter, Chapter Three, provides a detailed description of each of those primary functional blocks as well as describing a **PhotoGrav** Session and the essentials of the **PhotoGrav** Application. The description with appropriate graphics include: (1) PhotoGrav Sessions, (2) The Primary Toolbar and its operations, (3) Viewing Panes and Panels, (4) Interactive Mode, (5) Cloning—Comparison of Results, (6) Machine Selection, and (7) Automatic Updates. It is especially recommended to become familiar with these primary functional blocks located on the Primary Toolbar and the respective operations since these are vital in producing a digital image for laser engraving.

3.1 PhotoGrav Sessions

One of **PhotoGrav**'s primary design concepts is the notion of a "**PhotoGrav** Session" and its respective "Session File" (*.pgs). A "Session File" is a file that is designed to **save** the current state of ones work including all parameter settings, user preferences, machine and material info, <u>as well as the source image</u>. By permitting the source image to be saved with the session alleviates the need to remember where the "original" image file is located. One can simply reopen the "Session File" and perform any necessary modifications and/or adjustments without having to relocate the original image. The machine information will be stored in the "Session File" which is helpful, for example, if **PhotoGrav** is used with multiple engravers. This permits one to save **machine/material** "templates" such that the user can just open up the session "template" pertaining to that particular machine/material and begin using **PhotoGrav** with the machine and material info already selected and defined.

Whenever an image is opened, **PhotoGrav** will automatically insert that image into either a **new** session OR an existing active session. Either way there will always be only **one** image associated with a **PhotoGrav** Session.

Due to the "Session File" format, however, one must keep in mind that there are **two** modes of selecting a machine and/or material. These two modes are selecting the "Session" machine/material (Figure 3.1.1) and setting the "system" material/machine (Figure 3.1.2). The "Session" selection stays with that particular session and the "System Default" selection sets the default material/machine type

so that any new session that is created will default to the machine/material type that is selected in the "System Default" settings.

Session files can be very useful when becoming proficient with **PhotoGrav** in the following ways; when working with a difficult image, if multiple engraving machines are used, when working with multiple concurrent jobs, and in many other cases as well.   **PhotoGrav** allows multiple session files to be opened simultaneously and offers some functions specifically related to Session files such as Cloning (Figure 3.1.3).   For further instruction on cloning refer to Section 3.5 on Cloning— Comparison of Results .

PhotoGrav has the capability to email Session files for easier review. For example PhotoGrav Session Files can be emailed to PhotoGrav Technical Support or to another office location for review simply by clicking on the **Session→Email Session…** menu item (Fig 3.1.4).

From this point forward the majority of this section is in the context of a "**PhotoGrav** Session" file (.pgs files).

Fig. 3.1.1: Session
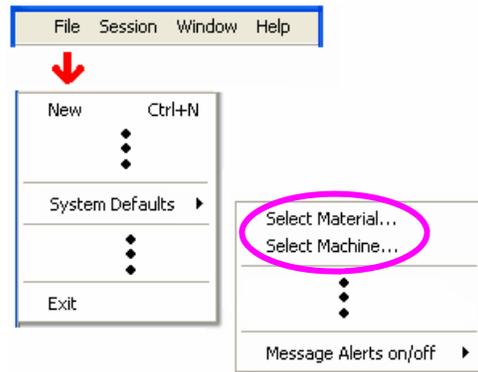
Fig. 3.1.2: System Default
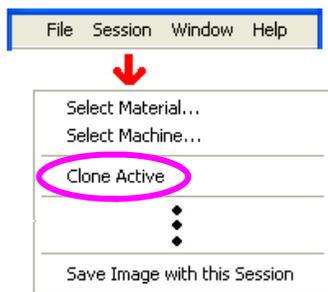
Fig. 3.1.3: Session Functions
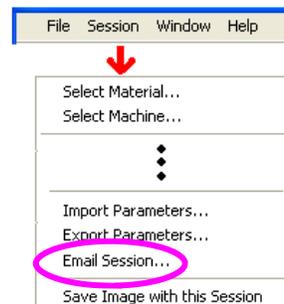
Fig. 3.1.4: Email Session

3.2   Primary Toolbar

3.2.1 Overview

PhotoGrav is designed for simplicity, therefore, all of the primary functions necessary to prepare an image for laser engraving are grouped together and displayed in the "Primary Toolbar" (Fig 3.2.1). The Primary Toolbar provides quick access to the most commonly used functions.
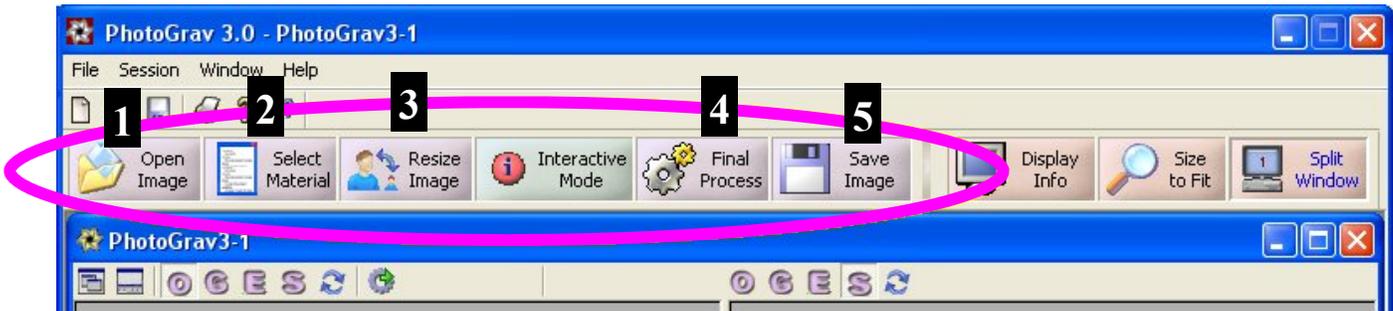
Fig. 3.2.1: Primary Toolbar

The Primary Toolbar has 5 basic functions that perform the minimum requirement operations to successfully laser engrave an image or photograph. As noted in Section 2.1 of this manual these 5 minimal steps are as follows:

1. Open an Image (Input Image).
2. Select the engraving material.
3. Resize the image to the desired size.
4. Process the image.
5. Save the image to disk.

3.2.2 Open Image **1**

The Open Image button simply displays a dialog window that allows an image in any **PhotoGrav** supported file type (bmp, jpg, tif, png) to be opened and inserted into either a new or existing session window. While the open file dialog filters the listed items to only show **PhotoGrav** supported image types. If the "All files (*.*)" option is selected any **PhotoGrav** file type can be opened such as **PhotoGrav** Session Files (pgs), **PhotoGrav** Parameter Files (prm, pgp), or **PhotoGrav** Supported Image Files (bmp, jpg, tif, png).

The image that is initially opened is considered the "Original Image". The image can be either color or grayscale. **PhotoGrav** then automatically converts the original image if necessary to a "Grayscale Image". **PhotoGrav** considers the grayscale image because it is often much more reliable to compare the grayscale image (rather than the color image) to the engraved image.

3.2.3 Select Material **2**

The "Select Material" button displays a dialog window listing all the available materials sorted by the various categories (see Fig 3.2.2). Remember that this material selection only changes the material for the "active" session. Refer to Section 3.1, Fig 3.1.2 to see how to change the default material setting. This list will be altered by the "Auto Update" feature (see Section 3.7) as more materials become available for download. **PhotoGrav** does not permit the user to modify this list due to the fact that many materials individually and specifically tested and fine tuned for the best results. While some material parameters are modifiable by the user there are a number of parameters that are fixed during the design and testing phase of that material. The material can also be chosen by double-clicking an item in the list or by highlighting the material and clicking the "OK" button. The selected material will then be displayed in the status bar at the bottom of the main application window.
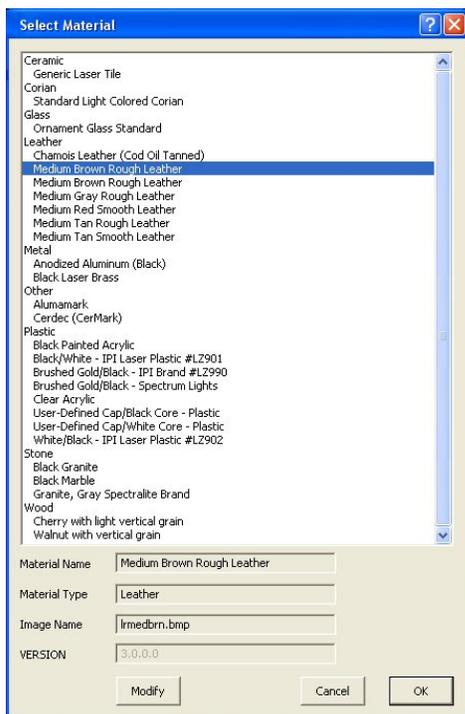
Fig. 3.2.2: Material Selection Dialog

Fig. 3.2.3: Modify Material Color

The **Modify Material Color** dialog window (Fig. 3.2.3) can only be invoked from the **Select Material** dialog window and provides the capability to the appearance of an engraving material. The capability to modify the engraving material's appearance enhances **PhotoGrav**'s usefulness in two ways. The more important of the two ways is that it allows a broad range of solid-color plastics to be effectively modeled by **PhotoGrav**. This is achieved by providing two materials both of which have a User-Defined Cap but one of which has a white core and the other has a black core. These user-defined caps can be modified to have any solid color as will be described below. The other way that the capability to modify the engraving material's appearance can be useful results from the fact that many engraving materials, although similar to those provided by **PhotoGrav**, might differ somewhat in color and brightness. The capability to alter their appearance might improve the fidelity of the simulated engravings produced by **PhotoGrav.**

3- 4

The material to be modified can be chosen by clicking a material item in the list in Fig. 3.2.2 and then clicking the "Modify" button. Pressing the "Modify" button causes the **Modify Material** dialog window to appear.

The controls in the "Color Adjustments" frame are used to modify the appearance of the engraving material. The "Brightness" and "Contrast" controls affect the overall brightness and contrast of the material for all colors equally. The "Brightness" modification can range from -100 to +100 and the "Contrast" modification can range from -1.00 To + 1.00. The modification values can be changed only by clicking the scrollbars, not by direct numerical entries in the textboxes.

The "Red Tint", "Green Tint", and "Blue Tint" scrollbars change the contrast of the respective colors. The tint modifications can range from -1.00 to +1.00 and can be changed only by clicking the scrollbars, not by direct numerical entries in the text boxes.

Modifications caused by the adjustments are immediately visible in the material image view window. The "**Reset**" command button resets all of the scroll bars to the "no adjustment" state since the last time this material was modified. The "**Reset to Default**" button resets the adjustments to the default setting of the material, in other words to the settings of the material when originally shipped.

As an example try selecting the "User-Defined Cap/White Core" material type under plastics. And click "Modify". Then adjust the "Green Tint" and "Blue Tint" slider bars so that both have a value of -1.00. Note that the effect of these values is that the material image view window turns from white to bright red. That red color could be further adjusted by changes in the "Brightness", "Contrast", and "Red Tint" scroll bars. The net result is that one can create almost any desired color for the cap of a solid-color plastic for which the core color can be either white (in the example) or black.

3.2.4 Resize/Resample Image 3

Resizing and/or Resampling the original input image (Fig 3.2.4) is almost always a requirement because one rarely receives the image in the actual size needed for engraving (this does vary some depending on the engravers policies). **PhotoGrav** offers the ability to resize/resample an image to the desired size without having to depend on other outside methods. **PhotoGrav** will raise a notification if it detects a discrepancy between the selected machine resolution (dpi) and the resolution (dpi) of the image. The image should be resampled to the same resolution (or an integer multiple of) as the desired engraving resolution (machine dpi setting). **PhotoGrav** uses the machine settings extensively to prepare and simulate the image to give the user an idea, estimate, or relative difference of what to expect when the actual

Fig. 3.2.4: Resize Image

engraving is performed. Therefore, **PhotoGrav** does not adjust the "actual engraver" setting, which is usually modified through the software driver that comes with the engraver, but rather only adjusts the "machine setting" in **PhotoGrav** which is then used to prepare the image for engraving.
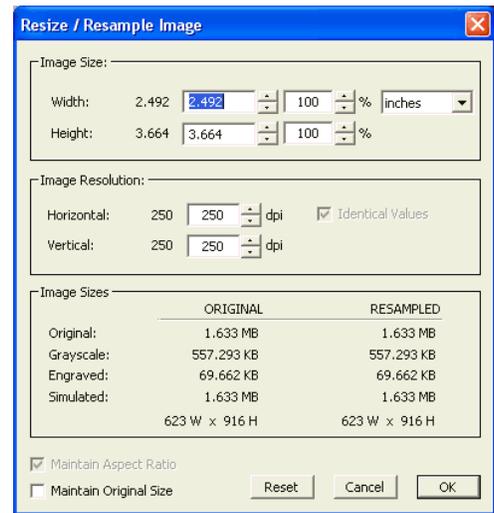
3.2.5 Final Process   4

The "Final Process" command button performs the actual processing necessary to produce an image ready for the laser engraver. This button should be pressed in every case prior to saving the image to disk. Once the "Final Process" button is clicked **PhotoGrav** will process the image using the current parameter settings. After the processing is complete **PhotoGrav** will switch the image viewing pane to either the "Engraved" image or the "Simulated" image determined by which image is selected in the viewing pane toolbar (see Section 3.3, Fig 3.3.2). There will now be a total of three or four images to use for comparison purposes in order to further fine tune the results if needed.

3.2.6 Save Image   5

Now that the material has been selected and the image has been opened, resized, and processed it is ready to be saved to disk for engraving (Fig 3.2.5). To do this simply select the "Save Images" button on the Primary Toolbar and save the appropriate images to disk in any of the **PhotoGrav** supported file formats. The only exception is the "Engraved" image which cannot be saved as a jpeg due to the fact this format usually uses a lossy compression type scheme which would create dire effects

Fig. 3.2.5: Save Image

on the engraved image. One can elect to save the images while flipping either horizontally, vertically or both. One may find the "Flip Horizontal" check box to be turned on depending on the material type selected due to the fact that some material types such as acrylic engrave better on the back side, therefore requiring the image to be flipped or mirrored. This can be altered, however, by modifying the parameters when in Interactive Mode and then saving the session as a Template Session.
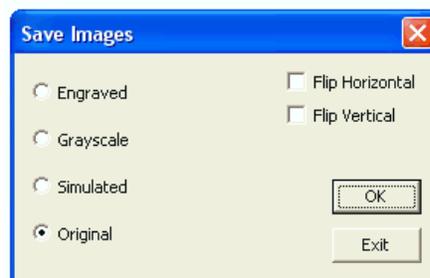
After the "Save Images" dialog is opened one must select the "Exit" button to close out of this dialog screen. The reason for this is that often it may be desirable to save more than just the "Engraved" image so this goes into a continuous loop until all images are saved as needed.

3.2.7 Display Info   6

The remaining buttons on the Primary Toolbar have to do with the way information is handled and viewed (see Fig 3.2.6). After pressing the "Display Info" button the "PhotoGrav Session Report" window will be displayed (Fig 1.6.1). This is a formatted report, that can be viewed or printed, of the parameter, machine, and image settings for a particular session. This report also includes thumbnail images of the original and simulated image types. This provides an opportunity to print and file every job performed while having quick access to all the data that was used for that job. One can also use it to quickly view all the relevant settings for a session in a neatly organized fashion. The ***PhotoGrav Session Report*** is also where an estimate of the engraving time can be located and any comments that might be helpful relating to the active session.

Fig. 3.2.6: Primary Toolbar

3.2.8 Size to Fit 7

The "Size to Fit" button zooms all the images to fit within the viewing panes (see Section 3.3 for further information on Viewing Panes and Panels).

3.2.9 Split Window 8

The "Split Window" button toggles between viewing the images in a single or double viewing mode (see Section 3.3 for further information on Viewing Panes and Panels).

3.3 Viewing Panes and Panels

PhotoGrav provides a few options for displaying information about the image, session, machine, parameter, etc. The session window is divided up into 2 primary views. The first is the "Image" view. This is where the images are displayed and image commands such as zoom in, zoom out, pan, etc. are performed. Due to the numerous sizes and resolutions of existing monitors **PhotoGrav** offers the ability to view the images in either single or "split window" mode. This allows for a larger viewing area where the images can be cycled one at a time in single view mode or individually selectable by pressing the corresponding toolbar button. On the other hand it also permits one to compare side-by-side the resulting images in split screen mode (Fig 3.3.1).
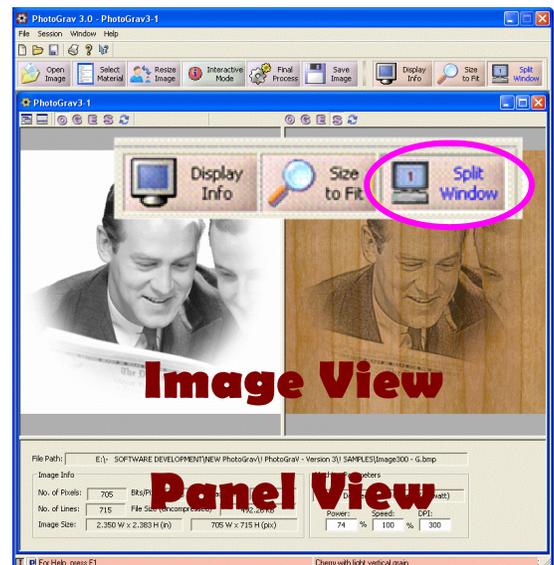
Fig. 3.3.1: Primary Toolbar
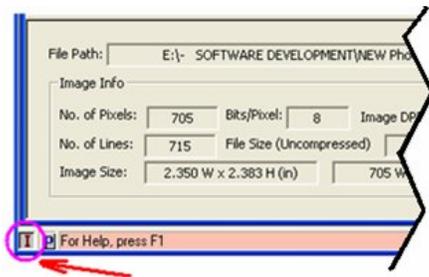
Fig. 3.3.2: Image Info
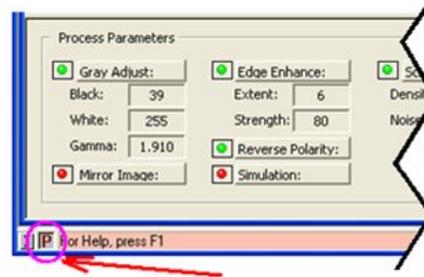
Fig. 3.3.3: Parameter Info

The second view that provides information is called the "Panel" view. The "Panel" view is further divided into two subsequent views named "Image Info" and "Parameter Info" (Fig 3.3.1). The "Image Info" panel (Fig 3.3.2) shows basic information about the image and the currently selected machine. The next sub panel is the "Parameter Info" panel (Fig 3.3.3) which displays a fixed summary of the current parameter settings. This "Parameter Info" view changes to permit adjustments and modifications to the parameters when in "Interactive Mode" which is discussed in Section 3.4.

Fig. 3.3.4: Hide/Show

These panel views can be hidden to again provide for larger viewing areas as needed by selecting the appropriate toolbar button from the **PhotoGrav** Session Toolbar (Fig 3.3.4).

Fig. 3.3.5: Image Selection

There are four images that one can select for viewing namely **O**riginal input, **G**rayscale, **E**ngraved/binary, and the **S**imulated images (Fig 3.3.5). If one has "Split Screen" selected then these images can be selected independently per image view. To open an image one can select the "Open Image" button on the primary command bar. This button can be selected even if there is no session window open in which case a new session window will be created and the respective image inserted into that session. If, on the other hand, an existing session is open then the selected image will be inserted over the existing image if an image exists. In other words, if the user already has a session open then he or she should create a "New" session prior to opening the image to prevent the replacement of the existing session's image.
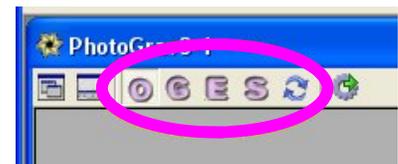
By left or right clicking of the mouse button in either one of the two Image View Windows one can incrementally zoom in or out respectively. It is also possible to drag a zoom "box" or rectangle around the desired area for closer inspection of the images. Another image command is the "pan" command. This command centers the image at the point where the mouse button was clicked. Holding down the [Space Bar] will activate this command (Fig 3.3.6).

Fig. 3.3.6: Image Selection

3.4 Interactive Mode

Fig. 3.4.1: Primary Toolbar

The **Interactive Mode Button** toggles between two modes of operation. When in "Interactive Mode**"** the **Interactive Mode Button** will show a <u>**green**</u> "i" icon indicating that **PhotoGrav** is in "Interactive Mode**"**. Similarly when **PhotoGrav** is NOT in "Interactive Mode" the button will display a <u>**red**</u> "i".

The "Interactive Mode" is designed for the primary purpose of providing a quick and efficient preview of the final image, since with average size images it would simply take too long to run through the entire **PhotoGrav** processing pipeline every time a small change is made to a parameter. With this in mind **PhotoGrav** distinguishes between "Preview" and "Final Process". The "Final Process" button (formerly called "Auto Process" in previous versions) takes the raw image data along with the current material, parameter, and machine settings and completely processes the image producing the binary or engraved image ready to be saved and engraved. On the other hand the "Preview" buttons (only available in "Interactive Mode" - Fig 3.4.2) process a scaled version of the image (NOT THE ORIGINAL IMAGE) suitable for rapid viewing as one adjusts and modifies the parameters in almost if not real time.

PhotoGrav does not restrict the image view display size therefore providing a larger viewing area for a more accurate representation of the resulting image. A larger viewing area does require more processing speed in order to maintain real time performance. The real time performance of interactively adjusting the parameter settings is a direct correlation to the size of the image and the size of the display screens viewing area. Since **PhotoGrav** permits arbitrary screen sizes it is better prepared to adapt to the increasing speeds of modern computers. Assuming 17" to 24" computer monitors and current average to high end computers one can expect almost real time performance when interacting with the parameters while in "Interactive Mode".

Due to the plethora of monitor and display types, resolutions, and sizes that exist in the market place today **PhotoGrav** offers a couple of options to facilitate the advanced user who relies on the "Interactive Mode" in their production cycle. The first option is the "Auto Preview" checkbox (Fig 3.4.2). This is provided to give the user the ability to regenerate the preview image automatically after each parameter adjustment without the user having to manually click on the "Preview" buttons. The user may select to turn this on or off depending on the image size and/or display screen size to increase performance.
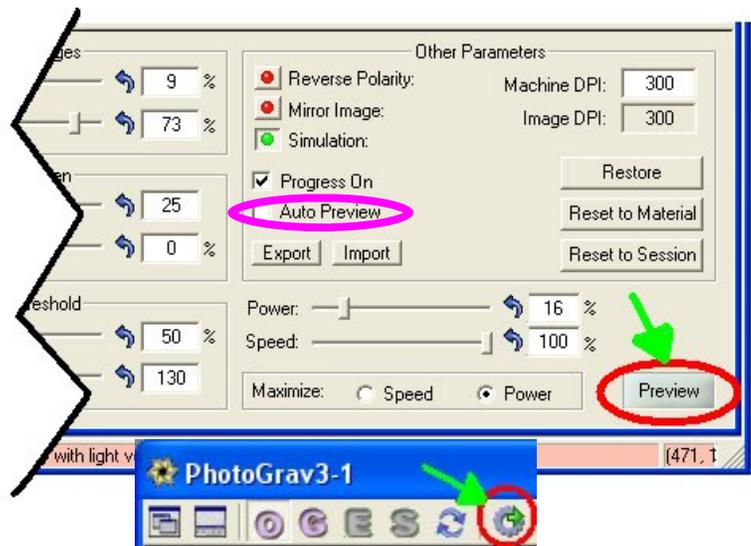
Fig. 3.4.2: Preview Buttons
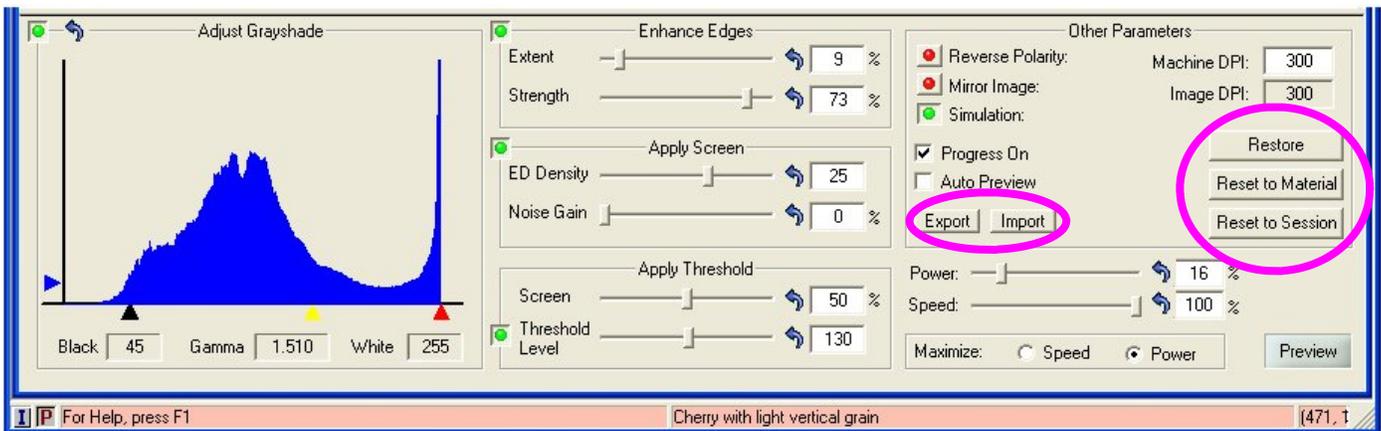
Fig. 3.4.3: Parameter Adjustment Panel

The second option is the "Progress Bar On" checkbox (Fig 3.4.2). This checkbox offers the user the option of increasing performance by turning this off. When the progress bar is turned off **PhotoGrav** will process the "Preview" image slightly faster, however, with larger images and depending on the speed of the users' computer one may want to turn this on. By turning this on it gives a "heads up" as to what **PhotoGrav** is doing followed by an indication when the "Preview" image is ready for display.

Once the image and parameters are determined either in "Interactive Mode" or otherwise then the user can select the "Final Process" button to process the image. Clicking on the "Final Process" button inherently assumes that the user is now ready to prepare and process the image for engraving and exporting. Once the final processing is complete one can export/save the images or compare the images to other sessions (see Section 3.5 on Cloning—Comparison of Results later on).

While working in "Interactive Mode" the user may want to restore the parameters to a previous value. **PhotoGrav** provides parameter restoration at 3 different levels (Fig 3.4.3). The first is "Restore" which restores the parameter settings of the current session to the values it carried along the last time that the image was processed using the "Final Process" button. The second method of restoration is "Reset To System". This resets the parameters to the default settings of the base material selected for that session. And finally the third level of restoring the parameters is "Reset To Last Saved". When one clicks this button it resets the parameters back to the settings since the **PhotoGrav** Session was last saved.

It may be desirable to export or import (Fig 3.4.3) some parameter settings while in Interactive Mode" and therefore **PhotoGrav** offers these capabilities through the selection of the respective buttons. **PhotoGrav** allows the user to import parameter settings from version 2.xx (.prm files) or version 3.xx and later (.pgp files), however, one can only export parameter settings in version 3.xx and above "**pgp"** format. The parameters can also be exported or imported via the menu bar at the top of the **PhotoGrav** Application Window.

The remaining comments in this section describe the various parameter settings and the respective controls. **PhotoGrav** has five major processing functions whereby it transforms the original input image into the Engraved and Simulated images. All processing function can be toggled on or off by clicking on the small green or red lights beside each processing function turning the functions on or off respectively. Furthermore, all processing functions can be quickly reset by pressing the small blue "**Reset**" arrow beside each control function.

3- 10

3.4.1 Adjust Grayshade

Figure 3.4.4 displays a histogram, or distribution, of the gray shades in the Original (input) image. The horizontal axis ranges from zero (black) on the left to 255 (white) on the right. The height of the distribution indicates the relative number of image elements (pixels) that have the gray shade indicated by the corresponding point on the horizontal axis. (If a distribution is very "peaked" at certain gray shades, then the peaks are truncated and other heights scaled to prevent the peaks from totally dominating the distribution). As an example, for the distribution displayed in Fig. 3.4.4, there are many more values of "white" in the image compared to any other gray shade producing a large spike at the very far right of the histogram. The rest of the histogram looks to have a higher concentration of values near the middle of the gray shaded spectrum.
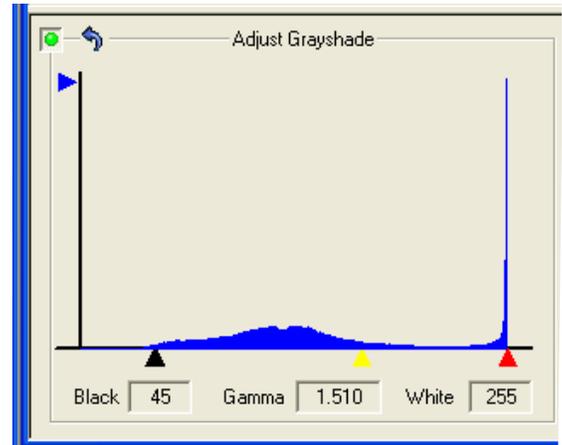
Fig. 3.4.4: Adjust Grayshade Function

The left (black) and right (red) triangles below the horizontal axis specify the black and white clipping values, respectively, for the "Adjust Grayshade" function, i.e., all grayshades to the left of the left triangle are set to black (zero) and all grayshades to the right of the right triangle are set to white (255) and the grayshades between are linearly scaled. The "Black" and "White" labels to the left of the distribution specify quantitatively the black and white clipping values (45 and 255, respectively, for the distribution in Fig. 3.4.4). The clipping values can be changed by "clicking and dragging" the triangles. As a result, the "Black" and/or "White" quantitative values will change and the effect will show up as a change in the Processed and simulated Image. The clipping values can also, of course, be reset by clicking the small blue "**Reset**" arrow. (*Note:* All the engraving materials delivered with **PhotoGrav** calculate the "1%" clipping values for the grayshade distribution).

The middle (yellow) triangle below the horizontal axis is the "gamma" for the gray shade transfer function. Changing the gamma value, by clicking and dragging the triangle, has the effect of simultaneously changing the brightness and contrast of the image. Moving the triangle to the right will generally make the Processed Image brighter and moving it to the left will generally make it darker.

The blue triangle (Fig 3.4.5) that slides in the vertical direction located on the left side of the histogram provides a scaling function so that a few values do not dominate the graph. Note that in Figure 3.4.5 the histogram shows a much more evenly distributed display thus far more readable. Both Figure 3.4.4 and Figure 3.4.5 are the exact same histogram but note how the two blue vertical triangles have different locations. By adjusting this vertical scaling triangle a much more readable view of the image distribution is achieved.
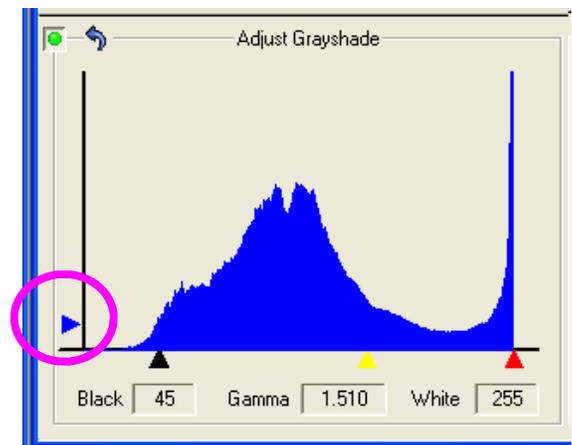
Fig. 3.4.5: Vertical Scaling

3.4.2 Enhance Edges

The "**Enhance Edges**" function provides the capability to both "smooth" the image and to enhance the image's edges. As with the "**Adjust Grayshade**" function, if the green "**On**" button is checked, then the function affects the image data; otherwise, if unchecked (red), there is NO effect regardless of the parameter settings.
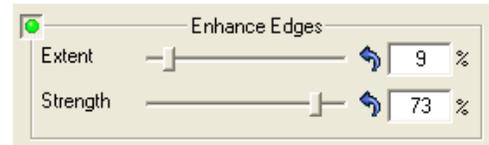
Fig. 3.4.6: Enhance Edges

The "**Extent**" parameter pictured in Fig. 3.4.6 can be modified by entering a value directly in the appropriate textbox (contains "9" in Fig. 3.4.6) or by clicking the associated horizontal scrollbar. The **extent** parameter specifies the relative size of the area around each pixel which is then smoothed. Small values indicate relatively little smoothing whereas large values specify relatively large smoothing.

The "**Strength**" parameter specifies the degree to which edges are enhanced or emphasized . The "**Strength**" parameter is controlled in a manner similar to the "**Extent**" parameter except that its values range from -100% to +100% rather than 0% to 100%. Almost all of the useful settings for the "**Strength**" parameter are positive but interesting effects can sometimes be achieved with negative settings.

Although **PhotoGrav** automatically sets parameter values appropriate to each engraving material, it is a good idea for you to experiment with the "**Extent**" and "**Strength**" parameter settings to get a feel for their effect which at times can be rather dramatic. An interesting way to do this is to have the "Simulation" ON and to turn the "**Enhance Edges**" function alternately ON and OFF to observe the effect.

3.4.3 Apply Screen

The "**Apply Screen**" function (Fig. 3.4.7) provides the capability to "screen" the image in preparation for thresholding which follows this function.

Fig. 3.4.7: Apply Screen

The "**Apply Screen**" function actually performs a Diffusion Dithering. Diffusion Dithering is a technique to convert a grayshade image to a binary image (black & white only, no shades of gray) wherein the shades of gray in the original image are represented in the processed binary image by differing densities of black and/or white dots. Diffusion Dithering accomplishes this by converting each gray shade in the original image to either a black or white value depending on its value relative to a predetermined "threshold" value.   The error in making this assignment is then "diffused" to neighboring pixels which eventually are also thresholded (and then error diffused) and so forth and so on throughout the entire image.

The Diffusion Dithering within **PhotoGrav** has been designed and optimized specifically for laser engraving and is controlled by the two parameters indicated in Fig. 3.4.7: (1) **ED Density** and (2) **Noise Gain**. (The ED stands for Error Diffusion). The "**ED Density**" parameter can be used to darken

lighter areas of the processed image without substantially affecting areas that are already dark and, vice versa, can be used to lighten darker areas of the image without substantially affecting areas that are already light. The "**Noise Gain**" parameter can be used to add noise to the image to reduce "contouring", "repetitive pattern", or "jpeg artifacts" effects that often occur when grayshade images are converted to binary images.

Both parameter values can be modified by clicking the scroll bars or by entering numeric values in the white text boxes directly above each scroll bar. Relative values for the "**ED Density**" parameter range from -100 (darken) to +100 (lighten). Relative values for the "**Noise Gain**" parameter range from 0% (no noise) to 100% (maximum noise).

3.4.4 Apply Threshold

The "**Apply Threshold**" function (Fig 3.4.8) linearly combines the last two control functions (Enhance and Screen), pixel by pixel and with variable weights, before thresholding the result to create an "Engraver-ready" binary image.

Fig. 3.4.8: Apply Threshold

There are two parameters associated with the "Threshold" function: (1) the "**Screen** %" and (2) the "Output **Threshold Level**". The first parameter, the "**Screen** %", specifies how the two inputs to the function are combined by specifying the weighting factor assigned to the input from the "Screen" function. The weighting factor assigned to the image coming from the "Enhance" function is then equal to (100 - Screen %) . A value of zero for this parameter specifies that the resulting data, before thresholding, is totally from the "Enhance" function. A value of "100" for this parameter specifies that the data, before thresholding, is totally from the "Screen" function. A value of "50" for this parameter specifies that the two inputs are equally weighted and then combined. The "combine" portion of the "**Threshold**" function is always ON, i.e., the two inputs are ALWAYS combined, before thresholding, using the weighting factors specified by the "**Screen** %" factor.

The second parameter, the "**Threshold Level**", specifies a threshold value which ranges from zero to 255. The threshold value is applied to the combined output of the "Enhance" and "Screen" functions, weighted as described above. If a combined value is less than the threshold value, then it is assigned a zero (black). If a combined value is greater than the threshold value, then it is assigned a one (white). The "threshold" portion of this function, unlike the "combine" portion, can be turned ON or OFF by checking, or not checking, the green/red checkbox located to the left of the label "Threshold Level". If the thresholding is OFF, then the simulation function, described in the next section, cannot be turned ON and an engraver-ready (binary) image is not produced.

Either parameter for this function can be modified by clicking the horizontal scroll bars or by entering a numeric value in the white text boxes immediately below the scroll bars.

3.4.5 Speed and Power

The vertical scroll bars labeled "**Power**" and "**Speed**" (Fig 3.4.9) specify the percentage of maximum power and the percentage of the maximum speed for the laser engraver currently being

modeled (You can change the laser engraver being modeled as well as the specifications for any laser engraver by selecting a different machine see Section 3.6). The "**Power**" and "**Speed**" controls should be very similar to the controls which actually exist on your laser engraver and should behave in the same fashion.

Fig. 3.4.9: Speed and Power

The "**Maximize Power**" and "**Maximize Speed**" (Fig 3.4.9) checkboxes determine whether the **Power** setting or **Speed** setting for your machine is maximized when it is necessary to modify these settings.   The necessity for modifying these settings occurs since **PhotoGrav**'s engraving materials were calibrated using a specific machine; therefore the **power**, **speed**, resolution, etc. of your machine may not match those of the "calibration" machine.   **PhotoGrav** strives to deliver the appropriate quantity of energy to each laser spot, based on the settings for your machine, and in so doing has a choice of what values to use for the **Power** and **Speed** settings (generally a large number of settings will all satisfy the energy requirement). If you are interested in engraving as fast as possible, then the "**Maximize Speed**" box should be checked. If you are more comfortable with a higher **Power** setting, then the "**Maximize Power**" box should be checked. These two boxes cannot both be checked or unchecked at the same time so the boxes also act as toggles, i.e., if you check the "**Maximize Power**" box, then the "**Maximize Speed**" box will automatically become unchecked and vice versa. (*Note: The effect of these checkboxes may at times appear confusing and it may at first appear to you that they are not working properly. It is important to remember that "Maximize" is used for both boxes to mean the maximum value for that parameter that will still result in the <u>proper energy being delivered to the laser spot</u> and that maximum value may not be 100%. For example, if the "**Maximize Speed**" box is checked, then it would be possible for the **Power** and **Speed** settings to be, e.g., 100% and 65%, respectively, which might at first seem incorrect since "**Speed**" was to have been maximized. However, in the example given, if the **Speed** is more than 65%, then inadequate energy will be delivered to the laser spot since the **Power** setting cannot be more than 100% (Speeding the engraver up delivers less energy to each spot). So, in this case, 65% is indeed the "maximum" value for the **Speed** setting subject to the constraint that the proper quantity of energy is delivered to the laser spot).*

3.4.6 Other Parameters

The remaining parameter settings and various other functions are located under the "Other Parameters" group box.

Fig. 3.4.10: Other Parameters

The text box labeled "**Machine DPI**", containing the value 300 in Fig 3.4.10, specifies the Engraver resolution, NOT the image resolution, in dots per inch. The value in this textbox is initially taken from the dpi value selected from the "Machine Preferences" dialog box. It should be noted that when changing the "**Machine DPI**" will only cause the DPI setting to become the Engraver resolution for the current session. The textbox labeled "**Image DPI**" is for reference only and thus cannot be altered by the user.

The "**Reverse Polarity**" checkbox provides the capability to set the polarity of the Engraved and Simulation images. Positive polarity materials are those for which the laser, when on, causes the

engraving material to become darker, e.g., most woods. Negative polarity materials are those for which the laser, when on, causes the engraving material to become lighter, e.g., black laser brass and acrylics. The "**Mirror Image**" checkbox provides the capability to "mirror-the-image" (flip left to right) the Engraved and Simulation images. This feature is useful for materials like acrylic which are engraved on the "back" of the engraving material but viewed from the front. For various reasons the processed image is not shown "mirrored" in the Image Viewing Windows, but rather the Engraved and Simulated images are flipped (by user selection) only when written to disk.

A few other options are also available such as turning the Simulation on or off as well as exporting or importing parameters either from the current or previous versions of **PhotoGrav**. Refer to the beginning of this Section (3.4) for further information on most of these settings and functions.

See Section 2.2 for a more complete discussion of the underlying rationale for the simulation capability and how it can be an extraordinarily useful tool.
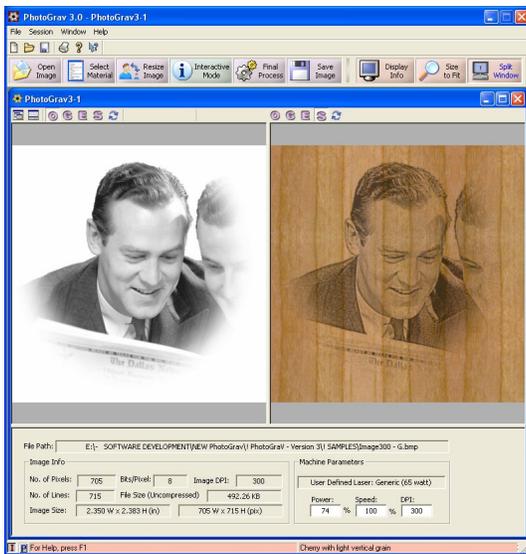
Fig. 3.5.1: Other Parameters
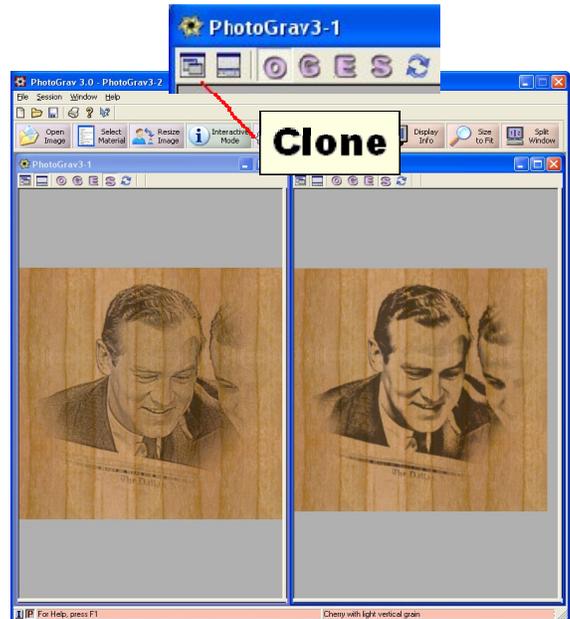
Fig. 3.5.2: Other Parameters

3.5   Cloning—Comparison of Results

The comparison of images whether simulated or otherwise can be an efficient time saving procedure when it comes to preparing the image for engraving. **PhotoGrav** offers two different methods by which one can compare the processed image. The first is to compare the various images solely within a particular session (Fig 3.5.1) and second is to compare the results of two sessions with each other (Fig 3.5.2).

Learning how to use the "Cloning—Image Comparison" features along with the simulation of results should again increase productivity. While the simulation is attempting to get as close as possible to the final results there are many variables that affect the results of the actual vs. the simulated images. Therefore, the simulation can be thought of as a relative comparison of the simulated images rather than an absolute final result. This essentially means that once one learns how a particular "simulated" image compares to the actual engraved image for a specific material and machine type; then a "relative" difference or pattern should emerge giving the user a sense of how to adjust the parameters to improve the actual engraving. This simulation feature was significantly relied on during the design of **PhotoGrav** to improve performance and efficiency.

PhotoGrav has a "**Clone**" function (Fig 3.5.2) to further assist in comparing processed results. This "**Clone**" feature assumes that the user wants to spin off or clone another session based on the current active session. This provides an exact duplicate of the current selected session or active session. This provides an efficient method to quickly process another session and compare the two (if desired) without having to go through the whole process of reopening the same image in another session. For example, it can be helpful to compare one simulated or engraved image (session X), where the parameters have been adjusted, with a second image (session Y) where the parameters have NOT been modified (i.e. default material settings).

3.6 Machine Properties

The "Machine Properties**"** dialog window (Fig. 3.6.1) can only be invoked from the main application menu bar and is used to select and modify the laser engraver and associated parameters which **PhotoGrav** is currently modeling. The "Machine Make" frame provides the capability for you to select your laser engraver manufacturer and model type. The "Machine Properties", "**Machine Resolution**", "**Machine Lens Spot Size**", and "**Machine Watts**" frames provide the capability for you to modify, add to, or specify completely, the parameters that essentially define the laser engraver model.
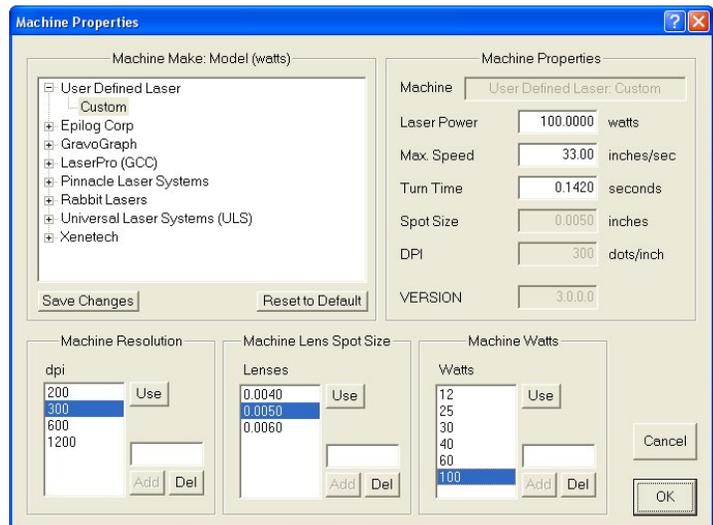
Fig. 3.6.1: Machine Properties

The list at the top of the "Machine Model" frame displays the laser engraver machines currently modeled by **PhotoGrav** including a "User Defined" machine for which you can completely specify the engraver parameters from scratch. Each machine manufacturer in the list also provides a "Custom" laser model type in the case where the specific model type is not known but the manufacturer is known. In the case of the "Custom" model type all the machine properties can be defined just as in the "User Defined Laser" case.

Selecting a machine from the list will enter the machine's name into the text box directly to the right of the list along with the machine model type. It will also change all the settings to reflect which machine type is selected.

Clicking the "**Reset to Default**" button will restore a machine's parameters, to the values they had when **PhotoGrav** was first installed, for whatever machine is currently selected. Any machine's parameters can be modified using the controls in the "Machine Properties" dialog window and, once the "OK" button is pressed, the modified parameters become the current parameters for the machine and are stored to disk as such when the current **PhotoGrav** session terminates).

The first two textboxes at the top of the "Machine Properties" frame specify the maximum power (in watts) and the maximum speed (in inches/second) for the current laser engraver. These two values obviously have a big influence on how **PhotoGrav** produces the Simulated Image. The third textbox from the top specifies the time, in seconds, for the laser to slow down, stop, and reverse direction for each scan line. This parameter is used only for calculating estimates of the engraving time, which are displayed in the **PhotoGrav Session Report** (see Section 3.2.7). A procedure for calculating this parameter for your particular machine is presented in **Appendix 3: Calculational Procedure for "Turn Time"**.

The list displayed in the "Machine Lens Spot Size" frame contains a list of the effective laser spot sizes (diameters in inches) for the lenses available to the simulated Laser Engraver. These are the values that are available to **PhotoGrav** for creating the Simulated Image. A single click of an item in the list only locally selects the item. When an item in the property listbox is selected two functions can be performed, namely "Del" or "Use". The "Del" button deletes the item from the list while the "Use" button places that value into the associated text under the "Machine Properties" frame. Double clicking on a list item will behave just as if the "Use" button was pressed. Also, values in the list textbox can be **Add**ed to the list by clicking the "**Add**" button.

PhotoGrav adjusts itself appropriately so that the simulated engraving is as realistic as possible. The lens that is installed on the laser engraver is the lens that should be specified in this textbox. Generally, for photographs, the spot size corresponding to the highest-resolution is the best lens to use, if that lens is available for your machine.

The second list is the "Machine Resolution" frame which contains a list of the resolutions (dots per inch) available to the simulated Laser Engraver. The controls in this frame behave identically to the controls in the "Machine Lens Spot Size" frame as described in the paragraph above. Similarly, the "Machine Watts" frame behaves just as the other two similar frames.

It is important to remember that there are two locations where the "Machine Properties" can be selected. The first one is located under the **File→System Defaults→Select Machine…** menu item (Fig 3.6.2). When this option is selected ONLY THE **DEFAULT** MACHINE TYPE IS CHOSEN which means that any **new** session that is created will
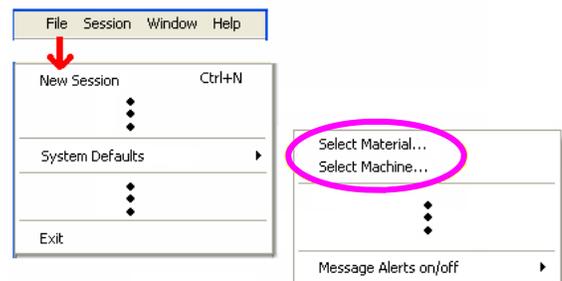
Fig. 3.6.2: Default Machine

use this machine type. The second method of opening the "Machine Properties" dialog window is located in the **Session→Select Machine…** menu item (Fig 3.6.3). When this method is used <u>ONLY THE **ACTIVE** SESSION MACHINE PROPERTIES ARE MODIFIED.</u>

Fig. 3.6.3: Select Machine

3.7 Automatic Updates

Another feature that can be very useful in **PhotoGrav** is the ability for additional materials and machine types (when available) to be added automatically via an internet connection on any computer that has PhotoGrav installed (Fig 3.7.1). This does not prevent one from still saving/exporting and loading/importing parameter files and **PhotoGrav** Sessions (**pgp** files) for both current and previous versions of **PhotoGrav** and custom configuring the machine settings as required.
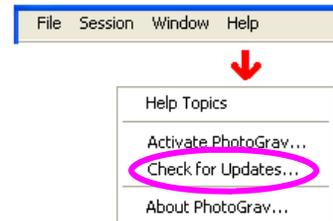
Fig. 3.7.1: Updates

The available method to check for updates is through the Help menu item as shown in Figure 3.7.1. There are three main items that PhotoGrav checks for when performing a "Check for Update" function. The first and second are to check for any new Materials and Machines. The third is to check for any updates to the application. If any one of these three checks indicates a need to update then a message listing the current vs. latest versions available (Fig 3.7.2) appears. The updates can then be selected to "Yes" go ahead and download or "No" just leave it as it is.
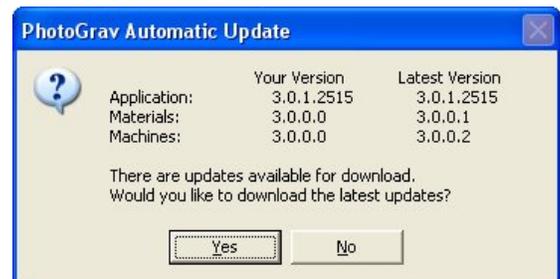
Fig. 3.7.2: Update Notification

Notes

Chapter 4
Troubleshooting

4.0 Introduction

This chapter consists of two parts. Section 4.1 presents solutions to problems you might occasionally encounter when using **PhotoGrav**. Section 4.2 specifies how to get technical support for any further difficulties you might have with **PhotoGrav**.

4.1 Solutions to PhotoGrav Problems

4.1.1.1 *Problem*

I click the **PhotoGrav** icon (the twirled star) to start **PhotoGrav** and absolutely nothing happens.

4.1.1.2 *Solution*

There is probably another copy of **PhotoGrav** currently running in a minimized window. Check the Windows TaskBar for any minimized **PhotoGrav** icons and close any running versions that you find. Then try again to start **PhotoGrav**. If this does not solve the problem, seek technical support as specified in Sec. 4.2.

4.1.2.1 *Problem*

I tried to "Print" directly to my engraver from the **PhotoGrav** program and it did not work. Why not?

4.1.2.2 *Solution*

PhotoGrav does not currently recommend trying to print directly to the specific "Printer" drivers supplied with most laser engravers. To engrave, save **PhotoGrav**'s "Engraved Image" to disk and use the program that you normally use for engraving (for example, CorelDraw), to send that image to the engraver. The "Engraved Image" produced by **PhotoGrav** is a binary image and should **NOT** be resized nor rotated once produced.

4.1.3.1 *Problem*

Occasionally one of my engraved images from **PhotoGrav** has a funny checked pattern.

4.1.3.2 *Solution*

This problem is probably caused by one of two conditions: (1) Your image dpi does not match your engraver dpi, or (2) Your image has areas of solid gray tones, a common occurrence for exported clip art, and **PhotoGrav**'s processing causes repetitive patterns in these solid areas.

To correct the problem: (1) Change the dpi of the input image and/or make sure the machine dpi is set correctly OR, (2) Use the **PhotoGrav** "Noise Gain" function (see Sec. 3.4.3) to break up any patterns.

4.1.4.1 *Problem*

The **PhotoGrav** installation program will not run to completion. It complains about some file not available because it is currently being used by some other program.

4.1.4.2 *Solution*

Make sure that you have closed all running programs before attempting to install **PhotoGrav**. If you are on a network, log off the network before beginning the installation. Novell networks in particular seem to cause installation problems for some programs.

4.2 Technical Support

Before requesting technical support, please:

- Check the preceding section, Sec. 4.1, for the possibility that your problem is already addressed in that section.
- Check the appropriate section of the user guide for detailed information about the **PhotoGrav** component that is causing you difficulty. Chapters 2 and 3 are essentially reference chapters and contain very detailed information that you might have overlooked in your first perusal of the document.

When you have determined that you definitely need technical support, the most efficient manner in which to receive that support is via email. The next most efficient means of requesting support is by FAX. However, if you need an immediate response, or if the email or FAX response is for any reason inadequate, then call one of the appropriate numbers listed below. Technical support is available Monday through Friday, 9:00 a.m.. to 5:00 p.m. (Eastern Standard Time).

When requesting technical support, whether by email, FAX, or phone, please have available the following information:

- Your full name and the name of the registered user, if different.

- Your street address, phone and fax number, and email address.

- The version number and the serial number of your copy of **PhotoGrav.**

  Both of these numbers should be available in the "**About PhotoGrav**" dialog box accessible on the Help menus while executing the program. The serial number should also be available at the bottom of page *i* of the **PhotoGrav User Guide.**

- As much of the following system information for the computer you are using as possible:
  - Make and model of the machine
  - Operating system
  - Quantity of memory

- If you are have difficulty getting good engraving results then also have your laser engraver information ready as well (i.e. make, model, max speed, max power and the resolution (dpi) that you are engraving). Refer to Appendix 1—Engraving Tips.

- A detailed description of the problem. Please try to list the steps and conditions which led to the problem and any error messages that were encountered.

For support with the **PhotoGrav** program itself, e.g., something doesn't seem to work right when **PhotoGrav** is executed or some sort of error is reported during execution, contact:

Email:	support@imagelaz.com
Web:	www.photograv.com
FAX:	(574) 534-5047
Phone:	(574) 534-0906
Address:	See our web site for current address

Comments about **PhotoGrav**'s current performance and suggestions for improvements and additions to future versions would be appreciated and can be emailed or mailed to the address provided on our web site at www.photograv.com.

Appendix 1

Engraving Tips

A1.0 Introduction

This Appendix consists of Engraving "tips" which should assist you when you are ready to actually engrave the photographs that you have processed in **PhotoGrav**. The tips are provided for a variety of the most common engraving materials that are suitable for engraving photographs. The tips are primarily "finishing tips" that should enhance the appearance of the engraved photos.

A1.1 Engraving Tips

1. Increasing the contrast on Cherry (or Maple) wood plaques.

After engraving, the use of liquid shoe polish will darken the engraved areas thus increasing the contrast. Care must be taken to prevent dye from bleeding under the plaque surface into the pores of the wood, permanently damaging the plaque. You will need the following supplies:

> Brown & Neutral Kiwi brand liquid shoe polish with foam applicator top
> paper towels
> leather chamois
> water

Follow these steps for best results (first you seal it, then you dye it):

> a. The cherry plaque should have a lacquered finish; it should NOT be raw wood.
> b. Laser engrave the plaque dry and unmasked.
> c. Wet the chamois and fold it to result in a pad that is several layers thick and about 4"x4" in size. Wring out the chamois so it is well soaked but not dripping.
> d. Smooth out the chamois so it is a nice flat pad.

e. Seal the engraving by using the NEUTRAL polish. Using the foam applicator, liberally dab the polish on the engraving and brush around to cover all engraved areas.

f. Immediately wipe off the excess polish with a clean pad of paper towel, quickly followed by the wet chamois. Wipe lightly and briskly to clean the surface without pulling lots of dye from the engraved recesses. You may need to re-fold your chamois pad several times to maintain a clean wiping surface.

g. Let the neutral dye dry for 10 min. to seal the wood pores.

h. Repeat the same procedure with the BROWN dye to darken the photo.

Shoe dye dries quickly and it is difficult or impossible to remove stains if you go too slowly and let it dry unevenly. Rubbing alcohol will clean some stains, but use sparingly as it can attack some wood finishes.

2. Engraving photos on Walnut wood plaques.

Walnut is a traditional wood in the industry but it surely does not work well for photo laser engraving since it tends to be quite dark and therefore results in very little contrast. If your customer insists on using walnut for a photo engraving, first try to convince him/her to let you put the photo on a separate plate like black brass or, better yet, the new Spectrum Lights ultra thin engraving material - it works fantastically well for photo engraving. If you do need to laser the photo into walnut, then use **PhotoGrav** settings for walnut that result in higher contrast and very little, or no, dot-dither shading so the processed image looks similar to a line drawing . Then, after engraving, use the dye procedure described in tip #1 above to attempt to get more contrast. However, use BLACK dye instead of the brown. Also, it is not necessary to seal the engraving first (with the neutral polish) because the walnut wood grain is tighter than cherry or maple so the polish won't bleed into the grain.

3. Engraving photos on Oak wood plaques.

Don't even waste your time trying it. Oak is very porous and has an uneven grain hardness. These characteristics result in a very inconsistent and uneven engraving. Also, if you try to increase contrast using the dye technique of tip #1, then the dye bleeds like crazy under the plaque surface. Oak is light colored but the laser engraving is light also so your photo will not show up well at all.

4. Engraving photos on Acrylic.

Engraving on the back of the plaque, with the photo flipped left-to-right, always looks better than engraving on the face of the plaque. (**PhotoGrav** automatically processes photos for "back" engraving on acrylics unless you override the default).

Cast type acrylics produce a nice white frosty cut, but extruded acrylics (usually 1/4" and thinner) result in engravings that are mostly clear which is usually not very good for photos.

To engrave an acrylic plaque, use very low power settings - just enough to frost the surface on clear acrylic or remove the paint on painted acrylic (**PhotoGrav** automatically sets an appropriate power value when acrylic is the selected material). Engrave the plaque after removing the paper mask and let it dry. After it is dry, gently wipe any white dusty residue off with a clean, dry cloth. Then polish with a different clean, dry cloth using Novus #1 plastic polish. Spray the polish sparingly on the product and clean with the cloth. Use a dry spot on the cloth to buff dry.

5. More ideas for engraving photos on Acrylic.

Vector cut shapes or silhouettes from clear 1/8" acrylic and then engrave portraits, or other photographs, on the cutouts..

Laser engrave the photo, wipe it clean, and color it with permanent markers or spray paint. Let the paint dry and then sand off the back, leaving a frosted looking background with a color filled photo. (**Note:** With this technique, you would **PhotoGrav**-process the image in positive polarity, not negative. **PhotoGrav**'s default polarity for acrylic is negative so you must override this default)

Spray paint the back of an extruded acrylic plaque before engraving. (We recommend Krylon brand spray paint.) Laser engrave the photo through the paint. Since it is extruded acrylic the engraving should be fairly transparent, so paint it again with another color, or back up with a shiny piece of gold, silver, or colored metal to show through the photo.

6. Engraving photos on Black Anodized Aluminum.

If , after engraving, the engraved areas are not very white looking, you might be using too **much** power, not too little. Try a lower laser power setting. Aluminum tends to have a narrow power response band for which the material turns nice and white. Too much power turns the aluminum a light yellowish color. Too little power does not remove all of the black anodized coating.

No clean up is normally needed but window cleaner works well if any is needed.

7. Engraving photos on Corian brand solid surfacing materials.

This material engraves nicely and is easy to color fill.

    a. Engrave your photo.
    b. Scrub out the engraving with hot soapy water and a toothbrush. Rinse thoroughly and blow out with compressed air.
    c. Let dry.
    d. Dab enamel paint into the engraved areas.
    e. Using a piece of card stock, squeegee the excess paint off. This action also forces paint into the little dots in the photo.
    f. Let the paint dry.
    g. Wet sand with a block using 220 grit wet-dry sandpaper to remove the rest of the paint from the face of the plaque.
    h. Buff with a very fine scotch brite pad.
    i. Rinse the plaque off and let it dry.
    j. Polish the plaque with automotive wax or a good counter top polish like Hope's brand polish.

This type of plaque holds up well outdoors. It provides a great alternative to cast bronze and works well with photos also!

Alternative, indoor use only:

    a. Use solid white Corian and engrave a photo or clip art
    b. Use Permanent Markers to color the engraving in a rainbow of colors.
    c. After the plaque is dry, it can be sanded. An easier method, however, is to wipe the surface with a block wrapped in a paper towel that has been dampened with rubbing alcohol.

8. Engraving photos on Spectrum Lights marking material.

This is a newer material, with a satin brass appearance, that works exceptionally well with **PhotoGrav** processed images. It is very thin, about .004", and comes with adhesive already on the back. Engrave the material dry and unmasked at very low power. (**PhotoGrav** defaults to a very low power setting for this material). No clean up is needed after engraving.

Then, using your laser vector cutting capability, cut out the picture as an oval frame or some other interesting shape. Then you just peel off the backing and stick it on your plaque or anywhere. Great stuff!

9. Engraving photos on coated Laser Brass, black or colors.

Only use brass that is specifically made for laser engraving.   This brass is shiny under the coating unlike the traditional black brass that is dull gold under the surface. Engrave the material dry and unmasked at just enough power to cleanly remove the coating and expose the brass. A larger power setting will wash out the detail in your image because brass does not absorb CO_2 laser energy and therefore the excess energy is simply "spread" out, blowing away the details. It is best to not polish the engraved plate very much. However, you might want to shine the plate up using a little Pledge furniture polish on a soft, clean cloth. Most paper towels can scratch brass plates, so it is best not to use them. If you do use paper towels, the only ones to use are Bounty brand towels since they tend to scratch less.

10. Reducing the white/frosty appearance of some wood engravings.

This "frosted" effect is caused by the laser not fully penetrating the clear finish on a plaque, especially in areas where there are few dithering dots. This effect can be reduced with a product know as "Almond Stick" which can be ordered from the Fuller Brush Company or can be found in some woodworking supply catalogs, furniture stores, or hardware stores. After engraving, you simply dab some of this product on the plaque surface and buff off with the palm of your hand. Most of the "white stuff" is subsequently hidden. Almond stick also hides small nicks and dings on wood plaques.

11. Engraving photos on Vinyl wrapped particle board plaques.

Most light colored plaques of this type are okay for engraving photos. After engraving, the "Black dye" procedure described in tip #1 works quite well.

The melamine type laminated plaques like PDU brand Spectra-Lights work exceptionally well for photo engraving. They accept dye and color fill readily and their surface is much more durable than most. Quail brand melamine plaques also work quite well.

One note of caution: Some of the cheaper plaques of this type may swell up around the engraved areas after you get them wet using the "Black dye" method. It is always wise to test your own suppliers' plaques before you commit to any job.

We hope these finishing tips are helpful and profitable to your business. It has taken years of trial and error, wasted materials, seminars, and talking to others at trade shows to develop these techniques for engraving photos that work well in our shop. The tips described above are techniques we really use in our daily production, and they do work. We continue to refine and test new ideas, but hopefully this existing information will already save you lots of time and money. Have fun.

Appendix 2

Calculational Procedure for "Turn Time"

A2.0 Introduction

This Appendix presents a procedure for calculating the "**Turn Time**" parameter which is used in the algorithm which estimates the time in seconds for an image to be engraved on your machine. See Section 3.6 for a brief description of the parameter and how it should be specified in the **Machine Properties** dialog window of the **PhotoGrav** program.

Section A2.1 describes a simple procedure which you can use to calculate the "**Turn Time**". Section A2.2 describes a somewhat more complex procedure which you can use to calculate the "**Turn Time**" under more varied conditions so that you can perform some consistency checks on the calculational procedure. Section A2.3 then presents the model used to derive the calculational procedure and the rationale behind that model.

A2.1 Simple Procedure

This section describes a relatively simple procedure for calculating the "**Turn Time**" parameter.

Procedure

1. Prepare two grayshade images in a format that is acceptable for sending to your laser engraver. Make the first image a black square that is 1" wide (along scan) by 1" high (across scan). Make the other image a black rectangle that is 2" wide (along scan) by 1" high (across scan). Produce the images at the same resolution that you intend to use on the laser engraver, e.g., 250 dpi would probably be a good choice for a ULS machine and 300 dpi would probably be a good choice for an Epilog or LMI machine.

A. To accomplish this in CorelDraw, start CorelDraw and create a new blank page as you would for any engraving job. Select the rectangle tool and draw a rectangle exactly 1.00" tall x 1.00" wide, approximately centered on the page (turning the snap to grid on will make this easier). Select the pick tool and select the rectangle you just drew. Fill the rectangle with solid **black** by using the paint bucket tool. Set the outline to **none** by using the outline tool. Save this file as 1X1.CDR. Repeat the procedure and create a 1.00" tall x 2.00" wide image and save it as 1X2.CDR.

B. To accomplish this in **Adobe PhotoShop**, start **PhotoShop** and set the Background color to black. Then, from the **File** menu, select **New**. In the dialog box that appears, set the **Width** to 1", the **Height** to 1", the **Resolution** to 250 or 300 pixels per inch, the **Mode** to Grayscale, and for the **Contents** select the option for "**Background Color**". Then click the "**OK**" command button. Save the image in any format that you can send to your engraver and give it a name so you can remember it as the 1" square. Repeat this process to create the 2" x 1" black image.

The images you have produced should appear as depicted in Fig. A2.1.1.

Along Scan ⟶

1"   2"

Across Scan

1"   1"

Fig. A2.1.1: Test Images

2. Engrave each of the two images making sure that your engraver is in raster mode, not vector mode, and that the speed is set to its maximum value (100%). Also, set the engraver resolution, r, to the same value as that used to create both images, e.g., r = 250 dpi or r = 300 dpi.   Record the time in seconds that it takes, as measured by your engraver, to complete the engraving. Designate the time to engrave the 1" x 1" square as T_1 and the time to engrave the 2" x 1" rectangle as T_2.

3. Calculate the "**Turn Time**" parameter, t, using the following formula:

$$t = (2T_1 - T_2) / r$$

where   t   =   "**Turn Time**" parameter in seconds
           T_1 =   Time (in seconds) to engrave the 1" x 1" square
           T_2 =   Time (in seconds) to engrave the 2" x 1" rectangle
           r   =   Engraver & image resolution in dots per inch

For example, if T_1 = 46 seconds, T_2 = 56 seconds, and r = 250 dots per inch, then t = 0.144 seconds and that is the number (0.144) which should be entered for the **"Turn Time"** parameter in the **Machine Properties** dialog window as specified in Section 3.6.

4. Perform the following check to see if the measured numbers make sense. Calculate, from the measured numbers, the maximum speed, s, for your engraver using the following formula:

$$s = r / (T_2 - T_1)$$ where s is measured in inches per second.

Using the same **example** numbers as those used in step 3, we get s = 25 inches per second for the maximum speed of the laser engraver used to generate the samples.

If, using the numbers you have measured, the value of s is not close to the maximum speed of your engraver as specified in your engraver documentation, then the value for the **"Turn Time"** parameter, t, as calculated in Step 3 is probably not reliable and any engraving time estimates which **PhotoGrav** produces are also not reliable. If engraving time estimates are important to you, then request assistance as specified in Chapter 4.

A2.2 More Complex Procedure

The procedure described in this section is actually not any more complex than the procedure described in Sec. A2.1 but it does require a few more variables for its specification. However, as a result, it is considerably more general than the previous procedure and will allow you to calculate the **"Turn Time"** parameter with higher precision and to perform consistency checks by measuring the parameter under several conditions.

Procedure

1. Prepare two grayshade images in a format that is acceptable for sending to your laser engraver. Make the first image a black rectangle that is w1 inches wide (along scan) by h1 inches high (across scan). Make the other image a black rectangle that is w2 inches wide (along scan) by h2 inches high (across scan). Produce the images at the same resolution that you intend to use on the laser engraver, e.g., 250 dpi would probably be a good choice for a ULS machine and 300 dpi would probably be a good choice for an Epilog or LMI machine. The images can be produced in CorelDraw or PhotoShop by small modifications to the procedures described in Sec. A3.1, Steps 1A and 1B. The images you have produced should appear as depicted in Fig. A2.2.1.
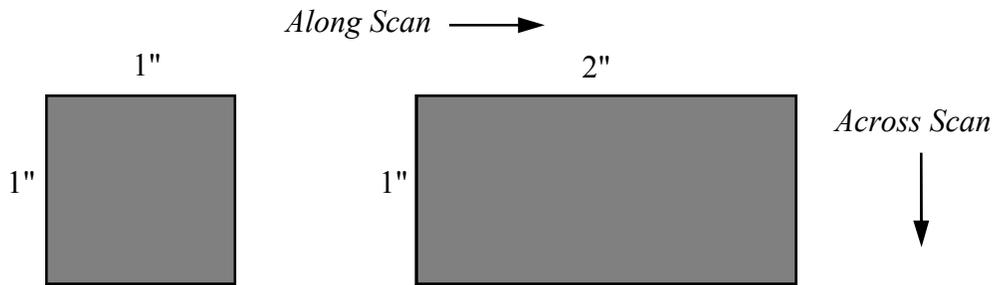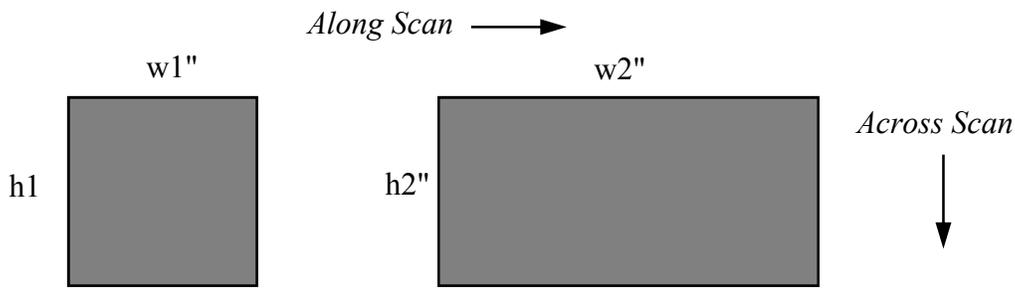
Fig. A2.2.1: Test Images

2. Engrave each of the two images making sure that your engraver is in raster mode, not vector mode, and that the speed is set to its maximum value (100%). Also, set the engraver resolution, r, to the same value as that used to create both images, e.g., r = 250 dpi or r = 300 dpi. Record the time in seconds that it takes, as measured by your engraver, to complete the engraving. Designate the time to engrave the the first rectangle as T_1 and the time to engrave the second rectangle as T_2.

3. Calculate the "**Turn Time**" parameter, t, using the following formula:

$$t = (h1 \times w1 \times T_2 - w2 \times h2 \times T_1) / ((w1 - w2) \times r \times h1 \times h2)$$

where
t = "**Turn Time**" parameter in seconds
T_1 = Time (in seconds) to engrave the first rectangle
T_2 = Time (in seconds) to engrave the second rectangle
r = Engraver & image resolution in dots per inch

For example, if w1 = 1", h1 = 2", w2 = 4", h2 = 1", T_1= 90 seconds, T_2 = 75 seconds, and r = 250 dots per inch, then t = 0.140 seconds and that is the number (0.140) which should be entered for the "**Turn Time**" parameter in the **Machine Properties** dialog window as specified in Section 2.6.

4. Perform the following check to see if the measured numbers make sense. Calculate, from the measured numbers, the maximum speed, s, for your engraver using the following formula:

$$s = (r \times (w2 - w1) \times h1 \times h2) / (h1 \times T_2 - h2 \times T_1)$$

where s is measured in inches per second.

Using the same **example** numbers as those used in step 3, we again get s = 25 inches per second for the maximum speed of the laser engraver used to generate the samples.

If, using the numbers you have measured, the value of s is not close to the maximum speed of your engraver as specified in your engraver documentation, then the value for the "**Turn Time**" parameter, t,

as calculated in Step 3 is probably not reliable and any engraving time estimates which **PhotoGrav** produces are also not reliable.

The procedure described in this section provides much more flexibility than the simple procedure described in Sec A2.1. For example, one can use larger rectangles and/or a larger value for the engraver and image resolutions to increase the precision of the calculated "**Turn Time**" parameter. Or one can use several pairs of different-sized rectangles, calculating the parameter independently from each pair, to determine the consistency of the calculated values. If you get inconsistent numbers for the parameter, or if the maximum speed, s, calculated above is not close to the manufacturer's published value, then request assistance as specified in Chapter 4.

A2.3 Calculational Model

Consider the rectangular black object in Fig. A2.3.1 which is an image which is to be engraved.
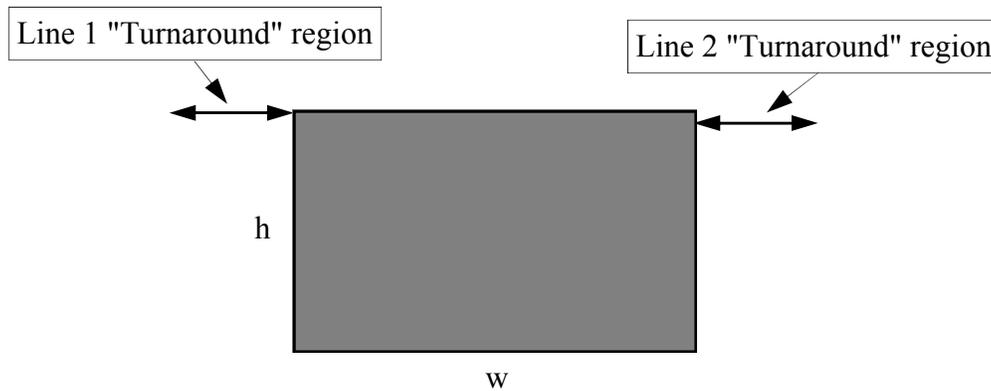
Fig. A2.3.1: Image to be Engraved

The width of the rectangle is "w" inches and the height of the rectangle is "h" inches. The "along scan" direction is horizontal in Fig. A2.3.1 and the cross scan direction is vertical. Assume that the image was created with a resolution of "r" dots per inch (dpi) and that it will be engraved at that same resolution. The region designated "Line 1 Turnaround region" in Fig A2.3.1 is the distance that the engraver requires, after scanning Line 1, to decelerate, move down (1/r) inches, and to then accelerate to begin the scan for Line 2. There is **one** such region associated with every scan line to be engraved.

Assume that the time, "t", that the engraver spends in this region is independent of the engraving speed, "s", and is the same for every scan line. Then the time spent on each scan line is (w/s + t) seconds where s is specified in inches per second, w is specified in inches, and t is given in seconds. The number of scan lines in the rectangle of Fig. A2.3.1 is (r x h) where r is given in dots per inch and h is measured in inches. Thus, the total time, T, to engrave the rectangle is:

$$T = (r \times h) \times (w/s + t)$$

Now assume that we have two rectangles to be engraved, one of dimensions w1 x h1 and the other of dimensions w2 x h2. The total times, T_1 and T_2, to engrave these rectangles are given by:

$$T_1 = (r \times h1) \times (w1/s + t) \text{ and}$$
$$T_2 = (r \times h2) \times (w2/s + t)$$

These two equations can be regarded as two equations in two unknowns, s and t (although s is "known" from the manufacturer's literature, it provides a convenient check to regard it as an unknown). The two equations can be solved for t and s with the following solutions:

$$t = (h1 \times w1 \times T_2 - w2 \times h2 \times T_1) / ((w1 - w2) \times r \times h1 \times h2)$$
$$s = (r \times (w2 - w1) \times h1 \times h2) / (h1 \times T_2 - h2 \times T_1)$$

which are exactly the formulas used in Sec. A2.2. Note that the speed, s, in these equations need not be the maximum speed of the engraver. That assumption was made in the preceding sections to simplify the procedures and explanations.

Obviously, the "Simple Procedure" described in Section A2.1 could be simplified even more by assuming that one does indeed know the speed of the engraver and then substituting that value of s directly in one of the two equations and solving for t directly. In that case, one need only make and engrave one rectangular image to determine t but this ultra simple procedure provides no consistency check at all.

The algorithm within **PhotoGrav** that calculates estimated engraving times is reasonably sophisticated in that it knows and uses the actual length of each line to be engraved (first "burn" to last "burn") and will not "time" regions for which no engraving is to be done. However, there is a risk in that sophistication in that, if the "printer" drivers used by a manufacturer are less sophisticated in controlling the engraver, then **PhotoGrav**'s time estimates could differ substantially from actual engraving times for that particular engraver.

Appendix 3
PhotoGrav and Clip Art

A3.0 Introduction

This appendix describes how **PhotoGrav** can process clip art to create engravable images that are really quite amazing. Although the procedure is described for color clip art from the extensive CorelDraw collection, the procedure should be applicable to other clip art collections after appropriate modifications.

A3.1 Procedure for CorelDraw Color Clip Art

Laser engraving the clip art from the CorelDraw collection 'as is' often produces less than desirable results. In fact, many times the engravings are totally unacceptable. On the other hand, following a rather simple procedure and then processing with **PhotoGrav** will yield reliable results that are often quite spectacular. Adhering to this procedure, you can now offer any of the thousands of Corel images to your customers with confidence that the final engraving will be not only acceptable but highly appreciated as well. In addition, you will not have to spend hours tweaking the art and possibly scrapping a lot of material in the process. If you have tried lasering some of the Corel art, you are probably aware of some of the problems: "hidden" lines appearing in surprising areas, poor contrast between different-colored areas, poorly defined edges, loss of detail, coarse dithering, funny checked patterns, unpredictable shading and depth, etc. The procedure described below, using **PhotoGrav** for the processing, solves all of these problems and more.

1. Start CorelDraw and create a new blank page.
2. Import the desired clip art from the Corel CD. (or any other clip art source)
3. Resize the art to the size you want it to be for the engraving.
4. Draw a rectangle slightly larger than the art and center it over the art.
5. Select only the rectangle and set it's fill and outline to NONE.

However, if you intend to engrave the clip art on a negative polarity material like black brass or black painted acrylic, then it is best to fill the padding rectangle with black so that only the clip art is engraved, not a rectangle cutout frame. Also, in this case, the rectangle must be put BEHIND the clip art. To accomplish this:

    A. Select the rectangle and fill it with solid black, no outline.
    B. From the "Arrange" menu, choose "Order" and then "To Back"
        (or press Shift+PgDn).

6. From the Edit menu choose **"Select All"** - this should select your art AND the invisible (or black) rectangle. (the rectangle is important because it forces Corel to pad your clip art export with a white, or black, border). If there are any other objects, or possibly a page frame, make SURE only your art and rectangle are selected.
7. With both the art and the rectangle still selected, choose **"Export"** from the **File** menu.
8. Select the **"File Type"** as **"Windows Bitmap (.BMP)"** (or jpg, tif, png file type).
9. Give the file a name of your choice.
10. **IMPORTANT:** Make sure you check the **"Selected Only"** checkbox.
11. Click on **"Export"** and you will be presented with a dialog of choices for your .bmp export. Select the following options:

    Color = 256 shades of gray
    Size = 1 to 1
    Resolution = Custom (250 dpi for ULS machines; 300 dpi for Epilog and LMI)
    Anti-aliasing =   (If available in your version of Corel,
                choose one of the following):

        Super sampling
        Normal sampling
        No Anti-aliasing

    "Super sampling" is the best choice since it retains more fine lines and results in smoother details. "Normal sampling" results in good edge smoothing but tends to fatten up fine details which are subsequently sometimes lost. "No Anti-aliasing" is not used for most art since it often results in jaggy edges.

12. Click on **"OK"** and a grayscale version of your clip art will be created.
13. Start **PhotoGrav** and load the .bmp image you just created.
14. Process the image with **PhotoGrav** and save the "Engraved Image".
15. Import this processed .bmp image back into your Corel layout and engrave it.

    (**IT IS VERY IMPORTANT**, that you do **NOT** resize or rotate the processed image after you import it back into Corel. Doing so would destroy the special dithering pattern created by **PhotoGrav**.)

Additional Tip:

Try importing a photo into CorelDraw and adding a fancy border or oval frame from the clip art collection. Select all of this, export it as a .bmp file, and process with **PhotoGrav** as described above. We have used this technique to create some really cool engravings - customers love them and will pay top dollar for them.

Use your imagination and **PhotoGrav**'s processing power! We would love to hear about your creative tricks.

Appendix 4

PhotoGrav Concepts and Design

A4.0 Introduction

This appendix presents the rationale behind several of **PhotoGrav**'s concepts and, at a high level, the design necessary to realize those concepts. The information duplicates some of the material presented in Sec. 2.2 but provides more detail about **PhotoGrav**'s model and about the procedures used to tune the parameterized processing algorithms for the engraving materials.

A4.1 PhotoGrav Concepts

The objective of the **PhotoGrav** program is to efficiently process digitized photographs so they can be engraved on a variety of common engraving materials with a high degree of confidence that the engraved photographs will be acceptable products. **PhotoGrav** achieves this objective in the following way:

1. It provides parameterized algorithms that have been found effective in processing photos for engraving.
2. It provides, for many common engraving materials, the algorithm parameters that result in near-optimal engraving for each material.
3. It provides an automated, or interactive, application of the algorithms to the subject photo for the currently-specified engraving material.
4. It provides a simulation of the engraving process so the "engraved product" can be inspected before it is actually engraved.

This section addresses "**Basic PhotoGrav Concepts**" as two major subtopics: (1) "Parameterized Algorithms and Engraving Materials" and (2) "PhotoGrav Simulation".

A4.1.1 Parameterized Algorithms and Engraving Materials

PhotoGrav provides four major algorithms for processing digitized photos into engravable (binary) images: (1) Grayshade Adjustments, (2) Smoothing and Edge Enhancements, (3) "Screening" Operations, and (4) Image/Screen Combinations and Thresholding. Each of these algorithms has several functional components and each component is parameterized to provide a broad range of possible effects. It is not the intent of this section to describe each algorithm and its components (see Sec. 3.4 for detailed algorithm descriptions) but rather to describe how the algorithms are "tuned" for each engraving material.

Basically, **PhotoGrav**'s algorithms are "tuned" for a specific material by an iterative process utilizing a combination of: (1) **PhotoGrav**'s simulation capabilities (described in the next section) and (2) experimental engravings on the specified material. An initial estimate is made, for the subject material, of what the parameters should be for each of **PhotoGrav**'s processing algorithms. The initial estimate is then specified to the **PhotoGrav** simulation capability and the result is inspected on the computer monitor. Adjustments are then made to the initial parameters until the simulation appears to be near optimal for several digitized photos. The "Engraved Image" produced by **PhotoGrav** is then actually engraved on the subject material and inspected. Based on the inspection, further adjustments are made to the parameters, the simulation is repeated, and further engravings are produced. This process is repeated until further iterations produce no perceptible improvements in the engravings. The overall "tuning" process, although simple, is rather tedious and would be extremely difficult without **PhotoGrav**'s simulation capabilities.

The derived parameters for the subject material are then stored as a data set specific to that material. When the engraving material is subsequently selected during a normal **PhotoGrav** session, these parameters are accessed and loaded as the current processing parameters. The stored parameters include flags that indicate whether or not certain special operations should be performed for the material. For example, for black brass, a flag indicates that this is a negative-polarity material and that the "Engraved Image" should be inverted from normal engraving polarity. Or, for black painted acrylic, flags indicate that this is not only a negative polarity material but also that the image should be mirrored horizontally before engraving. Any of the parameters specifying the processing for a specific material can be readily adjusted in **PhotoGrav**'s **Interactive Process** window. Adjustments can then be saved as a "PhotoGrav Session" and used as a template as needed.

A4.1.2 PhotoGrav Simulation

Although the tuning process described above results in "near optimal" parameter settings for each engraving material, engraving results are still often somewhat image dependent. In other words, the settings that produce an excellent engraving for one image on a specific material might result in an engraving that is less satisfactory for another image using the same engraving material. Further, it is very difficult to view the raw processed image on a computer monitor and to judge from that display whether or not the final engraving will be satisfactory. To overcome these difficulties, **PhotoGrav** provides, optionally, a simulation of what the processed image will look like once it is actually engraved on the selected material.

PhotoGrav's simulation capability is intended to provide a **WYSIWYG** (**W**hat **Y**ou **S**ee **I**s **W**hat **Y**ou **G**et) capability. In other words, the appearance of the simulated image on your computer monitor should be very close to the appearance of the actual engraving produced from the processed image (subject to some of the qualifying factors mentioned in Sec. 2.2). The simulated image is not merely an overlay of "dots" on top of a representation of the engraving material. Rather, it is a full-fledged simulation wherein a lens-power model, calibrated for each material, is used to calculate an **effective** spot size which is then "burned" into a representation of the engraving material. The word "effective" is emphasized in the preceding statement because the spot size that **PhotoGrav** uses for the simulation is the size of the spot that the laser creates on the subject material, not just the geometric cross section of the laser beam at the focal plane. The "effective spot size" is modeled as a two-dimensional Gaussian curve whose height (degree of burn) and width (area of burn) are dependent on the laser's power and speed settings, the lens, and the engraver's dpi setting relative to the image dpi. The effective spot size is calibrated for each material by engraving test images at several power settings and then matching the engravings to **PhotoGrav**'s Simulated Image by adjusting the effective spot size as a function of the previously-mentioned variables.

All simulation models contain some approximations and **PhotoGrav**'s model is no exception. Most of these approximations are very straightforward and require no explanation since they adhere very closely to reality.   However, one approximation does require some explanation and that approximation occurs when the engraver dpi does not match the image dpi. For example, suppose that an image is digitized at 250 dpi but is to be engraved at 500 dpi. If **PhotoGrav**'s simulated image were to be produced at 500 dpi, then it would be four times larger than if it were produced at 250 dpi and would take approximately four times longer to produce. So, in order to save both disk space and execution time, **PhotoGrav** produces the simulated image at 250 dpi but modifies the "effective spot size and power" so that an engraving dpi of 500 dpi is approximated.   To see this effect, start **PhotoGrav**, select an input image of 250 dpi (or 300 dpi), choose Black Laser Brass as the engraving material , and "Interactive Mode" the image. Within the **Interactive Mode** control panel change the Power setting to 15%. Type a value of 250 (or 300) into the "Machine DPI" and hit the "Preview" button. Note the laser spot size in the Simulated or Engraved image. Then choose 500 (or 600) DPI from the list and note that the spot has gotten much brighter and larger, especially in the cross scan (vertical) dimension. These differences in the effective spot size are indicators of the approximation that **PhotoGrav** uses when the engraver dpi does not match the image dpi.

As noted in Sec. 2.2, the Simulation Image might not always be a good representation of the actual engraving produced from the processed image due to factors that vary in an unknown way. However, if you take steps to minimize these variations and take the time to develop some skill in interpreting **PhotoGrav**'s Simulated image relative to your particular materials and engraver, then the simulation can be a powerful tool in reliably creating excellent photographic engravings. This notion is what is previously referred to as a "Relative" simulation.

Appendix 5

PhotoGrav License Agreement

IMPORTANT
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