VX3000 Film Scanner

User's Manual

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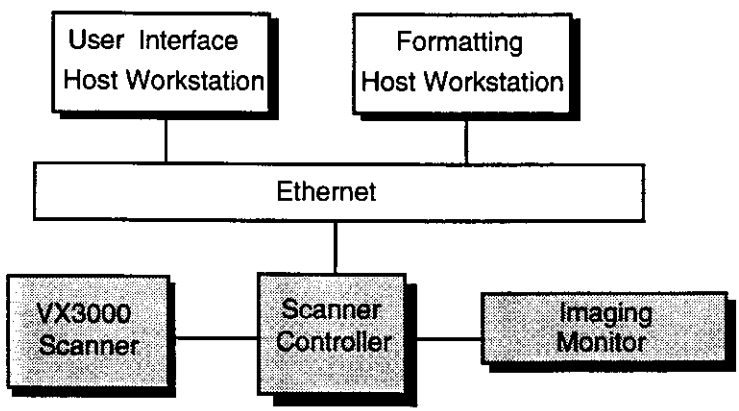
Introduction

The VX3000 Film Imaging System is designed to give you not only high quality image scanning, but also on-line, interactive previewing and mensuration capabilities. The VX3000 provides a broad range of resolution, generating precise geometric and radiometric results. The VX3000's upright, back-lit imaging area doubles as a traditional light table allowing you to view images through the live video camera. You can roam and zoom about the image, experimenting with various combinations of scanner settings such as resolution, brightness and contrast, which allows you to preview the various possibilities *before* actually scanning.

System Configuration

The VX3000 Scanning system, shown below, is configured with a scanner controller, imaging monitor, and scanner. You run the VX3000 application from your host workstation using your network.



Scanner Controller — The component that houses the computer hardware and software (vxscan) for the VX3000 scanner.

Imaging Monitor	The monitor on which you preview the image.
VX3000 Scanner	The scanner.
Ethernet	A standard Ethernet network that connects the Scanner Controller to the User Interface and Formatting Host Workstations.
Host Workstation	Any workstation that runs UNIX and X Windows, and is complete with a monitor, keyboard, and mouse. It is from this workstation that you run the VX3000 User Interface.
Formatting Host	A UNIX workstation on which the formatting software (vxformat) is installed and which is connected to the scanner controller via Ethernet. It may be the same as the host workstation.

VX3000 Conventions

The VX3000 User Interface uses standard X Windows conventions. For more detailed information about X Windows conventions, see your operating system manuals.

Using the Mouse

Within the VX3000 User Interface, the mouse is used to move the camera, select options, and set scanning parameters. See the *Backplane Representation* section for more information on moving the camera with the mouse.

Note: *The only time you press the middle-mouse button is to move the camera. Otherwise, always use the left mouse button. VX3000 does not use the third or right mouse button.*

Mouse Pointer Shapes

The mouse pointer changes shape when it is in different locations within the window. These different shapes provide visual cues to the current activity.

The pointer usually appears as an arrow cursor.

In the Viewing Area, the pointer appears as a cross for adjusting the size and shape of a scan area. A cross also appears on the image monitor for selecting points of interest.

An inverted "L" bracket appears when you are ready to draw the rectangle for defining a Region of Interest.

Clicking, Double-Clicking, and Dragging

Click means to press and release a button without moving the mouse. Double-click means to click a button twice in rapid succession. Drag means to press and hold a button while moving the mouse pointer.

Input Fields

Input fields are used to enter text or numerical values, for example, names of Regions of Interest or absolute resolution values. To select an input field, point to it and click the left mouse button. The text insertion point is then marked by a blinking I-shaped cursor in the box. Use the keyboard to type information into an input field. Use the Backspace and Delete keys to delete unwanted characters. The arrow keys move the cursor left and right. Some fields, such as the Memo field, can have multiple lines. Others, such as file names and paths, use standard System V UNIX naming conventions and sizes. When you are done entering text into a text field, either click on another text field or option menu, or press <Return>. This will cause vxscan to accept your input. Using <Return> in a multiple-line text field causes the cursor to advance to the next line. See the *File Naming Conventions* section for more information about file names.

Selection Boxes

Selection boxes allow you to select different options. Some selection boxes have buttons that you select, and others have fields in which you enter information. Either

enter the information requested or select the buttons necessary to complete the function and select **OK**. To exit the selection box without saving your choices, select **Cancel**.

Message Boxes

Message boxes provide helpful information about system operations. A message box appears automatically and will often prompt you to select OK to continue. Sometimes a message box does not require any action. For example, when you select Scan, the vxscan Working message box displays the progress of the scan.

Pull-Down Menus

Pull-down menus give you access to more options. There are two ways to choose a function from a pull-down menu using the mouse:

Drag method: Point to the menu you want to display, press and hold the mouse button, drag the pointer and highlight the desired function, and then release the button.

Click method: Point to the menu you want to display, click the mouse button once to display the menu. Point to the desired function and then click again.

Basic Scanning Steps

This chapter is a brief overview of the basic scanning steps. For detailed instructions and information about the scanning process, see the next chapters, *VX3000 User Interface Overview, Current Scanner Settings, Current ROI Description, and Menu Bar.*

The scanning process generally follows six basic steps, although some of these steps are optional depending on your scanning project and default scanning parameters.

- Naming the Regions of Interest.
- Defining the geometric parameters such as resolution, size, and location.
- Setting the radiometric attributes such as brightness and contrast, density or intensity, color or monochrome, lookup tables and filters.
- Selecting formatting options such as file format, pixel depth and formatting host.
- Confirming the Current ROI settings.
- Scanning the image.

Name the Regions of Interest

The Region of Interest (ROI) name is a UNIX directory name to which the image data (raw image tiles and region header file) are written. This name should be unique for every region, otherwise previous image data will be overwritten. For more detailed information on naming a Region of Interest, see *ROI Files* in the *Current ROI Description* chapter.

Define Geometric Parameters

You can interactively change the location and resolution of the scanner to view sections of your image prior to scanning. While previewing the image, you define a region to be scanned by drawing a rectangle around the area of interest. Vxscan provides tools for creating and sizing the rectangles that represent the regions to be scanned. You can control the ROI size by resizing the ROI rectangle or by providing values for the size in pixels, the size in inches or millimeters, or the resolution.

Set Radiometric Attributes

Part of the scanning setup process involves adjusting the brightness and contrast of the image using a histogram. You may also choose whether you want the output scanned in density or intensity modes and whether you want to apply a filter or a lookup table which will remap the digital result.

Select Formatting Options

Before scanning, you select the output file format, the pixel depth, and the name of the host machine on which you want the formatting process to run.

Confirm the Current ROI Settings

The Current ROI Settings are the values that will be used at the time scanning. As a last step before scanning, make sure these are set properly because they may differ from the Current Scanner Settings.

Select Scan

When you have confirmed that the Current ROI Settings are correct you are ready to scan. You can scan either single regions or multiple regions. During the scanning process, messages appear telling you about the progress of the scan.

Starting the Application

Starting the Scanner

Starting the application may vary depending on how the system is set up. The typical process involves logging in to the host workstation, beginning X Windows, remote logging into the scanner controller, setting the DISPLAY environment variable, powering the scanner on, and starting vxscan.

To start the VX3000 Scanner and the vxscan User Interface,

1. Turn the power on for the scanner and monitor. The green light on the front right-edge of the scanner is lit when the scanner is on.

2. Make sure that the host workstation is running X Windows and that the scanner controller is a recognized X host.

3. From the host workstation, remote login to the scanner controller.

4. Set the DISPLAY environment variable to your host workstation if it has not been set properly during the login process.

5. Type **vxscan** at the UNIX prompt. The scanner will perform a homing sequence, turning on the backlight, moving to known locations in X and Y, and adjusting the camera, lens, and filters. The vxscan window then appears on the workstation monitor. The initial state of the scanner after homing can be optionally specified by a .vxscanrc file in the home directory. See the *Setup and Calibration* chapter for more information about the .vxscanrc file.

Cleaning the Glass

The View Menu contains a **Clean** option for cleaning the reseau glass. This option simply turns off the scanner backlight and turns on the reseau light for a fixed period of time to illuminate the glass for ease of cleaning. From the **View** menu, select **Clean**. A message appears telling you how many minutes you have until the backlight comes back on. You can turn the reseau light off at any time by selecting **Cancel**. The limited time period is so that the reseau light is not inadvertently left on for extended periods. This option may be selected again if the time is insufficient.

Dirty glass, or obscured reseaus, can lead to scanning errors. The reseaus are etched into the back side of the glass at a width of 100µ and depth of 0.75µ. Therefore, it is very easy for fingerprints or other substances to prevent the reseau grid from being properly recognized.

For best results, use isopropyl alcohol (not ethyl) and many clean, non-abrasive, dust free wipes. Be careful to pour the solution onto the wipes, and not dip the wipes into the solution to prevent contamination. Whatever cleaning solution is used, it is important that it be removed completely so that its streaky residue does not obscure the reseaus. This can be accomplished by extensive rubbing and buffing of the glass (especially the back side) with clean wipes.

Mounting an Image

To mount an image,

1. Open the backlight box by grabbing the top of the light box assembly and moving it away from the scanner.

2. Place the image, emulsion side to the reseau (the etched grid on the front glass plate), in the backplane viewing area. If you have more than one image, place the images side by side in the backplane.

3. Close the light box assembly snugly. The image is now mounted.

Note: It is imperative that the emulsion side, or coating side, of the film be against the reseau. The back side of the reseau plate is the focal plane of the scanner. If the emulsion is separated from the reseau by the thickness of the film, geometric projection errors will occur.

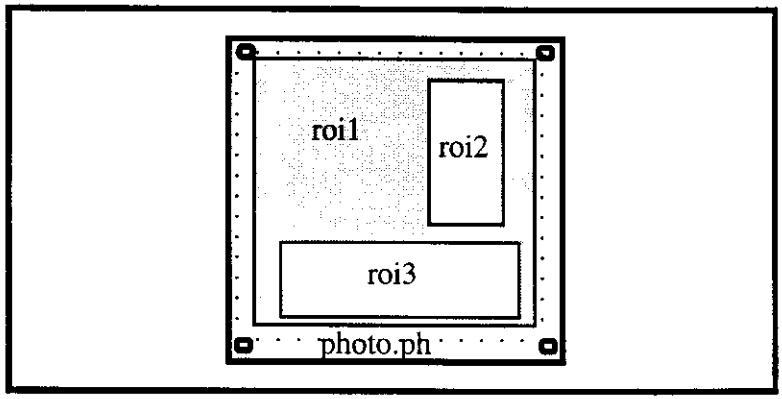
Overview of the VX3000 User Interface

The VX3000 Scanner system provides a user interface called vxscan for setting scanning parameters, naming files, and defining the areas to scan. This chapter presents an overview of vxscan's functions.

Regions of Interest

A primary feature of vxscan is the ability to select and define specific areas on the film that are of interest to your application and which you want to scan. These areas are called Regions of Interest (ROIs). Scanning one or several regions, each of which may have different scanning parameters, rather than the entire piece of film, conserves both time and disk space. An ROI may be defined as a very small subset of the film, or the entire piece of film. Many regions may be defined for one photo, all of different sizes, resolutions, and radiometric settings.

The following figure shows an example of three ROIs within a photo.

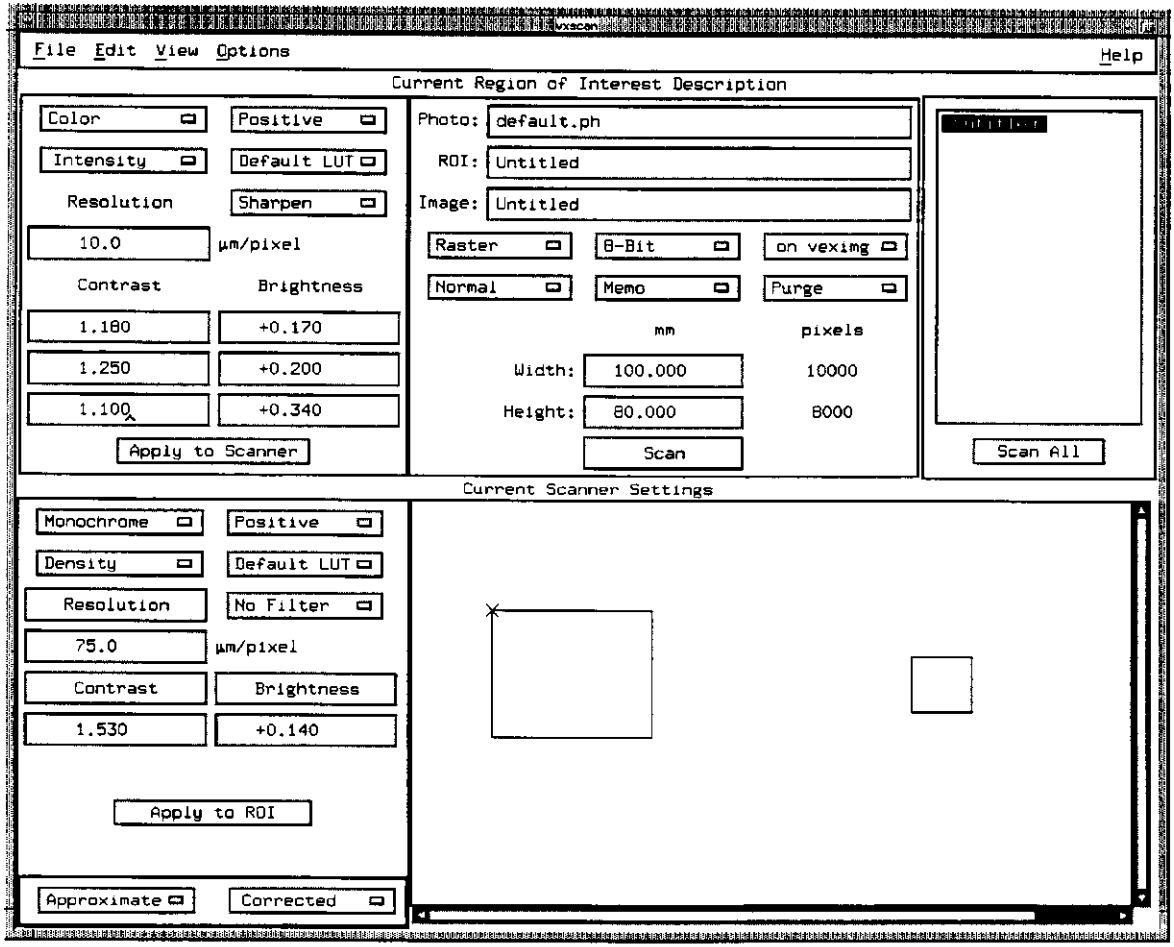


An additional level of abstraction is the photo itself. Information specific to each region, such as its scanning parameters, coordinates, file name, etc., can be stored in a

Photo File. All the information for all the regions belonging to a particular photo may be stored in the same file. In addition, multiple Photo Files may be open and used at the same time.

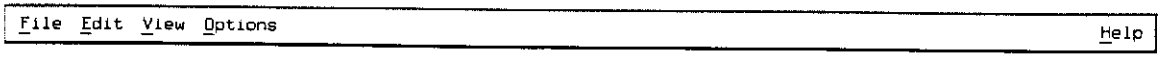
The Vxscan Window

When you start vxscan, the User Interface window appears as shown below.



The vxscan window has three major areas: the Menu bar, the Current Region of Interest Description, and the Current Scanner Settings.

Menu Bar



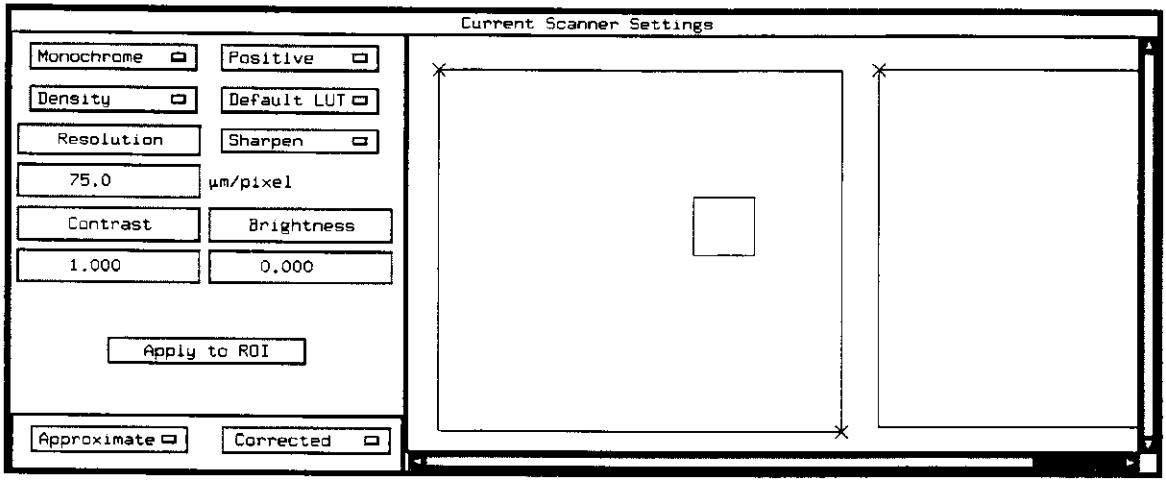
The menu bar displays the following four pull-down menus and a Help menu:

File	Open, close, save, and create new files and exit vxscan.
Edit	Create and delete Regions of Interest (ROI's), control ROI rectangle constraints, specify photo information, and digitize points of interest.
View	Display histogram or turn on the reseau light for cleaning the glass.
Options	Set preferences for units of measurement, photo coordinate system visibility and which dimension is automatically calculated.

For more information on the Menu Bar options and how each one is used, see the chapter, *Menu Bar.*

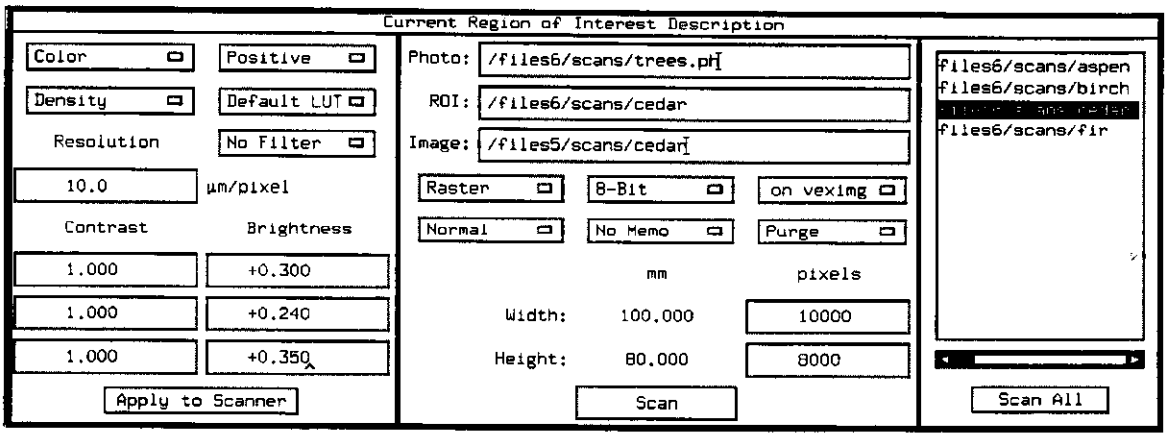
Current Scanner Settings

The Current Scanner Settings area in the lower half of the window displays the current settings for the scanner. This is where you can manipulate the scanner settings, observing the effects of these changes on both the image monitor and histogram until you achieve the desired results. In order for those changed values to take effect during scanning, it is necessary to apply the values to the Current Region of Interest Description above.



Current Region of Interest Description

The Current Region of Interest Description area displays information about the current Region of Interest (ROI). The current ROI is the one highlighted in the list of regions, and can be one that you have selected or one that you are creating for the first time. It can also be an ROI within the default Photo File that appears when you first begin. You can apply the current ROI settings to the scanner in order to preview the effects of these settings on the image monitor prior to scanning.



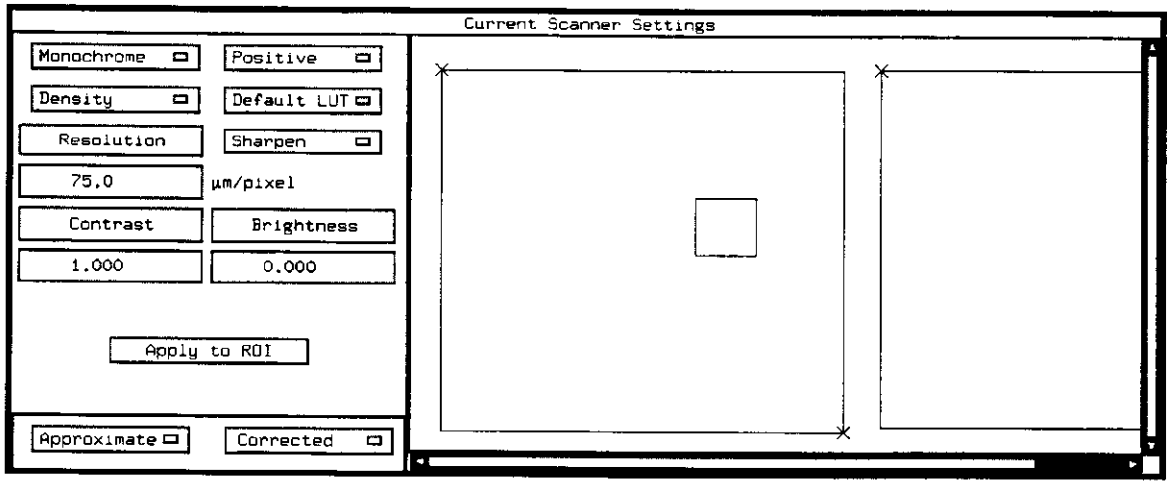
Using Current ROI and Current Scanner Settings

The vxscan User Interface window provides two methods for setting and adjusting current scanner settings and ROI scanning parameters: using the Current Region of Interest in the upper portion of the window, or using the Current Scanner Settings in the lower portion of the window. The Current Region of Interest allows you to select scanning parameters for a region without affecting the current scanner settings. The current scanner settings allow you to adjust and preview scanner settings independent from the values already set for that region. You may "dialog" between these two areas by using the "apply" buttons. For example, you can apply the current ROI settings to the scanner to verify that those settings are correct. Alternately, you can experiment with different scanner settings to determine what are the best settings for a specific region and then apply it to the region to be scanned. Only the settings in the Current

Region of Interest are used during the actual scanning process. Selecting a different ROI will cause the current ROI settings to change to reflect the new ROI.

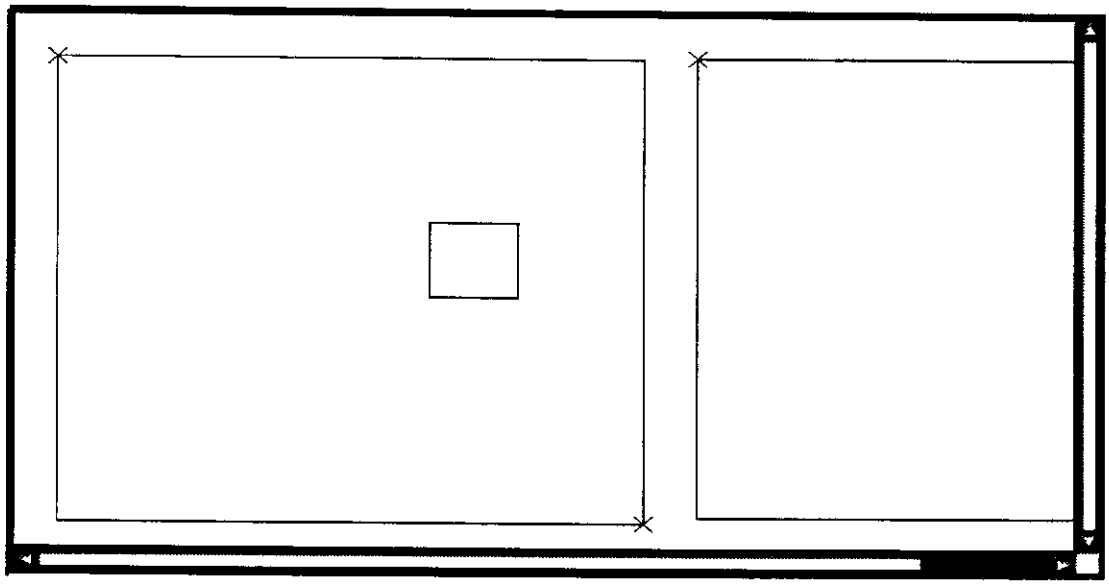
Current Scanner Settings

The Current Scanner Settings area in the lower half of the application window displays the current settings for the scanner.



Backplane Representation

Within the Current Scanner Settings area, a backplane representation of the 20" by 10" backlit scanner surface is displayed in the lower right portion of the window. This area is a visual representation of the scanner backplane, containing the camera field of view and rectangles defining ROIs and photo coordinate systems. The image within the current camera field of view is visible on the image monitor. This Backplane Representation is where you move the camera to roam in X and Y, define the position of your Region of Interest, digitize points of interest, or establish optional photo coordinates.



The Backplane Representation has three types of boxes, each with a different color:

- the camera field of view shown in dark blue
- the current Region of Interest shown in red (all other regions are magenta)
- optional current photo coordinates shown in green (other photo coordinates are cyan)

Camera Field of View

The dark blue box in the Backplane Representation represents the camera field of view. The camera field of view is that portion of the backplane currently visible by the camera. You can roam about the backplane by moving the cursor into the backplane representation and pressing and holding down the middle mouse button as you move in the X and Y directions, dragging the camera field of view. Releasing the middle mouse button will cause the image to be regrabbed. By adjusting the resolution, you can also zoom in on a specific area (Z axis). As the resolution setting is changed, the camera field of view will become respectively larger or smaller. See *Resolution and Radiometric Controls* later in this chapter.

To move the camera,

1. Position the mouse pointer within the Backplane Representation and hold down the middle mouse button while moving the mouse. This grabs the camera and moves it to a new location within the backplane. As you hold down the button and roam, the camera field of view is displayed on the image monitor in "live" mode.

2. Release the middle mouse button when you are satisfied with the new camera position. As soon as you release the mouse button, the camera re-grabs and re-displays the image.

Moving the mouse cursor inside the camera field of view will cause the cursor to be drawn on the image monitor. The cursor will appear to slow down in the backplane representation, but will move at normal speed on the image monitor. Especially at high resolutions, the cursor may appear to be trapped in the camera field of view, and the mouse will need to be moved a comparatively great distance to exit the camera field of view.

Region of Interest Rectangles

One of the steps in defining your scanning area is to draw a rectangle around the area to be scanned. Before doing this, you may want to set some parameters for that rectangle, such as the correct units of measurement. See the *Options Menu* section in the *Menu Bar* chapter for more information.

Drawing an ROI Rectangle

If you are creating a new ROI, the position of the ROI in the backplane may be undefined, in which case the cursor appears as an inverted L bracket in the Backplane Representation. Clicking the left mouse button will place the upper left corner of the ROI at your current position. The size of the new ROI rectangle is determined by the size and resolution settings in the Current ROI Description. The resultant ROI rectangle may be moved or rubberbanded to resize the region, as described below. See *New ROI* in the *Edit Menu* section of the *Menu Bar* chapter for more information on creating a new ROI.

If your application requires very accurate positioning where regions must be at precise, known locations with respect to film locations, you must turn on Accurate Mode before positioning an ROI rectangle. See *Accuracy* later in this chapter.

To draw and resize a new Region of Interest rectangle,

1. In the Backplane Representation, move the cursor to the upper left corner of the area you want to scan. The pointer will appear as an inverted "L" bracket outside of the camera field of view. Inside the camera field of view, the pointer will appear as a "+". To position accurately with respect to the film, the cursor needs to be within the camera field of view (where the camera is positioned over the corner of the ROI, and the cursor is visible on the image monitor), with Accurate Mode turned on.

2. Press the left-mouse button. A rectangle appears with an "X" in the upper left corner. Use this corner to reposition the rectangle by pointing to the "X" and holding down the left mouse button while dragging the rectangle to another location.

   The "X" indicates a defined corner point which constrains the other corners of the rectangle. When just one corner is defined, the other three corners can be "rubberbanded" to resize the rectangle, and moving the defined point moves the entire rectangle. When more than one corner is defined, the resizing behavior is dependent on the relationship between the constraining points and the corner to be resized. Often you will select two adjacent corners to constrain the opposite corners of the rectangle from moving in either the horizontal or vertical directions. For example, if you clicked on the upper left and lower left corners, the upper and lower right corners are constrained from rubberbanding in the vertical direction. Conversely, if you clicked the upper left and right corners, you would constrain the lower corners from moving in the horizontal direction. Selecting opposing corners prevents the undefined corners from being resized. Defining all four corner points effectively "locks" the rectangle and prevents any resizing.

3. To delete a constraining corner point, make it the active point by clicking on it, and then select **Release Point** from the **Edit** menu to release the active corner. Active, or current corners are drawn in read. Other corners are drawn in magenta.

Note: *If you have selected "Size in millimeters/inches" for automatic calculation, you will not be able to dynamically resize the ROI rectangle because the ROI is constrained by the resolution and pixel size settings. See the* Options Menu *section in the* Menu Bar *chapter for more information about automatic calculations.*

Making an ROI the Current ROI

When working with several Regions of Interest, you will notice that the currently active ROI rectangle is displayed in red, while the inactive ROI rectangles are displayed in magenta. An ROI rectangle can be made active either by clicking near or close to a corner of that rectangle, or by selecting the ROI name in the list of regions.

Deleting the Current ROI Rectangle

Deleting a rectangle deletes the position definition of an ROI only, not the region and its parameters.

To delete an ROI rectangle,

1. First make sure that the rectangle you want to delete is the *current* ROI rectangle. Either select it from the list of regions or click on the rectangle in the Backplane Representation.

2. From the **Edit** menu, select **Delete Rectangle.**

Scroll Bars

Use the scroll bars on the right and lower edges to adjust the currently visible part of the Backplane Representation. To move vertically, click on the up and down arrow on the right side. To move horizontally, click on the left and right arrows at the bottom. You can also click and drag either bar.

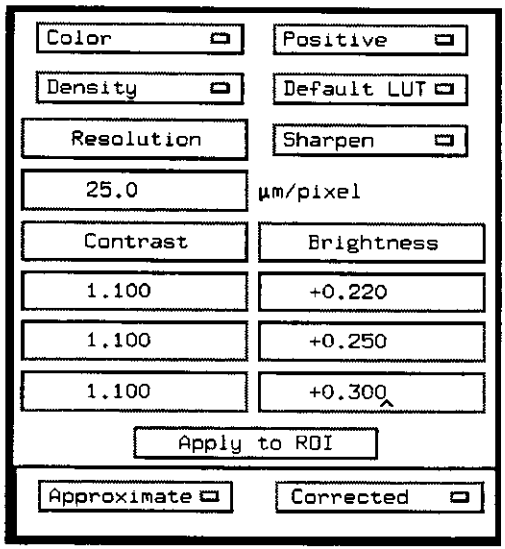
The purpose of the scroll bars is to compensate for the difference in aspect ratios between the Backplane Representation and the scanner. If the aspect ratios were the same, the scroll bars would be full width and height and would not scroll. For ease of use, use the maximize option of X Windows to enlarge the window as much as possible rather than using the smaller default size.

Photo Coordinate Rectangles

In addition to the camera field area and the ROI rectangles, a photo coordinate system may be associated with each of the Photo Files. The optional Photo Coordinate rectangle can be used to establish a photo coordinate system using known points on the image. Photo coordinates are depicted by a green rectangle for the current photo, and cyan rectangles for other opened photo files. For more information about using photo coordinates, see *Options* section in the *Menu Bar* chapter.

Resolution and Radiometric Controls

Vxscan's Current Scanner Settings area contains several resolution and radiometric settings that affect your preview of the image. The image monitor will reflect the changes made to these settings, but when the image is scanned, only those settings in the Current Region of Interest Description will be used. Remember to apply any changes made in the Current Scanner Settings to the Current Region of Interest before scanning if so desired.



Color Type (Monochrome/Color)

The Color setting specifies the type of image as either color (RGB) or monochrome. To scan a color image in monochrome, select monochrome instead of color. If you select Monochrome, one Contrast and one Brightness input field appears. If you select a color, three Contrast and three Brightness input fields appear for RGB.

Image Type (Positive/Negative)

Type indicates the output results as either positive or negative. Negative causes the gray values of the image to be inverted, causing negative film to be displayed as positive on the image monitor.

Intensity/Density

To understand the difference between the Intensity and Density settings, some common terms need to be reviewed.[1] [2] When film is processed, areas of the image receive different amounts of illumination and thus have varying degrees of blackness. The blackness of a negative, or its light-stopping power, can be expressed numerically in the following different ways:

Transmittance

Transmittance is the ability of a material to allow light to pass through it and is usually expressed as a fraction or a percentage: what comes out divided by what went in. For example, if 100 units of light are directed at a material and 90 units actually pass through, the transmittance of the material is 9/10, or 90%.

Opacity

Opacity is just the opposite of transmittance. Opacity refers to a material's ability to block or absorb light. It can be found by dividing 1 by the material's transmittance and its value can never be less than 1. Using the example above, the opacity of the material would be 1.11.

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[1]Ralph E. Jacobson, Sidney F. Ray, and Geoffrey G. Attridge, The Manual of Photography, Focal Press, Butterworth-Heinemann Ltd. 1988, pp.170-171.

[2]Phil Davis, Beyond the Zone System, 3rd Edition, Focal Press, Butterworth-Heinemann Ltd. 1993, p. 26.

Density

Density is the common log of opacity. For example, if a material transmits 25% of the light that strikes it, 25% is equivalent to the fraction of 1/4, the reciprocal of which is 4. The opacity of the material is therefore 4, and the density is the log of 4, or 0.604. Here are some examples to help clarify this relationship.

%Transmittance	Opacity	Density
100	1	0
75	1.33	0.124
50	2	0.3
33.3	3	0.48
20	5	0.7
10	10	1
5	20	1.3
2	50	1.7
1	100	2.0

Density is the unit used most often in sensitometry. Like opacity, it increases with increasing blackness, but has the following advantages:

1) The numerical value of density bears an approximately linear relationship to the amount of silver or image dye present. For example, if the amount present in an image of density 1.0 is doubled, the density is increased to 2.0. The opacity, however, increases from 10 to 100, or tenfold. Thus, calculations between several optical components that are *multiplicative* because they use transparency or opacity, become *additive* when using optical density.

2) The final aim is to relate the tones of the print to those of the subject. Blackness in the print depends on the way the eye assesses it, and is therefore essentially physiological. The law governing the effect produced in the eye when stimulated is not a simple one, but over a wide range of viewing conditions the response of the eye is approximately logarithmic. Thus, if we examine a number of patches of a print in which the density increases by equal steps, the eye accepts the steps as of equal

blackness increase. From this point of view, a logarithmic unit is the most satisfactory measure of blackening.

Using the Vxscan Intensity/Density Settings

The vxscan **Intensity** setting is essentially transmittance and the vxscan **Density** setting is the density value, or log transform of Intensity. So, which setting is appropriate? Use **Density** to accentuate structures within the darkest areas. Use **Intensity** to accentuate structures in the brightest areas. Your choice also depends on the final film writing process; use **Density** if your printing setup assumes density data.

Lookup Tables (LUTs)

A custom Lookup Table (LUT) is an ASCII (text) file that specifies how original or input gray values (0-255) are mapped to output gray values (0-255). The file contains 256 lines of paired integers separated by blanks or tabs. This file can contain optional comments, preceded by a '#' sign as the first character on a line. It is recommended that the name of a custom LUT end in '.lut' to aid in managing the files. The following is an example of a LUT file:

```
# log LUT
#
0       0
1       31
2       50
3       63
.
.
.
254     255
255     255
```

In the example, the first two lines are comments. The next 256 lines specify a mapping between input gray values such as 3, and the corresponding output gray value such as 63.

Because LUTs are tedious to create using a text editor, it is recommended that they be generated by spreadsheets or other software. Vxscan does not include tools to produce custom LUTs.

Vxscan allows a custom LUT to be associated with each color channel (white, red, green, and blue). If the "Current Scanner Settings" are set to Monochrome and "Custom LUT" is selected, then a file selection dialog box is displayed. This allows you to specify the name of the custom monochrome LUT. If the "Current Scanner Settings are set to Color, you are prompted to enter Custom LUTs for red, green, and blue. These LUTs may be the same or different for each color.

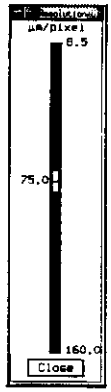
After selecting the name or names of the LUTs, the display on the image monitor and optional histogram will reflect the application of the LUT(s) to the image. Use of the LUT(s) may be disabled/enabled by toggling between "Default LUT" and "Custom LUT". The LUT(s) may be applied to the ROI by using the "Apply to ROI" button.

Because custom LUTs are files, they can also be managed by using the vxscan File menu. By using Open/LUT/Monochrome,Red,Green,Blue, you can load a LUT for each color channel. If a LUT has already been loaded for a given channel, it will be closed and replaced. Close/LUT/Monochrome,Red,Green,Blue removes the association between a LUT and a color channel.

Resolution

There are two ways of setting the resolution:

- Click on the Resolution button in the Current Scanner Settings area to display a resolution slide bar. Drag the slider to adjust the resolution.



- Type the resolution value into the text box below the Resolution button in either the Current Scanner Settings area or the Current Region of Interest Description area.

If you want a precise resolution level, type the value in the box. If you type the value in the Current ROI, you must apply the settings to the Current Scanner Settings in order to view the results. You can also experiment with values by clicking on the Resolution button and using the slider bar. As you change the resolution setting, the camera box in the Backplane Representation changes size and the image monitor reflects the actual field of view of the camera.

Note: *If you have selected to have the resolution automatically calculated by using the Auto Calculate Dimension option in the Set Preferences selection box, you will not be able to adjust the resolution in the Current Region of Interest area. See the* Options Menu/Set Preferences *section in the* Menu Bar *chapter for more information.*

Filters

The **No Filter/Sharpen** selection box allows you to select an optional high pass edge enhancing filter to be passed over the data. See the *Filters* appendix for more information.

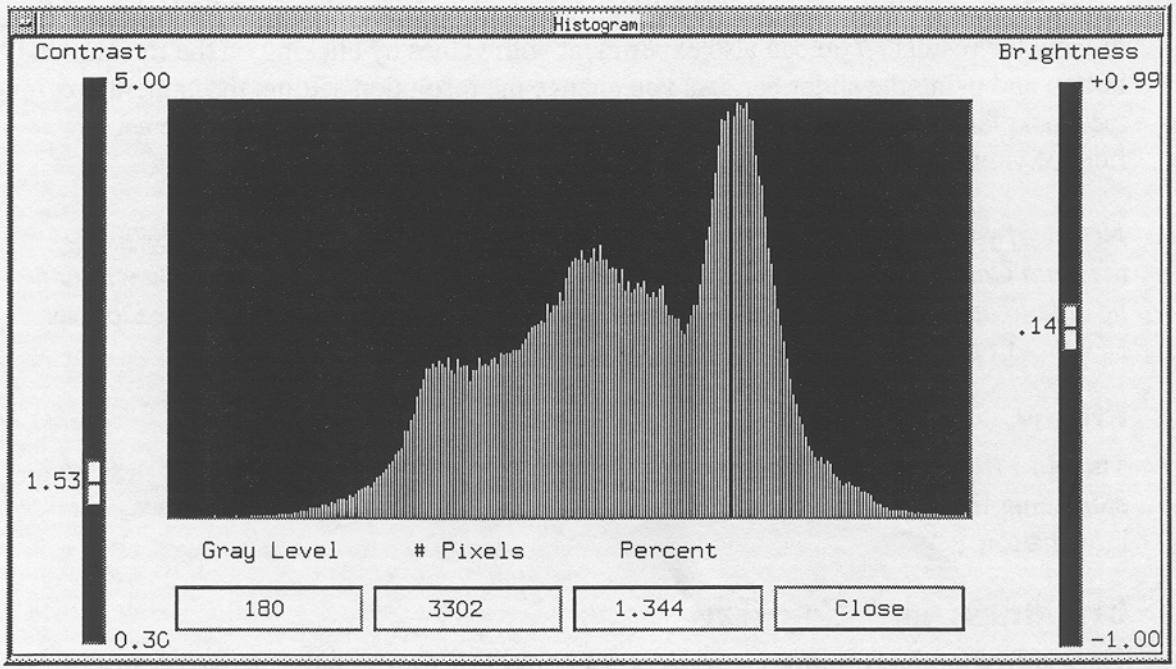
Brightness and Contrast

The purpose of the Brightness and Contrast controls is to match the characteristics of the image to the range of numbers that are used to represent the brightness of each pixel

in the image. This range of numbers, or gray values, extends from 0 for the darkest part of the image to 255 for the brightest part. The goal is to use as much of this range as possible. For example, if an image was low in contrast, i.e. it started out with gray values between 150 and 240, you would want to stretch it so that what was 150 becomes 0, and what was 240 becomes 255, thereby using the full range. Or if an image was dark, you would want to increase the brightest value from, for example, 200 up to 255. By adjusting the Brightness and Contrast settings, you can achieve a more optimal range and distribution of gray values for monochrome images and color values for color images.

Note: *For best results, always adjust Brightness before adjusting the Contrast.*

Pressing either the Brightness or Contrast buttons displays a histogram. You can also select **Histogram** from the **View** menu. For a monochrome image, the following dialog box appears.

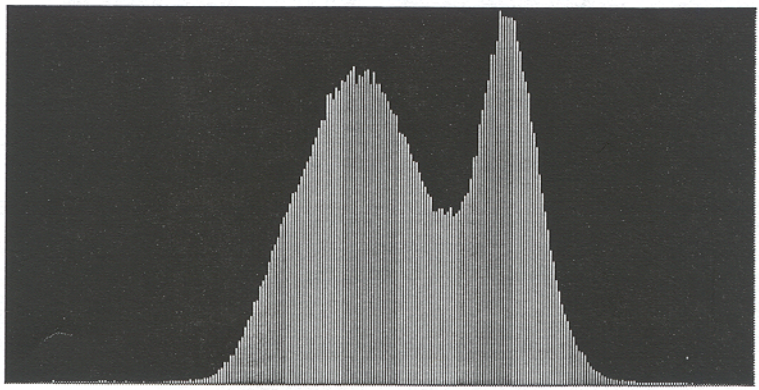


The slide bar on the right adjusts the brightness of the image and the slide bar on the left adjusts the contrast of the image. The X axis on the histogram depicts the available range from dark (0, on the left) to light (255, on the right), while the Y axis depicts the number of pixels in the camera field of view at the corresponding gray value. Thus, in the example above, the field of view contains values ranging from about gray value 40 to 235, with peaks at 85, 135, and 180.

You can also see specific gray levels and number of pixels by clicking anywhere inside the histogram. The boxes at the bottom of the histogram display the gray level for that point (0-255), the number of pixels in the image that contain that gray level, and also the percentage of the total number of pixels that contain that gray level. In the example above, clicking on a point within the histogram displayed a gray level of 180. 3302 pixels in the image have this value which is 1.344% of the total number of pixels.

Adjusting Brightness

The Brightness control is used to control the overall brightness of the resultant image. Increasing brightness increases the amount of light transmitted through the film to the camera. Decreasing brightness lowers the light level. The brightness adjustment effectively moves the entire histogram either to the right (brighter) or to the left (dimmer), without having much effect on the range of the gray values used.

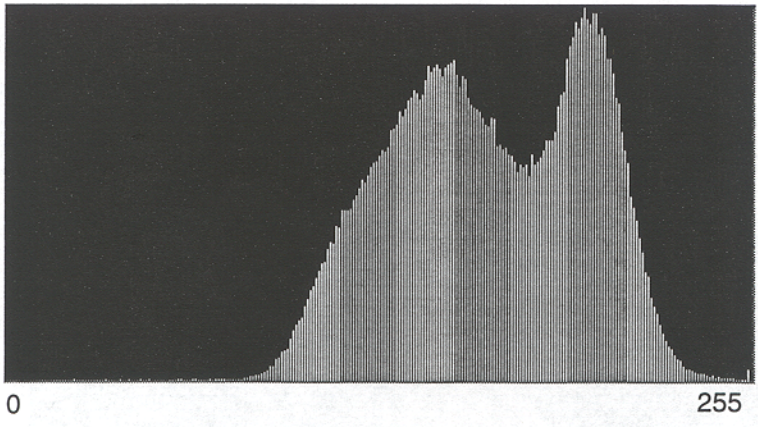


This histogram shows a less than ideal match between the image intensities and the gray values representing the image pixels. Note that no pixels have

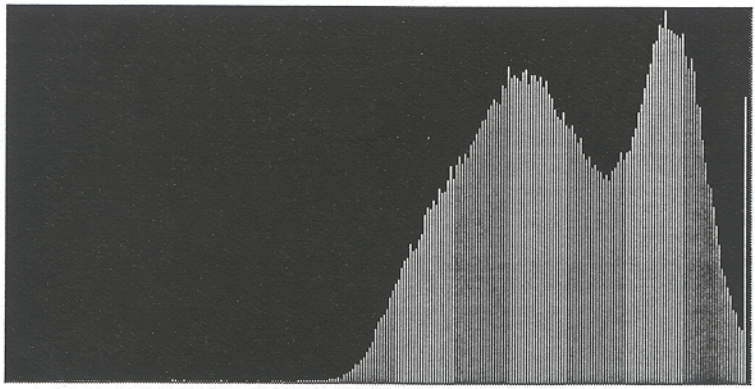
a gray value of 0 or 255, thus reducing the radiometric resolution. To correct this, increase both the brightness and contrast.

To properly set the brightness, first make sure that the resolution is set to the resolution at which you will be scanning. Move the camera field of view to the brightest parts of the image and look at the histogram. Adjust the histogram such that there are just a few pixels with a gray value of 255. The histogram should be just falling off, not peaking. Move the Brightness slider bar up to increase the brightness (sliding the histogram right), down to decrease (sliding the histogram left). If you see a spike at 255, decrease the brightness. If the brightest pixel has a value less than 255, increase the brightness. It is a good idea to check several bright areas on the image, and set according to the brightest one. Be careful to look only at the film and not include any of the empty backlight in the camera field of view.

Note: *Spikes in the histogram can also be caused by dirt or scratches on the film.*



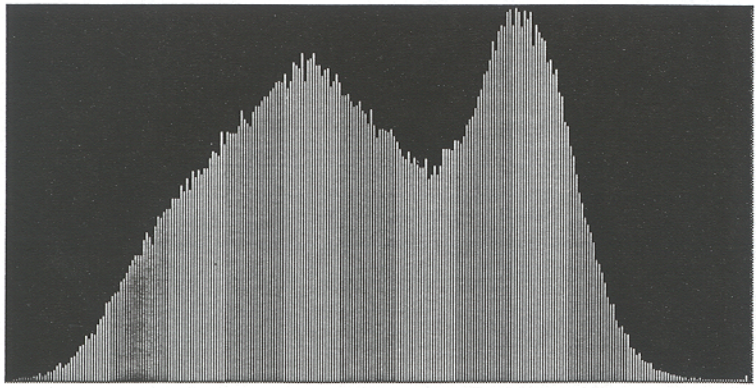
This shows the effect of increasing the brightness. Note that as the right hand side of the histogram is moved towards the right, or 255, that the left hand side moves up as well. This is the proper setting for the brightness control.



This histogram is an image that is too bright. Note the big spike at 255 (the highest gray value). This will result in clipping, whereby bright areas of the image with different brightness levels will all be represented by 255, thus destroying the detail in those areas. To correct this, decrease the brightness. The contrast control may also have to be adjusted, either up or down.

Adjusting Contrast

The Contrast control can be thought of as the "stretch" factor. The Contrast value is the number used to scale the gray value range. Thus, setting it to 1.0 does no scaling and is considered the normal setting. Setting it greater than 1.0 stretches the histogram, away from the gray value 255. For example, assume that the Brightness control is set so that the brightest gray value in the image is 255. Assume that with the Contrast set to 1.0, the darkest gray value is 35. The goal is to stretch or rescale the histogram from the 255 side so that 35 becomes 0. You can also compute the Contrast number by dividing 255 by the original range. In this example, the original range was 255 to 35, for a range of 220. 255 divided by 220 equals 1.13, so you would set the Contrast to 1.13. Be aware that if you stretch the Contrast too much, some values will be clipped at 0.



This shows the effect of increasing the contrast control. Note that the right hand, bright side stays in the same place at 255, and that the left hand side of the histogram get stretched towards zero. This is the proper setting for the contrast control. The brightness should be adjusted first.

To set the Contrast for an image, use the resolution you will use at scanning time. Move the camera field of view to the darkest parts of the image and look at the histogram. Move the Contrast slider bar up to increase the contrast, down to decrease.

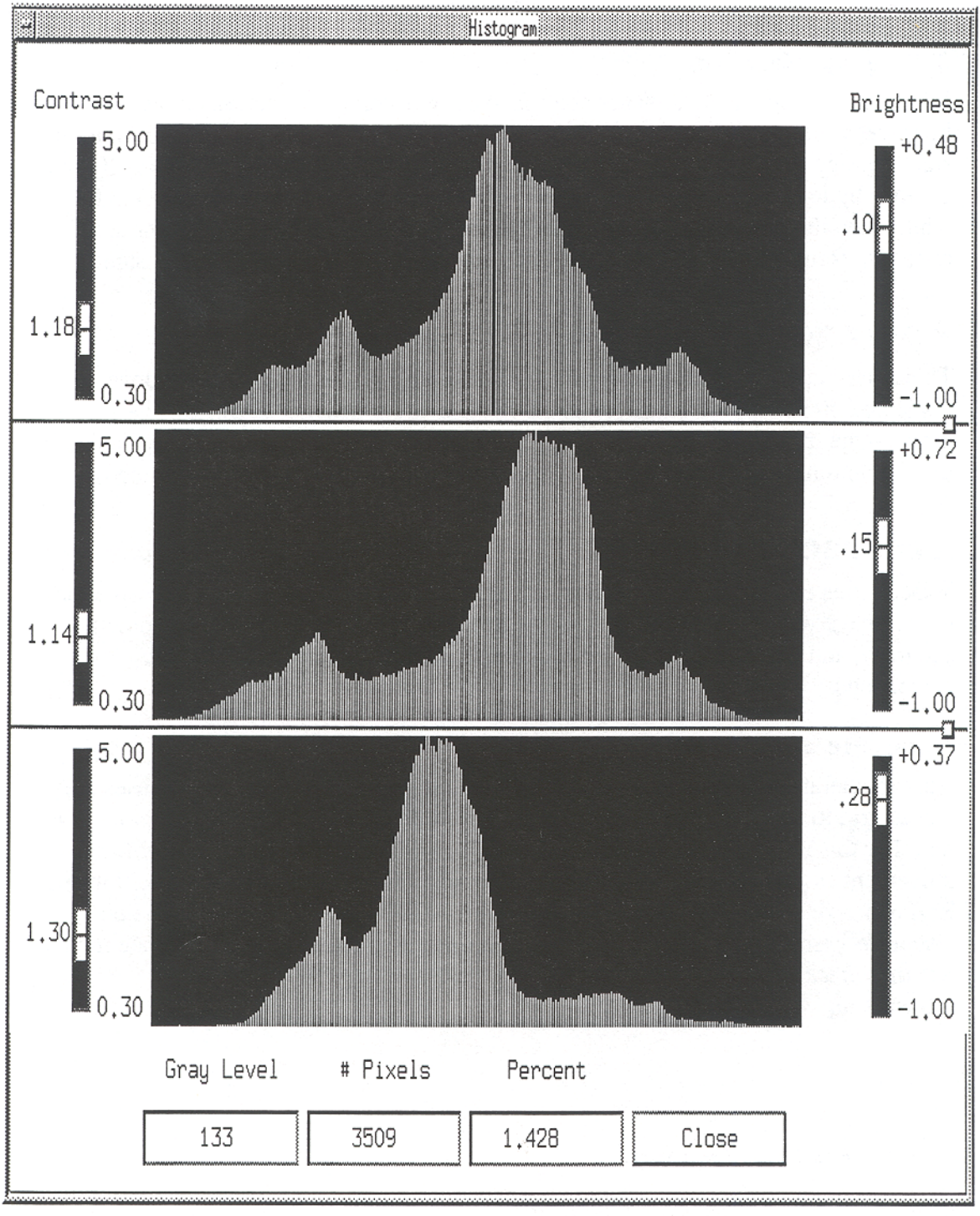
Setting the Contrast to a value less than 1.0 will shrink the histogram to the right toward 255 so that the gray value zero will map to something greater than zero. For example, if you set the Contrast to 0.97, 0 will map to 255 minus (255 times 0.97) or 7. With this setting, there will be no gray values less than 7 in the resulting digital image, regardless of how dark the image is. Thus, setting the Contrast to a number less than 1.0 actually shrinks the output gray value range and would rarely be desired.

Color Histograms

Setting the Brightness and Contrast controls becomes a little more complex when working with color images. To set the Brightness, follow the same steps you would for black and white except look at something white and bright. If there is nothing white, you will have to set it by eye by looking at the preview image. Set all three brightness values such that the peaks line up about the same gray value for optimum color balance. It is common for the three brightness settings to be different. Make sure

that the image is not saturated (i.e. there is no spike at 255 in any histogram). To set the Contrast, go to the darkest area and proceed as with black and white except you should set all the Contrast controls to the same value (use the smallest individual setting). If you do not do this, areas of different opacities on the film would have different color balances. This would mean, for example, that a gray step wedge could be greenish in the bright areas, white in the middle areas, and red in the dark areas.

Note: *Every time a value in the current scanner settings is changed, the image is regrabbed. This regrabbing process is slow in color. For faster results in color, set the values in the Brightness/Contrast boxes in the Current ROI Settings, not in the histogram, and then apply to the scanner.*


Histogram
Contrast
Brightness
5.00
1.18
0.30
+0.48
.10
-1.00
5.00
1.14
0.30
+0.72
.15
-1.00
5.00
1.30
0.30
+0.37
.28
-1.00
Gray Level
Pixels
Percent
133
3509
1.428
Close

Setting up Negatives

In negative mode, the radiometric controls behave differently. Increasing the brightness shifts the histogram to the left, and increasing the contrast stretches it to the right. For color negatives, setting the color balance can be difficult, and generally must be done by looking at the preview image. If a black area in the film is known to be white, then the histogram peaks can be lined up using the brightness and contrast controls. Remember that in color, all three contrast values should be set the same.

Apply to ROI

This button applies all of the Current Scanner Settings to the Current ROI above. As explained previously, changes you make to the Current Scanner settings while you preview the image are not automatically used when you scan. You must use the Apply to ROI button to apply those settings to the Current ROI for the actual scanning.

Accuracy

Vxscan uses two different toggle buttons for determining whether to apply corrections to the image while you preview: Accurate or Approximate modes control geometric accuracy, and Corrected or Raw modes control the application of radiometric corrections.

Accurate and Approximate Modes

Vxscan operates in two modes, Accurate and Approximate. Accurate mode uses the reseau grid to accurately determine the camera position, while Approximate mode does not. For this reason, use the Approximate mode while roaming and zooming for faster movement as you preview an image. Use the Accurate mode to precisely position your ROI rectangles relative to the film or when you establish photo coordinates. You can also have vxscan remind you with a message whenever you are not in Accurate mode. See the *Check Location Accuracy* section in the *Menu Bar* chapter for more information.

Corrected or Raw Modes

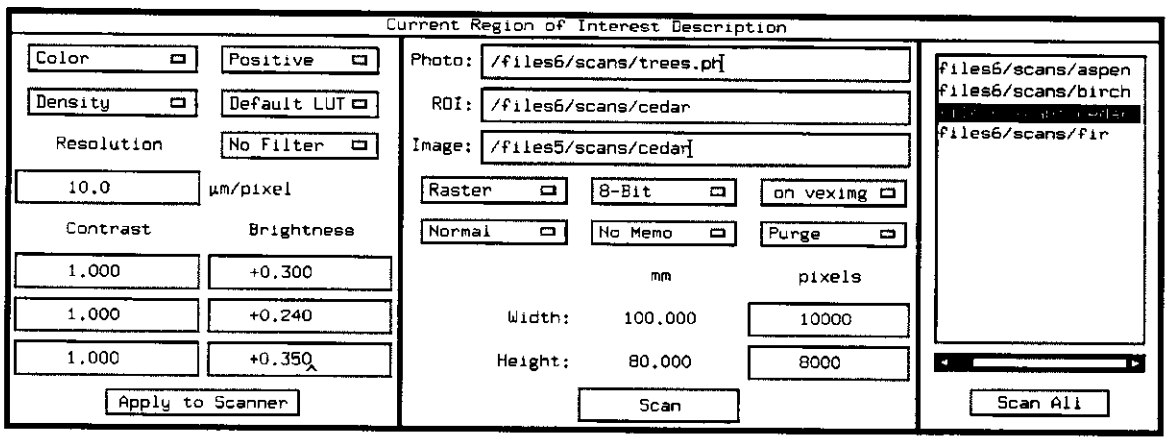
The **Corrected/Raw** selection box is used to choose whether or not you want vxscan to apply radiometric corrections to the image as viewed on the image monitor. With the **Corrected** mode, vxscan applies the radiometric calibrations to correct the image. This includes applying all the current radiometric settings and calibrations to correct for backlight and lens fall-off distortions. With the **Raw** mode, vxscan does not perform these corrections, making it especially useful when working with color images where the corrections take more time. Use **Raw** for faster camera movement during random viewing. Use **Corrected** for a more accurate preview and for determining brightness and contrast settings.

Color Monitors and Color Balance

When working with color images in Corrected mode, adjustments to any settings which change the scanner state, such as Contrast/Brightness, require vxscan to not only recalculate all of the radiometric settings, but also perform color dithering on the image. Dithering is necessary because the scanner scans using a range of 16 million colors, while display monitors and their associated image processing boards only have the capability for 256 colors. This dithering process takes time and will alter the spatial resolution that you see on the image monitor. If you wish to see the preview image more quickly, turn off the Corrected mode (use Raw).

Current ROI Description

The settings within the Current Region of Interest Description are similar to the Current Scanner Settings with the major difference that the Current ROI settings are those actually used at scanning time, whereas the Current Scanner Settings are for making adjustments while previewing the image.



Resolution and Radiometric Controls

The resolution and radiometric controls are the same in the Current ROI Description as they are in the Current Scanner Settings with the following exceptions. The Resolution control does not display a separate dialog box with slider controls. Instead, you have only the option of entering a specific resolution value in the text box. Similarly, the Contrast and Brightness controls provide only text boxes for entering specific values.

Apply to Scanner

This button applies all of the settings within the Current Region of Interest Description to the Current Scanner Settings. Changes you make to the Current ROI Description are not automatically used by the Current Scanner Settings when you preview the image.

You must use the Apply to Scanner button to apply those settings to the Current Scanner Settings in order to preview the changes on the image monitor.

File Names

Each Region of Interest has associated with it the name of the Photo file to which it belongs, an ROI name, and an Image name. The use and conventions of each of these file names is described below.

Photo File

A Photo File name can be assigned to each photo that is mounted for scanning. Within each Photo File, one or many Regions of Interest (ROIs) can be defined, each with a specific ROI File name. In addition, multiple Photo Files can be viewed and used at one time. Each Photo File has a system name with a .ph extension and an optional description called a Photo ID. New Photo Files may be named anything you want, as long as they follow UNIX naming conventions and have a .ph extension. Photo Files do not need to be saved in order to scan an image, but you must save Photo Files if you want to preserve the scanning parameters and any digitized points.

When you open an existing Photo file, all of the Regions of Interest for that Photo file are displayed in the list of regions on the right. The name of the current Photo file is displayed in the **Photo** description field and the name of the currently selected Region of Interest is displayed in the **ROI** field. You can open as many Photo files as you want, each with varying numbers of ROIs.

Default Photo File

Vxscan uses a default Photo file, default.ph, when the application is first started. This default file can be used to store scanning parameters that are used often. For example, if you are scanning a set of images that all use the same resolution, contrast, and brightness settings, those settings can be stored in the default.ph file, saving you time when you scan each image. Because default.ph is an actual Photo file, you must save it as you would any other Photo file in order to save your default scanner parameter settings. The default.ph file must be located in the current working directory from

which you run vxscan to be used as a default file, otherwise, vxscan uses the system defaults.

Note: *Loading a Photo File changes the Current ROI to be the first ROI in the Photo File, and changes the ROI Settings appropriately, but does not affect the Current Scanner State. The .vxscanrc file specifies the Current Scanner State when the vxscan user interface first begins.*

ROI Files

Scanned regions are stored in directories that are created using the file name specified in the **ROI** field. This directory is where tiles, information files, and, if you do not specify a directory name in the **Image** field, formatted images are stored. For example, if you specify */directory1/region1* as the ROI name, an image directory called *region1* is created under the directory */directory1*. */directory1* must already exist and have write permissions. The scanned regions are given file extensions to specify the type of image file. See *File Naming Conventions* for the extensions that vxscan assigns. Vxscan uses the default ROI directory name, **Untitled**, until you supply one. If you decide not to supply an ROI file name and use the default name of **Untitled**, a directory called **Untitled** is created in your current working directory when you scan.

Note: *Images can become very large, and scanning in color requires three times the amount of disk space as a monochrome image, so select directories accordingly.*

To name the current Region of Interest,

1. Click on the **ROI** input field. Use the Backspace or Delete keys to delete any existing name such as "Untitled."

2. Type a full path name (if different than the directory in which you are working) followed by the new directory name for the Region of Interest. The name appears in the list of regions on the right when you click outside the text field or press <Return>. Vxscan checks to see if you have write permission for the given directory.

Note: *All systems shipped prior to August 1993 have a maximum ROI directory name of eight characters.*

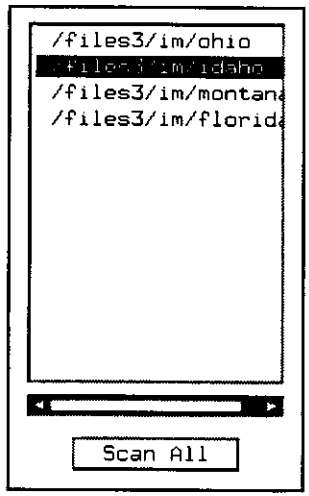
Image Files

Because of the potentially large size of scanned image files, you have the option of storing the raw scanned tiles in a different location than the final formatted image or Photo File itself. The **Image** field is an optional directory where the final formatted scanned images are stored separately from the raw scanned tiles. The directory specified must already exist. Vxscan creates a sub-directory in the specified image directory which has the same name as the ROI directory name. If you do not enter a different directory name in this field, the formatted scanned images are stored in the same directory that you have specified in the **ROI** field.

Vxscan also allows you to specify a remote *host* machine on which the formatting software executes. The formatting process will run much faster if the image directory is a directory on a disk resident on the formatting host. See *Host Machine* in this chapter for more information.

List of Regions

Within the Current Region of Interest area, the list of regions displayed on the right are either ROIs that you have created or ROIs contained in an existing Photo File. If you have more than one Photo File opened, all of the regions from all of the Photo Files are listed in Photo File order.



File Naming Conventions

Although you provide the Photo file, ROI and image names, vxscan appends certain file extensions when storing the scanned images. Every scanned image is assigned an information header file using the extension, .rh. Every raw tile is a file which has its tile number appended. For example, region1nnmm.w, where

nn = tile number in x (across)
mm = tile number in y (down)
w = the color channel (monochrome in this example)

In the example above, a monochrome image has the extension .w appended. When you select color scanning, the three color bands - red, green, and blue - are stored in separate files as tiles, but the resultant image may be stored in a single file if BIF (band interleaved) is selected. Color image tiles have the extensions .r, .g, and .b appended. In addition, each of the formats has its own extension appended, such as .bsf or .bif.

For example, a monochrome scan in a BSF (band sequential file) format would have the following files:

region1.rh
region1.bsf.w

The following example is a color (RGB) scan in BSF format:

region1.rh
region1.bsf.r
region1.bsf.g
region1.bsf.b

File Processing and Storage

Vxscan uses several settings in the Current ROI Description to determine how the image will be processed and stored: format, bit-depth, host machine, and whether the raw tiles are purged or preserved.

Format

Vxscan has several formats in which the scanned images can be stored.

- **Native** - raw tiles, not yet formatted together.
- **Raster** - Sequential pixels, column major order. Band sequential or band interleaved determination is based on bit depth as specified below.

Bit Depth

In addition, vxscan provides choices of bit depth, either **8-bit** or **24-bit**. **8-bit** is used for either monochrome images or band sequential color. **24-bit** is for color images which are to be formatted as band interleaved by pixel.

Formatting Host

Because formatting scanned images can take more time than the scanning process, depending on the capabilities of the formatting host, vxscan allows you to designate a remote host machine on which the formatting software executes. The selection box just to the right of the bit depth box lists the available machines. In most system

configurations, greatest speed will be achieved by selecting the host on whose disk the resultant image data is to reside. See the *Setup and Calibration* chapter for information on setting up host machines.

Purge or Preserve

Vxscan provides the option of saving or deleting the raw scanned tiles. Because the tiles can take up a large amount of space, you can choose to have them deleted as the image is formatted. **Preserve** saves the tiles in the directory you designate in the ROI field. **Purge** deletes the tiles while the image is being formatted, and is generally the desired choice.

Memo

The Memo field can be used to type in descriptive information or comments about the current Region of Interest. This is helpful in keeping track of scanned images because the ROI file name may be too short and the scanning parameters not descriptive enough to clearly identify the region. The memo information is stored in the saved Photo file.

Region of Interest Size

The current Region of Interest's size is determined by three variables:

- Resolution (in micrometers per pixels or dots per inch)
- Size (in inches or millimeters)
- Size in pixels

Changing any of these variables will affect the others. For example, if you change any one of the variables either by typing in values or by rubberbanding the ROI rectangle, the other values will change accordingly.

One of these three variables is calculated from the other two, and may not be specified dynamically. For example, if you select Resolution for automatic calculation, you can alter the size of the Region of Interest in inches or millimeters and the size in pixels. Vxscan will then automatically calculate the resolution. You can select which one of these variables vxscan will automatically calculate for you by setting the Auto Calculate

Dimension in the vxscan Preferences selection box under the Options menu. See *Options Menu* in the *Menu Bar* chapter for more information.

Millimeters/Inches

Millimeters or Inches specifies the width and height of the scanned area. This dimension is measured either in metric with millimeters or in English with inches, according to the units you select in the vxscan Preferences selection box.

Pixels

Pixels specifies the size of the scan area in pixels.

Scanning

If you have created multiple ROIs, you can either scan them one at a time or all at once in sequential order.

Before scanning, make sure you have:

- Defined the Regions of Interest and supplied an ROI name for each.
- Set all of the scanning parameters in the Current Region of Interest area for each region you are scanning.
- Saved the Photo file if desired. (You can also do this after scanning.)
- Reflected all desired preview settings from the Current Scanner Settings to the Current ROI by using the **Apply to ROI** button.
- Estimated the approximate size of the scanned image(s) and provided adequate disk space.

Scanning a Single ROI

1. Select the area you want to scan (if there is more than one region listed) by clicking either on the ROI rectangle in the Backplane Representation or on the name of the

region in the list of regions. The ROI name will be highlighted and its rectangle drawn in red.

2. Select **Scan**. The vxscan Working window appears, providing messages about the progress of the scan. An information request window appears when the scanner has finished scanning to inform you that the scan is complete.

3. Select **OK.**

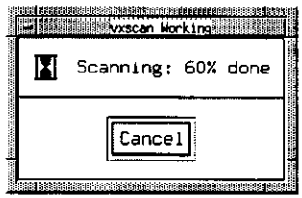
Scanning Multiple ROIs Sequentially

1. First make sure to delete or close all unwanted ROIs and Photo files including default.ph and Untitled.

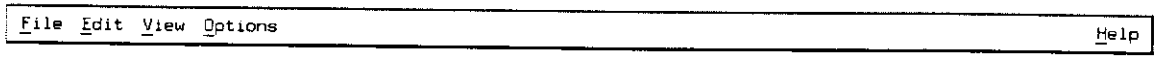
Note: *Every open Photo file must have at least one corresponding ROI. Therefore, if you delete the last ROI for a Photo file, vxscan will generate a new ROI using default parameters. You must close the Photo file to remove the last ROI.*

2. Select **Scan All**. The scanner scans all of the areas in the list of regions in the order in which they appear. The system highlights the area it is currently scanning and displays the vxscan Working message box providing messages about the progress of the current scan.

Note: *At any time after you have started to scan, you can stop the scan by selecting the* ***Cancel*** *button within the small "Working" box. Depending on the image being scanned, the scanning process may take a moment to stop.*



Menu Bar



The menu bar displays four pull down menus and a help menu. Located within the pull down menu items are options to create and save files, to digitize points, to control the behavior of vxscan, and to exit the application.

File Menu

The File menu, located under the menu bar, contains the following options:

New
Open
Close
Save
Save As
Exit

These options allow you to create or alter Photo files, custom LUTs, and the initialization file, .vxscanrc. The File menu also has the option of exiting from vxscan.

New

The New option creates a new Photo file in addition to any existing ones. New changes the current ROI to be the first ROI in the newly created Photo File, using the ROI values from the last ROI in the previous Photo file. When you select New, you will see **default.ph** assigned as the default Photo file name and **Untitled** as the new ROI name.

Open

When you select the Open option, you have two choices:

Photo
Custom LUT

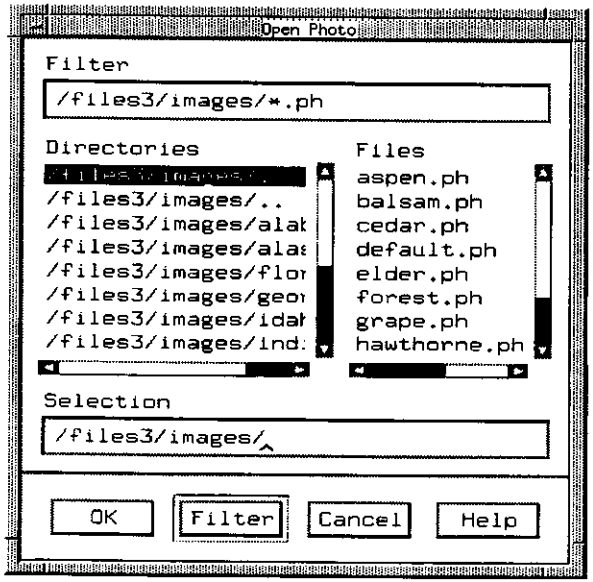
Selecting **Photo** allows you to open a previously saved Photo File. When you select a Photo file name using the file selection box, the scanning parameters for the first ROI stored in that file appear in the Current ROI Description, and additional scan areas that were previously defined appear in the list of ROIs.

Selecting **Custom LUT** allows you to choose a previously created custom look-up table (LUT) that will "map" the scanned image values to alternate values.

By using Open/Custom LUT/Monochrome,Red,Green,Blue, you can load a LUT for each color channel. If a LUT has already been loaded for a given channel, it will be closed and replaced. Close/Custom LUT/Monochrome,Red,Green,Blue removes the association between a LUT and a color channel. For more information about how LUT files are used, see the *Lookup Tables(LUT)* section.

File Selection Box

When you open, or save as, a file, a file selection box appears with the following fields.



Filter
The Filter box displays the current directory filter being applied to this directory name search. The Filter determines which file names will be displayed in the Directories box. The Filter uses regular UNIX naming conventions.

To start the search using the filter,

1. Click in the Filter box and type the directory where you think the file is located, an asterisk, and the extension if one exists. Use the Backspace and Delete keys if necessary. The asterisk is used as a wild card so that *any* file with that extension within that directory will be displayed.

2. To make the Filter take affect, click on the **Filter** button at the bottom of the box. You can also press Return instead.

Directories
The Directories box lists all the directories which reside below the specified directory in the filter box. To scroll through the list of directories, click on either the up and down arrows. To see the entire path, click on the left or right arrows.

To select a directory, use one of the following:

- Double click on one of the directories listed in the Directories box to highlight it and the Files box then lists those files for the directory you selected.

- Click on the directory you need and press the Filter button.

To go up one directory the directory tree, double click on the directory name which is followed by two dots (/files3/images/.. in the above example).

Files
The Files box lists the files in the specified directory that match the filter.

To select one of the files in the Files box,

Click on one of the files in the Files box. That file name appears in the Selection box.

Selection
The Selection box displays the current file you have selected. You can either use the Filter, Directories, and Files boxes to search for and select a file, or if you already know the name, you can type it directly into the Selection box.

Close

The Close option closes the current Photo file. If you have made changes without saving, you will be prompted to save your changes. When you close the last Photo file you opened, the default Photo file, default.ph, will remain along with the default ROI, "Untitled." (If there is no default.ph, the system program defaults are used.)

Save

The Save option saves either the current Photo file or the .vxscanrc file. If you are using an existing Photo file when you select the Save option, all changes are saved to

that file. The Save option saves the current Photo file to the name listed in the Photo file name box.

The .vxscanrc file is a startup file that contains the desired state of the scanner parameters when vxscan begins. To create and save a .vxscanrc file, correctly set all the settings in the Current Scanner State area and then select Save/.vxscanrc. The settings will be saved in the .vxscanrc file in your home directory and will be used as the initial setup state next time vxscan is started.

Save As

The Save As option saves a Photo file to a new file name so that you can create another file while preserving the original file. The new Photo file name is specified in a File Selection Box, which is described above. Save As only works with Photo files, not with the .vxscanrc file.

Exit

The Exit option exits vxscan and returns to the UNIX prompt. A window may appear prompting you to save any changes you may have made to the Photo file. This option also shuts down the scanner. It is recommended that you always exit vxscan in this way. Exiting either via the X Window's window manager menu or other termination methods prevent the application from properly terminating remote processes (e.g. vxformat), and may have undesirable effects on the scanner controller state.

Edit Menu

The Edit menu, located under the menu bar, contains the following options:

New ROI
Delete ROI
Release Point
Delete Rectangle
Photo Info
Acquire Points
Acquire Centers

New ROI

The New ROI option creates a new Region of Interest in the current Photo File. When you select New ROI, a new ROI appears with the name **Untitled.** The new ROI uses the settings such as resolution and saturation from the previous ROI. See the section, *Naming a Region of Interest* in the previous chapter for information on changing the ROI name. See *Drawing an ROI Rectangle* in the Current Scanner Settings chapter for more information on positioning the new ROI. Also see *Resolution and Radiometric Controls* for information on changing the ROI parameters.

Delete ROI

The Delete ROI option deletes the current ROI, including the name, any parameters you have set, and the ROI rectangle.

1. First make the ROI you wish to delete the *current* ROI by either highlighting the ROI name in the list of regions or clicking on the rectangle in the Backplane Representation.

2. From the **Edit** menu, select **Delete ROI.**

Note: *You cannot delete the last ROI in a photo, as each Photo file must contain at least one ROI. If you attempt to do so, a new ROI will be created with the default parameter settings.*

Release Point

This option releases the currently active point on the current ROI rectangle.

1. First make sure that the point you want to release is currently active. If not, click on the point to make it active. The current point is drawn in red, others are drawn in magenta.

2. From the **Edit** menu, select **Release Point.** The point is deleted and the rectangle is recalculated based on the remaining points or the indicated size.

Delete Rectangle

The Delete Rectangle option deletes the current ROI rectangle in the Backplane Representation. Only the rectangle position is deleted, not the ROI itself.

1. Make sure the rectangle you want to delete is current. The current ROI rectangle is drawn in red, other rectangles are drawn in magenta.

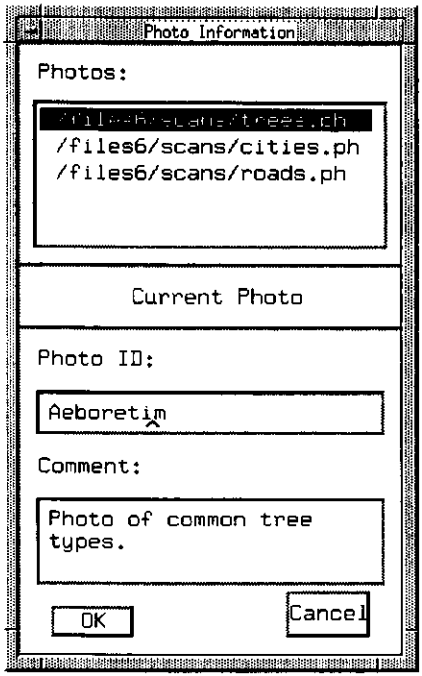
2. From the **Edit** menu, select **Delete Rectangle**.

Photo Info

The Photo Info option is used to assign a Photo ID and additional comments to a Photo File. This is helpful in keeping track of scanning projects because a Photo File's name may be too short to clearly identify the Photo File. Using the Photo ID field and the comments field can help you further identify files.

To assign a Photo ID or change an existing one,

1. From the **Edit** menu, select **Photo Info.** The following selection box appears:



The top portion of the box shows you the Photo file names of all of the open Photo Files.

2. Click on the Photo file name you want to look at or change.

3. Click in the Photo ID field and type in a new Photo ID (or change the existing one).

4. You can optionally click in the **Comment** field and type in comments.

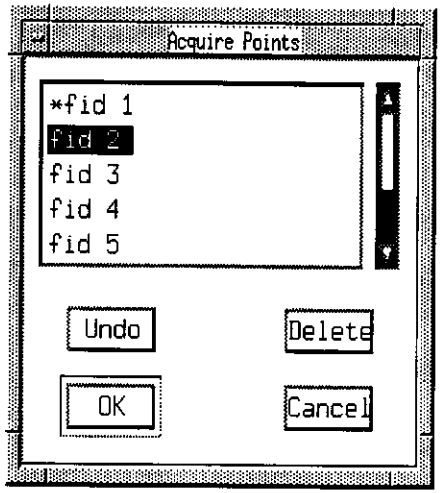
5. Select **OK**.

Acquire Points

The Acquire Points option is used to digitize points of interest on an image and save them along with the scanned image for later post processing.

To digitize points,

1. From the **Edit** menu, select **Acquire Points.** The following selection box appears:



2. Highlight a point of interest in the list, for example, "fid1" (fiducial).

3. Move the camera and zoom to the resolution required for your application over the point you want to digitize.

4. Digitize the point using the left mouse button. An asterisk appears next to the point name listed in the Acquire Points box.

5. Continue using the above steps to digitize additional points.

   Undo simply undoes your last action, a delete or an undo.

   Delete deletes the current (highlighted) digitized point.

   Cancel exits the Acquire Points box without preserving any digitized points.

6. When you are done digitizing, select **OK.**

Note: *Digitized points are stored in the Photo file and are only saved if you save the Photo file prior to exiting vxscan.*

Post Processing

When points are acquired in vxscan the point names and corresponding X and Y coordinates are stored in the photo file and can be used in post processing. Points are stored in both scanner coordinates (microns from the upper left hand corner of the scanner) and in photo coordinates. You can also write your own software to read data from the Photo files. Vexcel Imaging can supply a library of C functions which you can call to access the information. See the Vxinfo Documentation manual for more information on how to use these utilities.

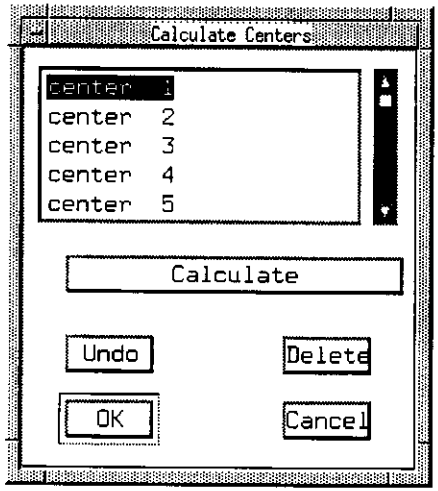
Acquire Centers

The Acquire Centers option is similar to Acquire Points but gives you much greater accuracy than hand digitized points. Acquire Centers calculates the center of each point to sub-pixel accuracy of one-tenth of a pixel. Acquire Centers is used as part of the geometric accuracy test for the scanner and gives you confirmation that the scanner is working properly.

The Acquire Centers computation requires that the points be centrally symmetric and light-colored against a darker background. The pug holes (circular holes drilled in the film emulsion) use by many photogrammetrists meet these requirements. Poor contrast or not symmetrical points could cause vxscan to miscalculate the point.

Note: *Always use the highest resolution possible when acquiring centers and make sure that the Current Scanner State is set such that the points you will be capturing with Acquire Centers have high contrast.*

1. From the **Edit** menu, select **Acquire Centers**. The following selection box appears:



2. Highlight a point of interest in the list, for example, "center1".

3. Move the camera and zoom to the resolution required for your application over the point you want to digitize. You will see a green box on the image monitor which you can resize over the point by moving the upper left and lower right corners. This box is used to constrain the area that vxscan uses for calculating a center. The box narrows the search region, isolating the point from other radiometric highs.

4. Press **Calculate** to find the point value. A plus sign (+) is displayed on the image monitor confirming the point and an asterisk appears next to the point name listed in the Calculate Centers dialog box.

5. Continue using the above steps to acquire additional centers.

   Undo simply undoes your last delete or undo.

   Delete deletes the current (highlighted) digitized point.

Cancel exits the Calculate Centers dialog box without preserving any digitized points.

6. When you are done acquiring centers, select **OK.**

Note: *Acquired centers are stored in the Photo file and are only saved if you save the Photo file prior to exiting vxscan.*

Like Acquire Points, acquired centers are stored in, and can be retrieved from, the Photo file. See the *Post Processing* section above for information on extracting the acquired centers data.

View Menu

The View Menu contains the following options:

Clean
Histogram

The **Clean** option is used when cleaning the reseau glass. The **Histogram** option is used for viewing the histogram representation of the camera field of view.

Clean

This option simply turns off the scanner backlight and turns on the reseau for a fixed period of time to illuminate the glass for ease of cleaning. From the **View** menu, select **Clean**. A message appears telling you how many minutes you have until the backlight comes back on. You can turn the reseau light off at any time by selecting **Cancel**.

Histogram

The **Histogram** option displays a single histogram for monochrome images and three histograms for color images, one each for red, green, and blue. The histogram can also be displayed by selecting the Brightness or Contrast buttons. See the section, *Contrast and Brightness* for complete information on using the Histogram.

Options Menu

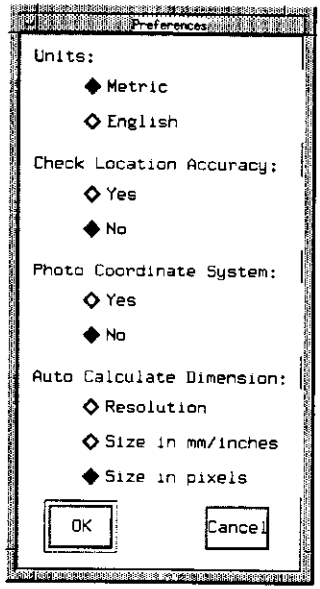
The Options Menu is used for setting system preferences that affect the way you set your scanning parameters and define your Regions of Interest.

Set Preferences

The Preferences option allows you to control various aspects of how the application behaves. With Preferences you set the units of measurement, select a dimension for automatic calculation, and enable or disable Photo coordinates.

To display the Preferences selection box,

From the **Options** menu, select **Set Preferences**. The following selection box appears:



Units

The Units setting determines which units of measurement will be used, either English (size in inches, resolution in dots per inch) or metric (size in millimeters, resolution in µm/pixel). To select a type of unit, click on the toggle button next to the units you want.

Check Location Accuracy

If you select **Yes** for Check Location Accuracy, you will see a warning message box appear when the coordinates positioned are approximate, not accurate. If you select **No**, the messages about accuracy are turned off. See *Accuracy* in the *Current Scanner Settings* chapter.

Photo Coordinate System

Select **Yes** if you want to see the photo coordinate system rectangle displayed in the Backplane representation when defining Regions of Interest. Select **No** if you do not.

The ROI locations and acquired points are stored in both scanner and photo coordinates. Scanner coordinates are in microns from the upper left hand corner of the scanner. A photo coordinate system may be established relative to the film, so that photo coordinates may be used in a post process to tie ROI locations or acquired points back to locations on the film. Accurate photo coordinates require that you be in Accurate mode when establishing the coordinate system.

In the backplane representation, the small box in the upper left corner of the photo coordinate box is the origin of the photo coordinate system and is set to 0,0. The lines at right angles from this 0,0 origin represent the X and Y extents. The 0,0 origin and the X extent of the photo coordinate box can be positioned over a known point on your image such as a fiducial mark. The Y extent is used to determine the handedness of the coordinate system.

Auto Calculate Dimension

Vxscan uses three variables to define the dimensions of an ROI: resolution, number of pixels, and height/width in either inches or millimeters. One of these dimensions is calculated while the other two are defined by the user. The Auto Calculate Dimension

option is used to specify which dimension you want automatically calculated. The two dimensions you do not select for automatic calculation then become variables for which you can enter the information. For example, if you select resolution for automatic calculation, the vxscan window provides input fields next to the size in mm/inches and size in pixels to allow you to type in the information.

Remember that the choice you make for automatic calculation affects your control of those dimensions. For example, if you have selected "Size in mm/inches" for automatic calculation, you will not be able to dynamically resize an ROI rectangle in the Backplane Representation because the system will compute the dimensions for you. Likewise, if you have selected to have the resolution automatically calculated, you will not be able to adjust the resolution, only the size in pixels and the size in mm/inches. See *Region of Interest Size* in the *Current Scanner Settings* chapter for more information about how this option affects your region size.

Appendix A: *Filters*

Image processing hardware in the scanner controller supports high speed convolution of a so-called kernel with an image. The default sharpening kernel for the VX3000 Film Scanner is a 3 x 3 array:

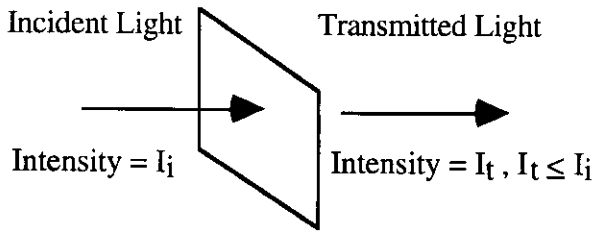
0	-1	0
-1	8	-1
0	-1	0

followed by a division by four. In the process of convolution, this kernel may be thought of as being moved across the image so as to be centered over each pixel. The gray value of each of the nine pixels in the 3 x 3 neighborhood is multiplied by the kernel value on top of it; these products are added together and the sum is divided by four. This is the value of the pixel in the output image which occupies the same position as the one upon which the kernel is centered. This is an example of a high pass filter. It exaggerates differences between neighboring pixels, which is why the kernel is positive in the middle and negative at the edges. The division by four is required to prevent a changed in the average gray level of the image; i.e., $(0 - 1 + 0 - 1 + 8 - 1 + 0 - 1 + 0)/4 = 1$.

The calibration file *filters.cal* is an ASCII file which contains several kernels used in processing scanner images. A knowledgeable user could customize the VL_ENHANCER kernel (the one used when Sharpen is selected) to be a more aggressive high pass filter. However, one should remember that sharpening also enhances noise, graininess, etc. It is recommended that the VL_SHARPEN and the VL_LOWPASS kernels not be modified; they are used to remove artifacts introduced by image resampling.

Appendix B: *Intensity vs. Density Linear*

Suppose we have a transparent filter illuminated by a beam of light:



There are three common measures of the degree to which the filter absorbs light:

(1) Transparency (T) $= \frac{I_t}{I_i}$ $0 \leq T \leq 1.0$

(2) Opacity (O) $= \frac{1}{T} = \frac{I_i}{I_t}$ $1.0 \leq 0 \leq \infty$

(3) Optical Density (OD) $= \log_{10}(0) = \log_{10}\left(\frac{I_i}{I_t}\right)$ $0.0 \leq OD \leq \infty$

Restating the above definitions in words:

(1) Transparency is the ratio between the intensity of the transmitted light and the intensity of the incident light.

(2) Opacity is the reciprocal of the transparency.

(3) Optical Density is the common logarithm of the opacity.

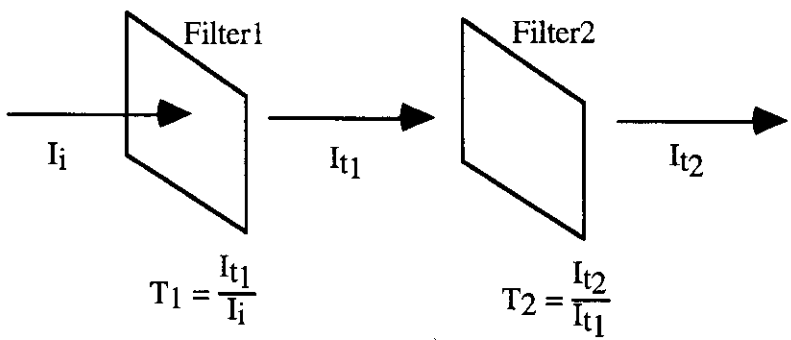
An example: Suppose a filter blocks 50% of the incident light. Then

(1) Transparency $= \frac{0.5\ I_i}{I_i} = 0.5$

(2) Opacity $= \frac{1}{\text{Transparency}} = 2.0$

(3) Optical Density $= \log_{10}(\text{Opacity}) = 0.301$

So, the reason to deal with logarithms (optical density) is because the interactions between multiple optical components which are *multiplicative* in terms of transparency and opacity become merely *addidive* in optical density.



Solving for I_{t2} we get

$$I_{t2} = (T_1 \cdot T_2)\, I_{t_i}$$

So, if we combine two filters which each block 50% of the incident light, what is the transparency of the pair taken together? The first one blocks half the light ($T_1 = 0.5$) and the next one blocks half of what the first one blocks, so $T = 0.5 \cdot 0.5 = 0.25$
Opacity $= \frac{1}{T} = 4.0$ and

$$OD = \log_{10}(\text{Opacity}) = \log_{10}(4) = 0.602$$

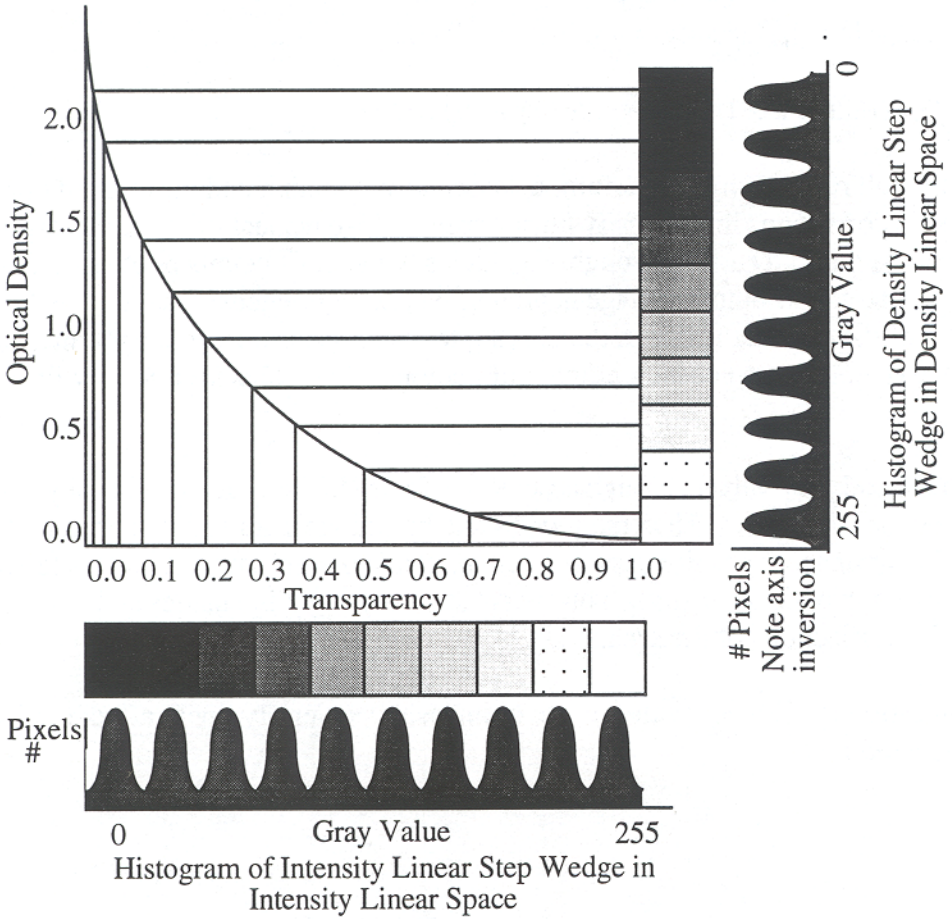
$$OD(\text{Filters } 1 + 2) = OD(\text{Filter } 1) + OD(\text{Filter } 2)$$

This is the full reason why we perform a densemap calibration and make all of our radiometric corrections in a "density linear" space. If we neglect the spectral response of the sensor, the CCD array is roughly an intensity meter (it counts photons striking each of its pixels). If output voltage is proportional to light intensity, and the A/D converter of the digitizer is linear, then each gray value spans the same light intensity difference (i.e., is some constant number of photons wide). This is "intensity linear" space.

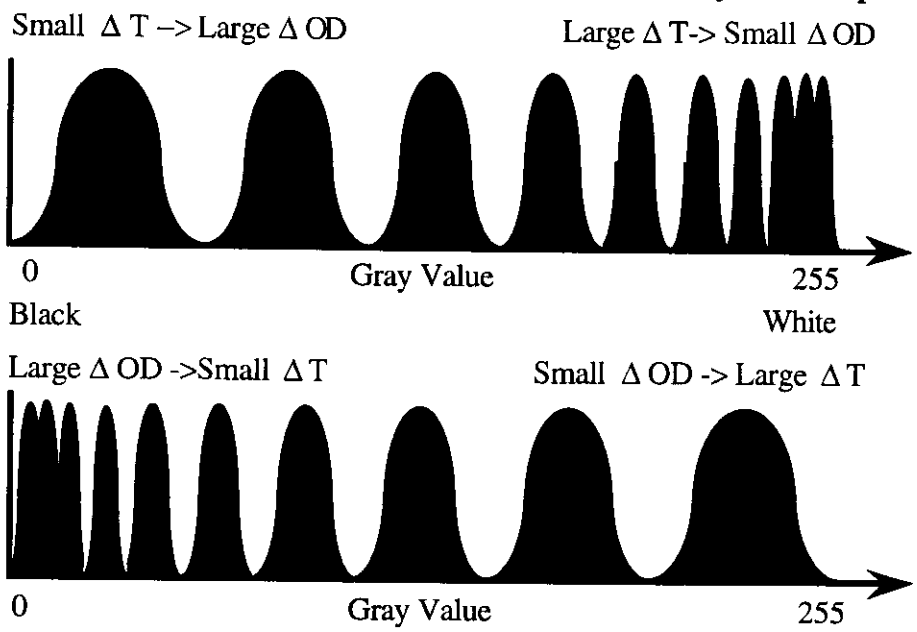
We remap pixel gray values through a Look-Up Table (LUT) called the Density Map to make them density linear. Then fall models and backmodels are simply added to the density-linear image for radiometric correction. (Note that fall models and backmodels are expressed in optical density). This works at all backlight intensities and neutral density filter selections of the scanner.

So the question is: How does the choice of intensity vs. density linear affect the way an image looks?

Intensity vs. Density Linear



Histogram of Intensity Linear Step Wedge in Density Linear Space



Histogram of Density Linear Step Wedge in Intensity Linear Space

Appendix C: *Setup and Calibration*

Setup

Before beginning vxscan, certain UNIX environment variables must be correctly set. Typically, these variables are already set up within the .cshrc file in the user's home directory. If not set properly during the login process, these variables will need to be set from the command line.

The host workstation must grant permission for the scanner controller to use it as an X host. From the host workstation, type:

xhost *controller name*

See the Installation Manual for more information on setting the xhost automatically.

Log on to the controller (must have an account on the controller).
Either add the following commands to the .cshrc file, and then source it, or type them in at the command line:

setenv VX_HOME *value*	(default set at installation: /files/vexcel/cal this is the directory where the mastername file resides)
setenv DISPLAY *hostname*:0.0	
setenv VX_PRINT_LEV *value*	(sets print level; set to 0 for more speed and less printout; for diagnostics, set to 5, for example)

For more information about setting environment variables, see the Installation Manual.

Calibration

The VX3000 scanner must be calibrated before using. See the Installation Manual for more information and contact Vexcel Imaging Corporation before beginning.

During the normal installation and calibration process, a file is modified which contains information about available formatting hosts on the network. Also, at that time, the formatting program vxformat is installed on those hosts, file systems are mounted on the scanner controller, and common accounts are created on both the formatting hosts and the scanner controller. If more hosts are to be added, please see the Installation Manual for further information on how to do so.

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