Error Management in Forensic Digital Imaging … A Resolution for the Entire Criminal Justice Community

(This presentation can be downloaded from www.Foray.com
Training > Tutorials > Presentation-NIST Error Management Symposium)

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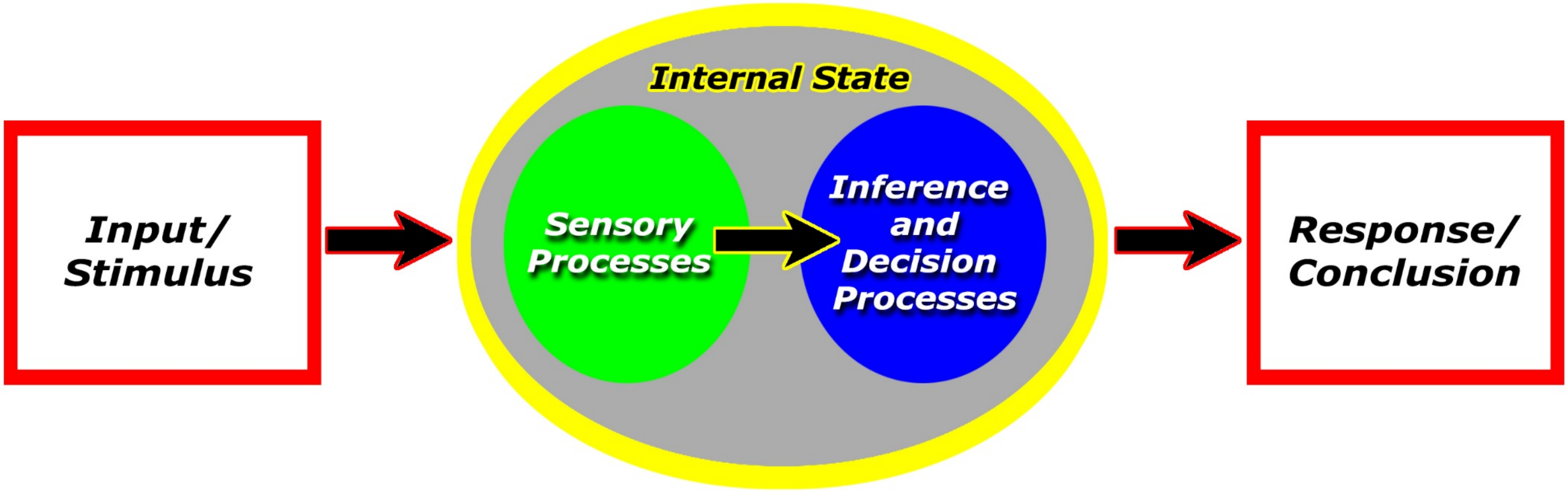
FORAY TECHNOLOGIES

Bias and Uncertainty …

When judgments are made under uncertainty, two general types of errors are possible – false positives and false negatives. A decision maker cannot simultaneously minimize both errors because decreasing the likelihood of one error necessarily increases the likelihood of the other.

(David M. Green & John A. Swets, Signal Detection Theory and Psychophysics, 1966)

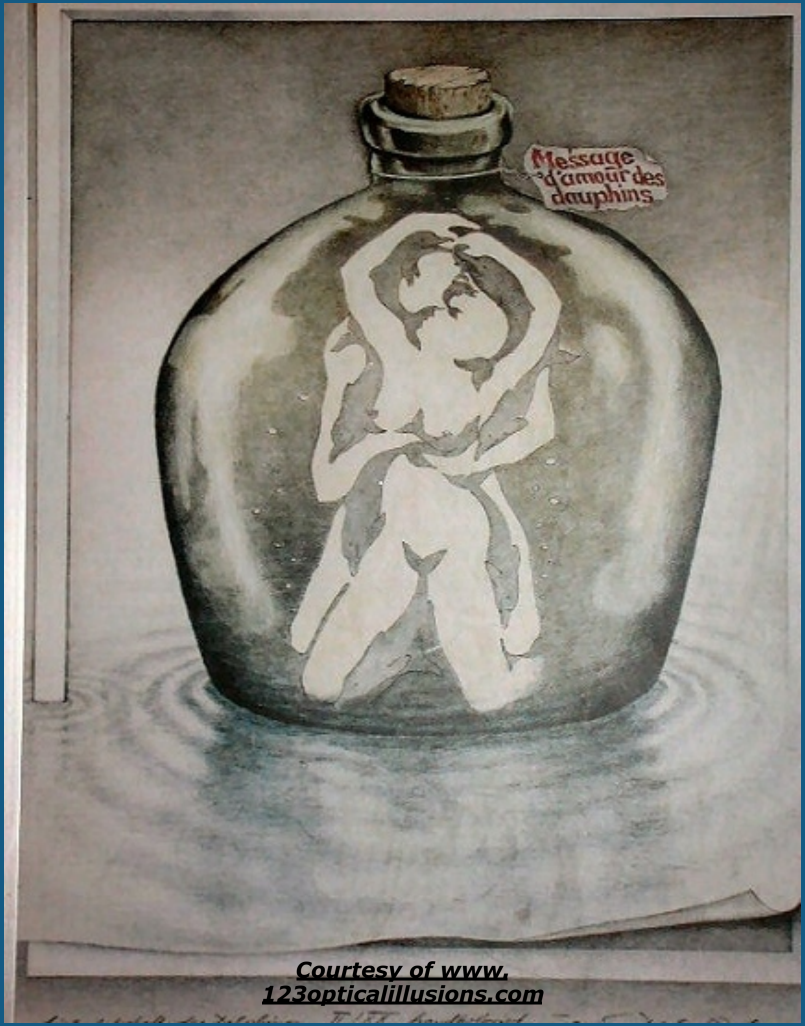
Bias and Uncertainty …



(From Macmillan & Creelman, Detection Theory, 2005)

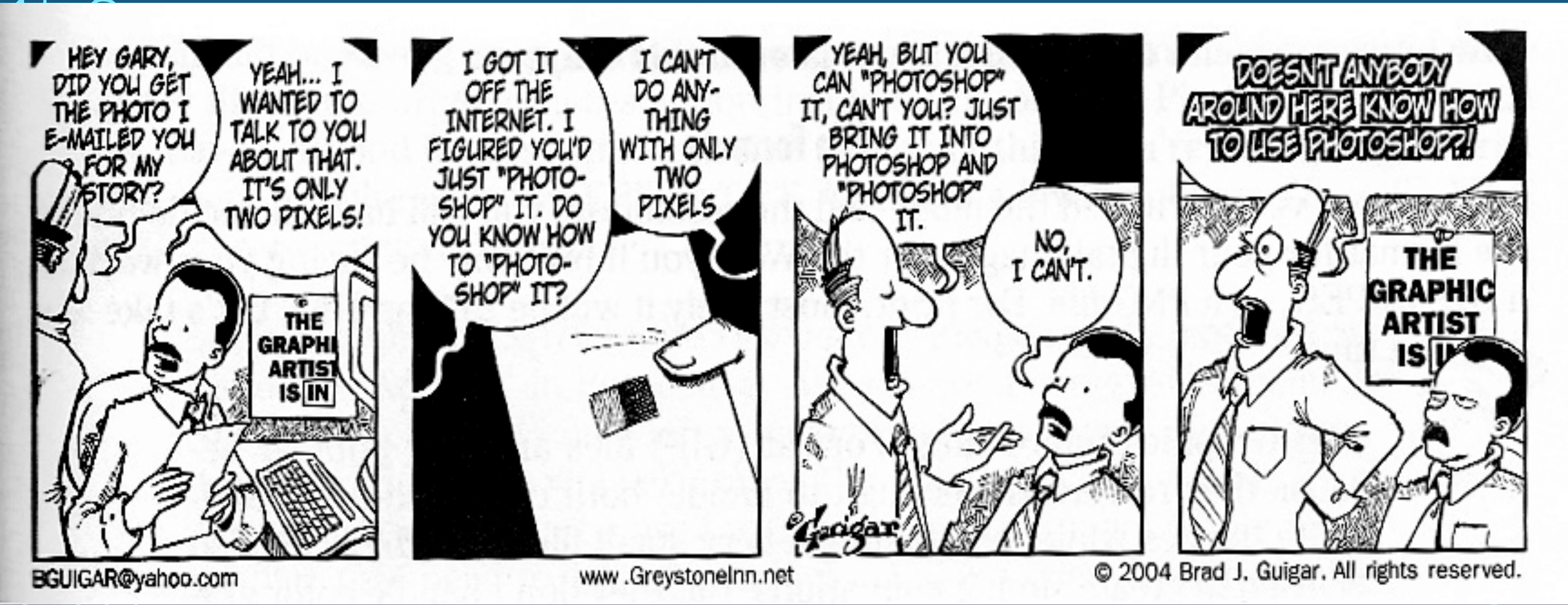
Are YOU biased?

(What do YOU see?)

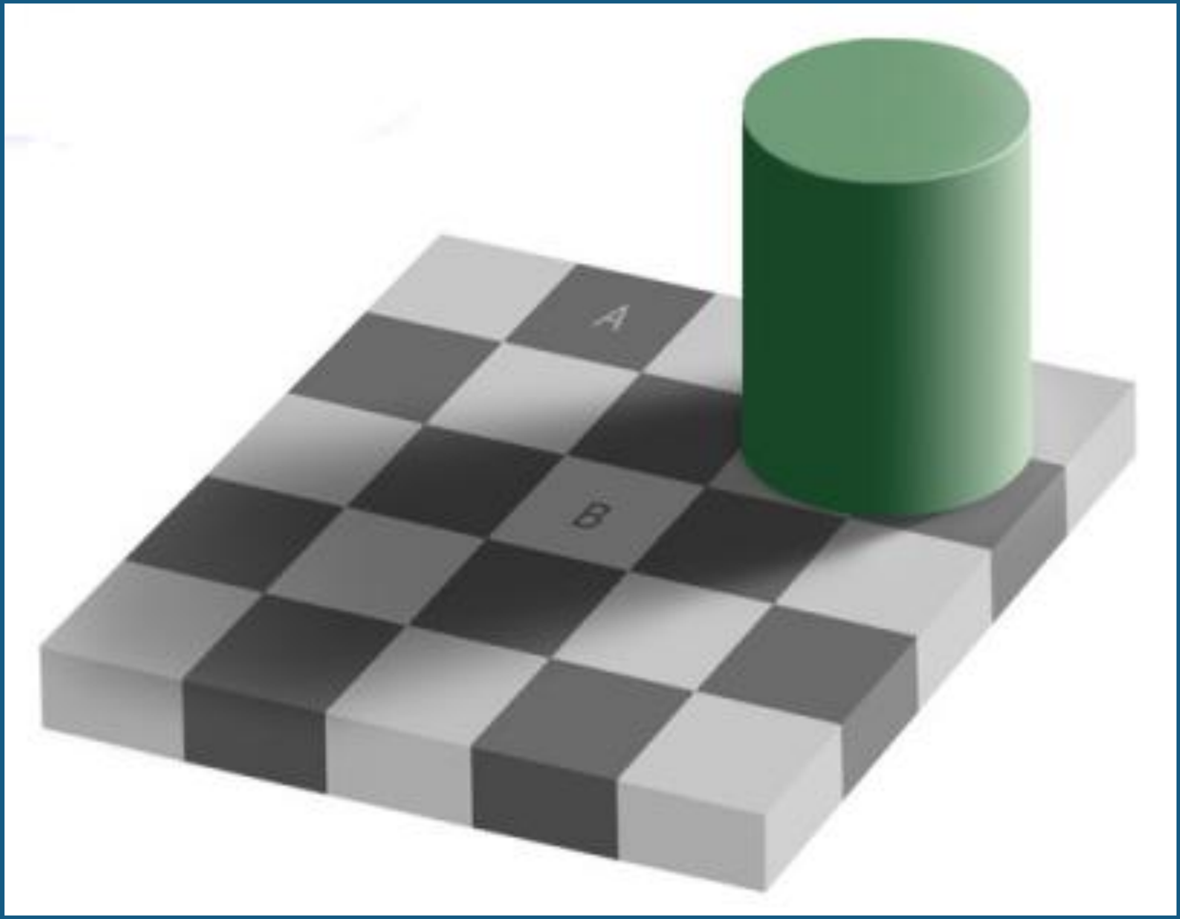


Courtesy of www. 123opticalillusions.com

First, know your limits and the limits of technology…



Are blocks A & B the same shade of gray?



I fought the law …

State of Connecticut versus Alfred Swinton

The Connecticut State Supreme Court conclude that the trial court properly admitted into evidence the computer-enhanced photographs

But improperly admitted the overlays created in Adobe Photoshop because the expert relied on the overlays for his opinion but yet he had “no more than an elementary familiarity” with the program used to create the overlays

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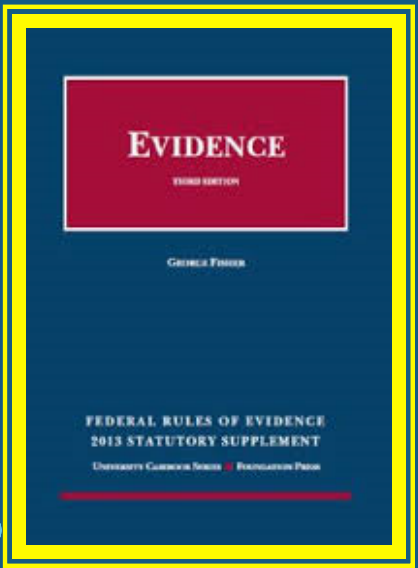
Federal Rules of Evidence …
(aka "Swinton Six")



provide guidance for the acceptance of forensic evidence based upon compliance with standards:

(1) *The equipment is accepted as "standard" in the field*

(2) *Proper procedures were followed*

(3) *Reliable (standard) software programs are used*

(4) *The equipment is in good working order, and*

(5) *The exhibit is properly identified as the output in question.*

(6) *Operated by trained and competent users*

They're only words …

But we must understand some basic technologies and terminologies to develop reliable standards. The most commonly used but misunderstood terms are:

- ***Resolution***
- ***Pixels Per Inch (PPI)***
- ***Dots Per Inch (DPI)***
- ***Samples Per Inch (SPI)***

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To err is human …

Techniques for error management include:

- ***Use appropriate equipment/file formats***
- ***Use appropriate techniques***
- ***Collect standardized data***
- ***Develop standardized reporting***
- ***Extend peer review***
- ***Develop a culture of quality improvement***

CAPTURE ISSUES

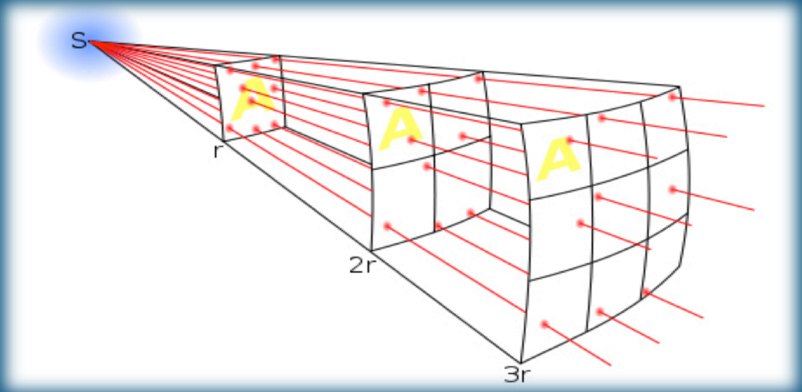
What issues must be managed when photographing an evidentiary object (piece of evidence)?

What is the resolution required to capture minute detail in an object, such as a fingerprint, footprint, tire tread, questioned document, autopsy photo, blood spatter, or other image used for analysis, comparison, and conclusion?

- ***What is the resolution of the camera or other capture device?***
- ***What is the size of the area/object being captured?***
- ***What is the distance from the camera lens to the object being captured?***
- ***What is the lens that is being used?***

The distance …

from the lens to the object may vary, which means the resolution (PPI) will also vary significantly



NOTE: In photography, the inverse-square law means that the resolution is inversely proportional to the square of the distance from the source of that physical field of view.

Validating your computer and software settings …

What are the potential issues that you must consider when validating your camera?

- ***What is the resolution of:***

Of your monitor:

- ***1920 x 1200 pixels***
- ***1680 x 1050 pixels***
- ***1440 x 900 pixels***
- ***1280 x 800 pixels***
- ***1024 x 768 pixels***

Of your image:

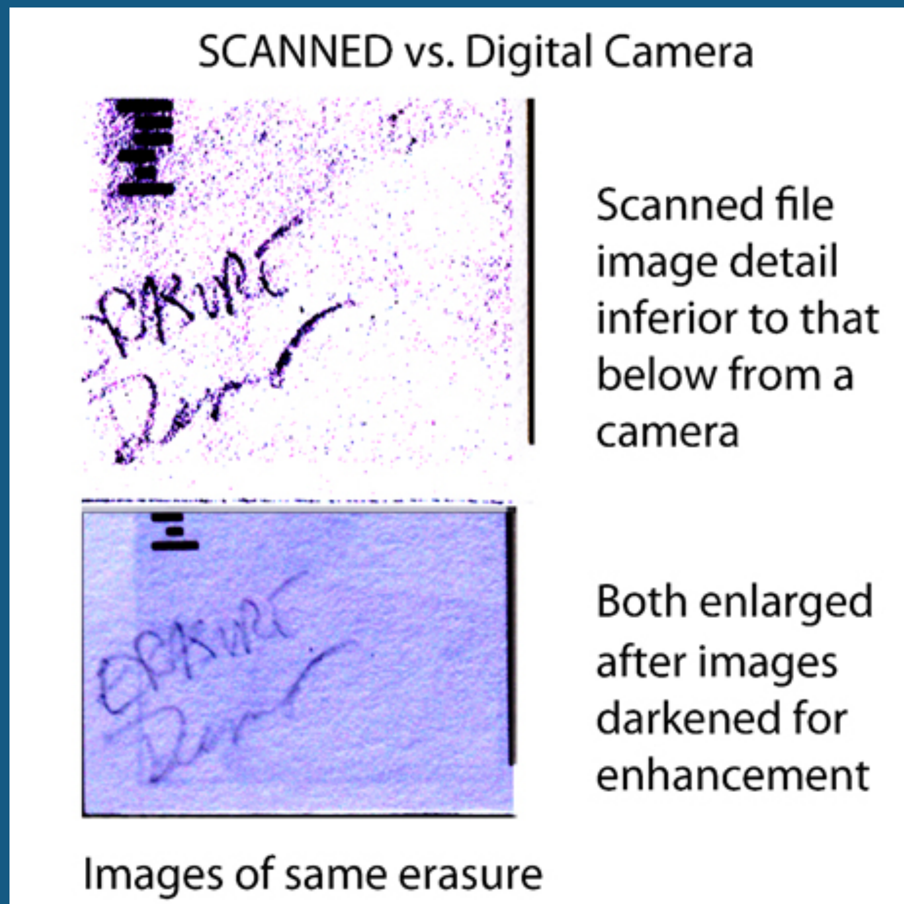
- ***6016 x 4016 pixels (24 MP)***
- ***4928 x 3280 pixles (16 MP)***
- ***3968 x 2976 pixels (12 MP)***
- ***3872 x 2592 pixels (10 MP)***
- ***3072 x 2048 pixels (6 MP)***

Validating your computer and software settings …

What are the potential issues that you must consider when validating your camera?

- ***What is the size of the imaging sensor:***
  - ***18.7 x 14 mm (1.8x focal length multiplier)***
  - ***22.3 x 14.9 mm (1.6x focal length multiplier)***
  - ***23.6 x 15.7 mm (1.5x focal length multiplier)***
  - ***36 x 24 mm (1x focal length multiplier)***
- ***And what effect does this have on your lens?***

To scan or not to scan …
that is the question



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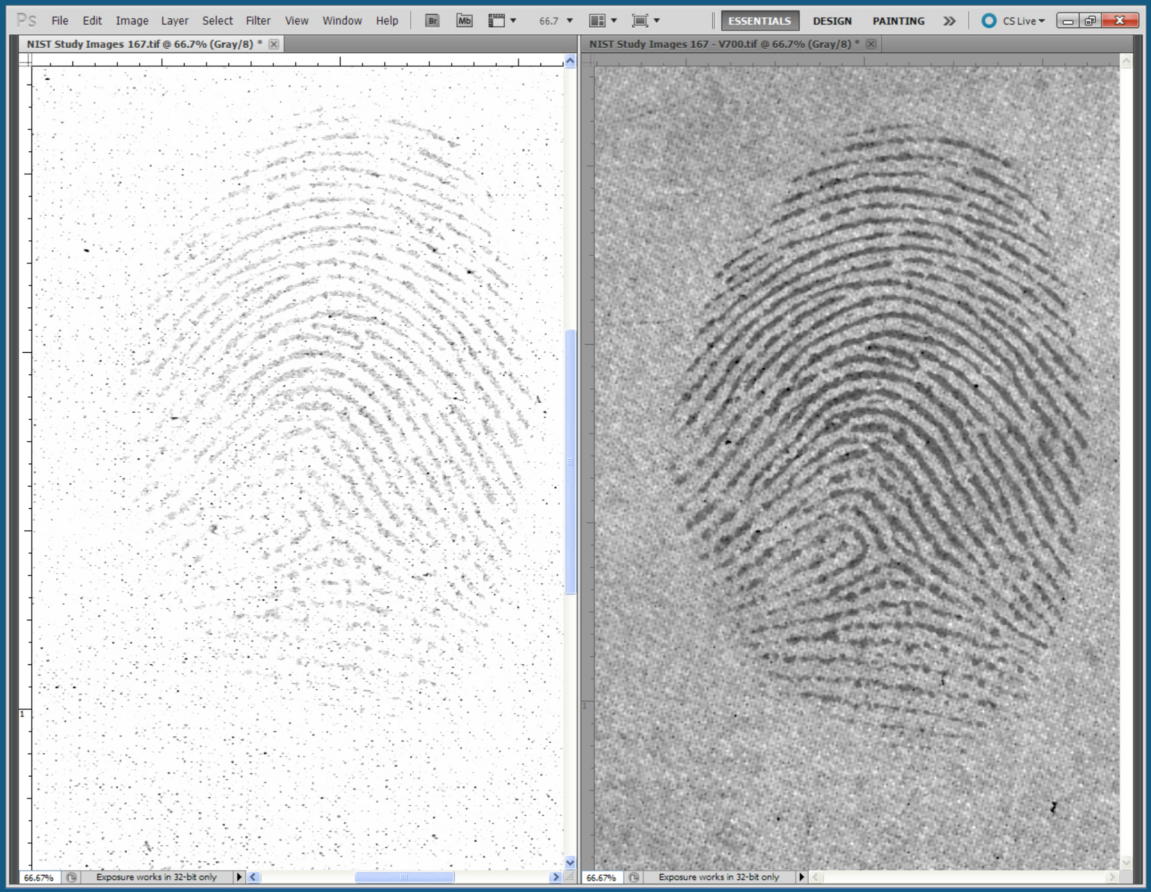
All scanners are *NOT created equal!*



HARDWARE ISSUES

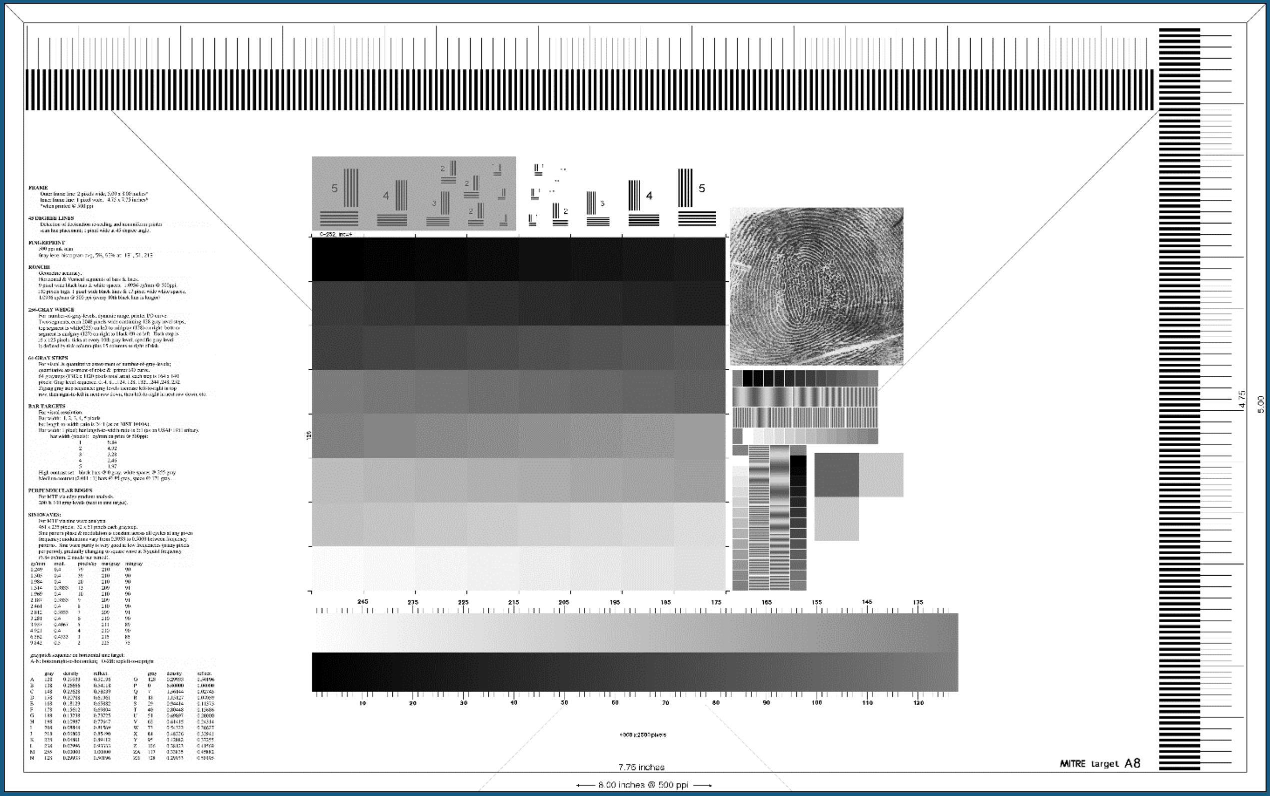
Validating your hardware and software settings …

What are the potential issues that you must consider when validating your computer:

- ***Is your computer equipped with an appropriate video card***
- ***When setting Preferences, which option provides the highest image quality when displayed:***
  - ***Graphics Processor function Enabled***
  - ***Graphics Processor function Disabled***

Validating your computer and software settings …

- *Use a standardized test target in which you know precisely what level of detail is contained within the image file*



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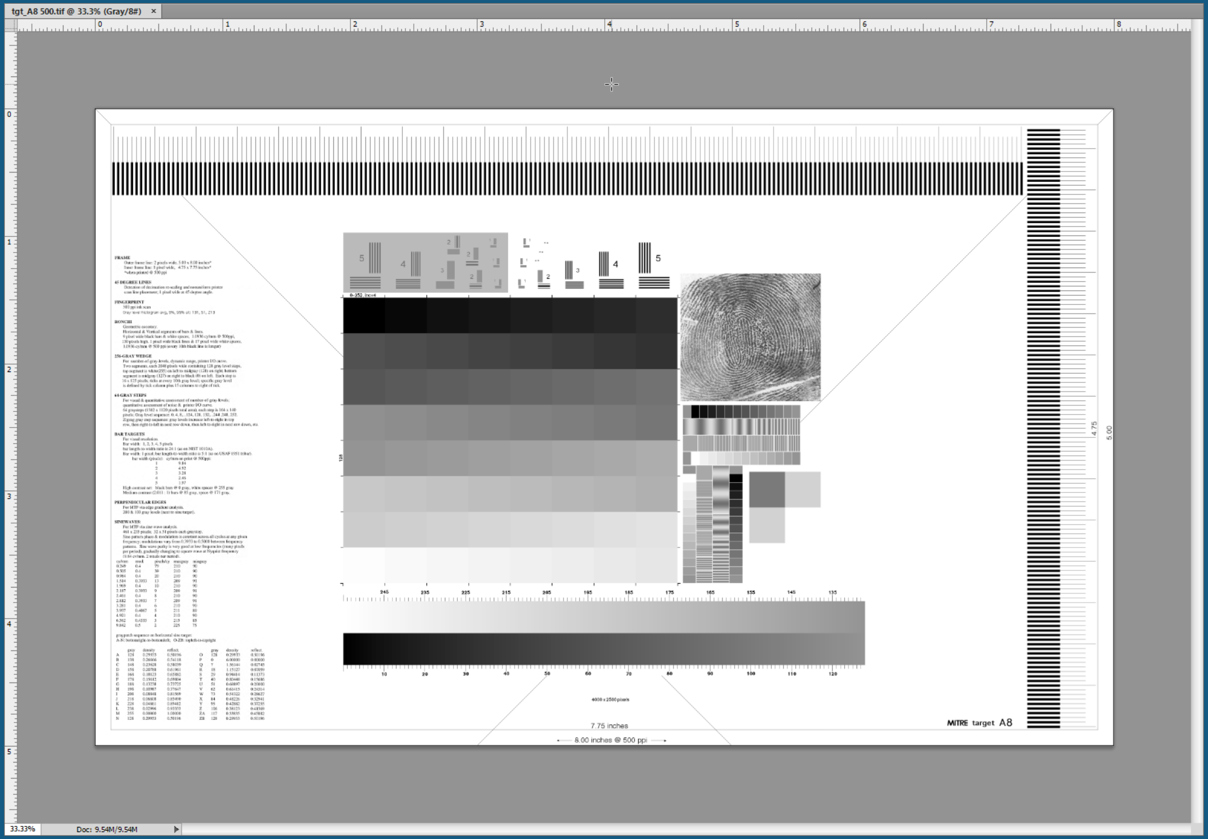
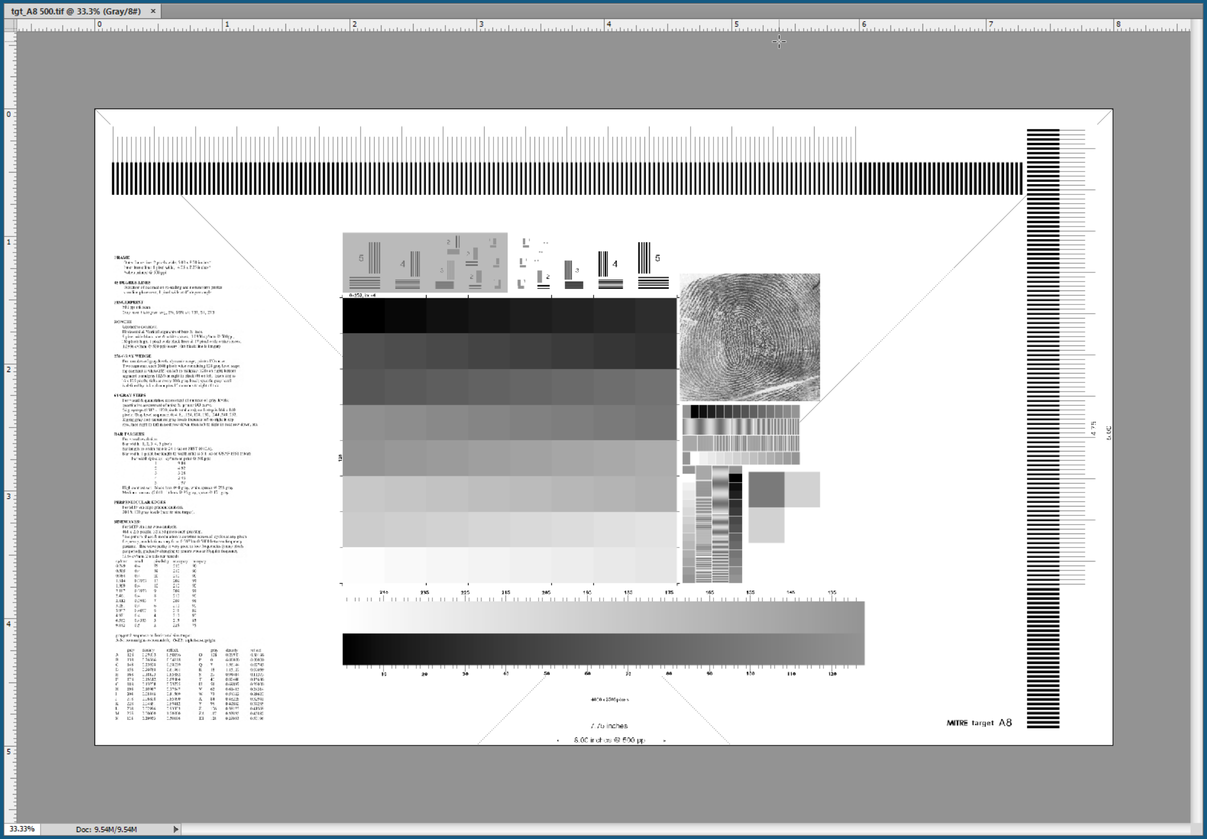
Validating your computer and software settings …



Edit > Preferences > Performance

- ***Graphics Processor Settings***
- ***Use Graphics Processor function Enabled***

Validating your computer and software settings …



Edit > Preferences > Performance

- **Graphics Processor Settings**
- **Use Graphics Processor function Disabled**

FORMAT ISSUES

Common camera formats …

RAW: **RAW files are simply the unprocessed sensor data from a camera**

12 – bit Grayscale = 4,096 shades of gray
14 – bit Grayscale = 16,384 shades of gray
16 – bit Grayscale = 65,536 shades of gray

JPG: **An image format that reduces the image file size – sacrificing image quality – so that the image does not require as much storage space**

8 – bit Grayscale = 256 shades of gray

TIF: **A non-compressed format used for storing digital images**

8 – bit Grayscale = 256 shades of gray

Using the appropriate file types

***Compression* – a process for reducing the size of a file to facilitate the storage and transfer of large files.**

***Lossless Compression* – a format (such as RAW or TIF) used for reducing the size of a file where no information is lost, but the compressed file may use fewer bits to represent the information. When the file is re-opened, <u>the original data is reconstructed.</u>**

***Lossy Compression* – a format (such as JPG) used for reducing the size of a file where information is lost and <u>cannot be retrieved in its original form.</u>**

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Altered or Compressed?

Digital images should not be compressed to save space unless a loss-free (aka lossless) method is used – lossy (aka lousy) compression is <u>NOT</u> an acceptable method!

NOTE: JPG compression removes pixel values, relocates pixel boundaries, alters pixel colors, and reduces resolution differently for different locations in the same image.

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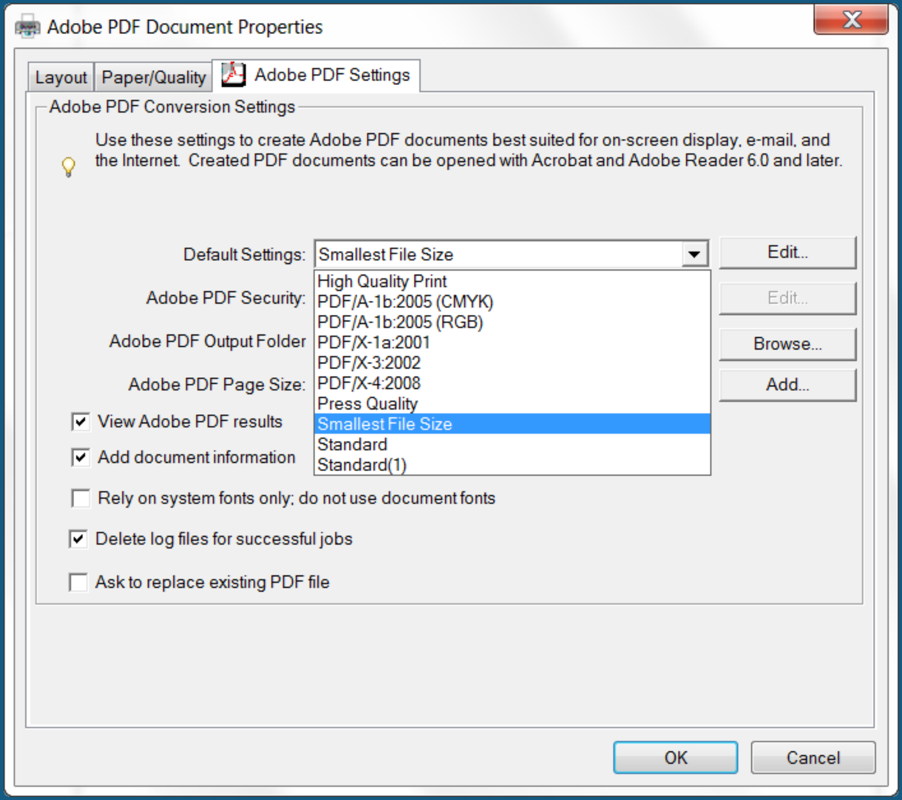
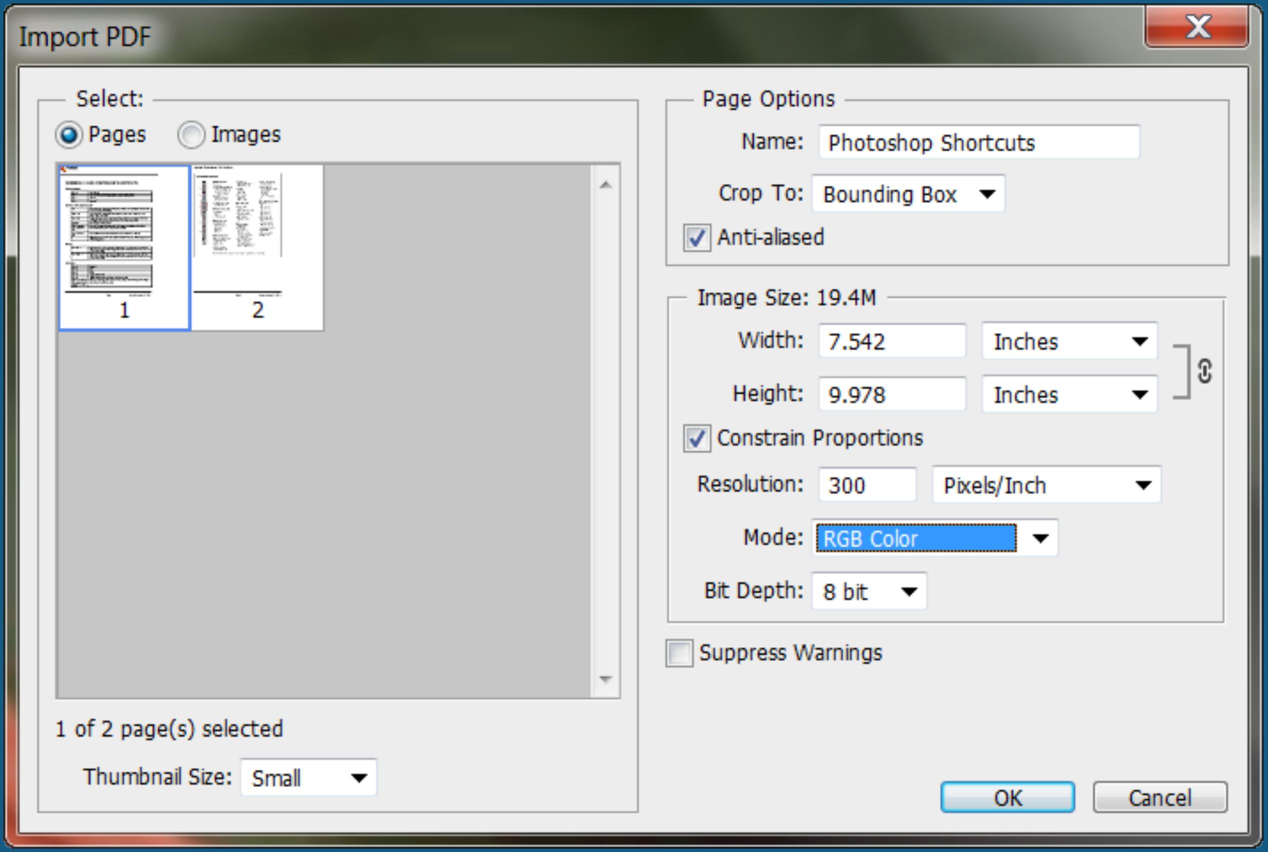
PDF Compression

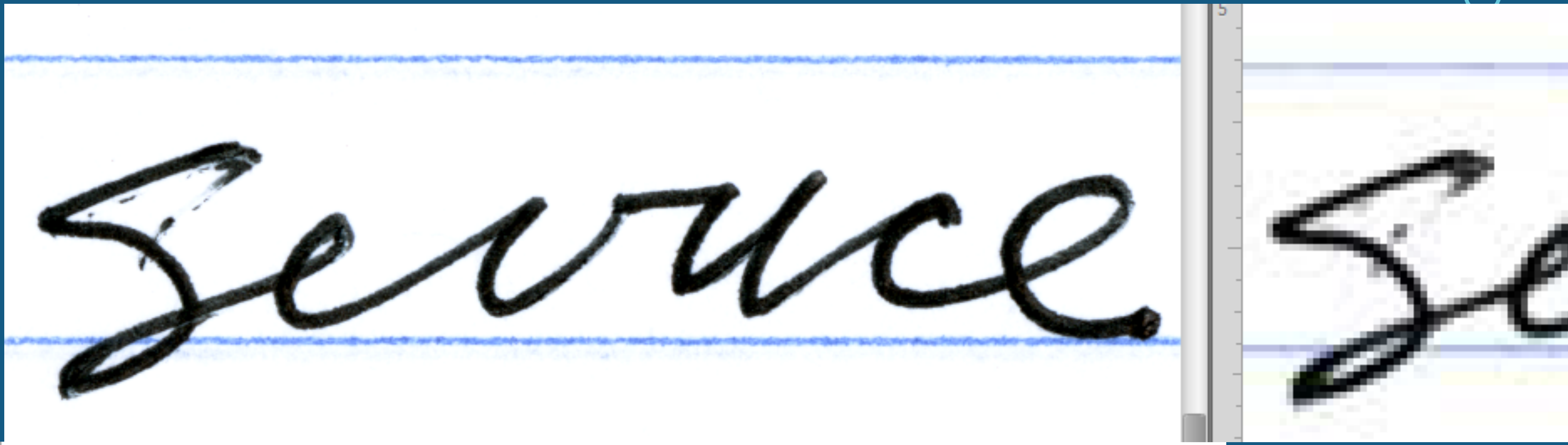
WARNING: Using the standard default PDF settings, images with a resolution greater than 225 PPI are down-sampled to only 150 PPI, and the down-sampled images are then compressed using standard JPG compression with only medium image quality.

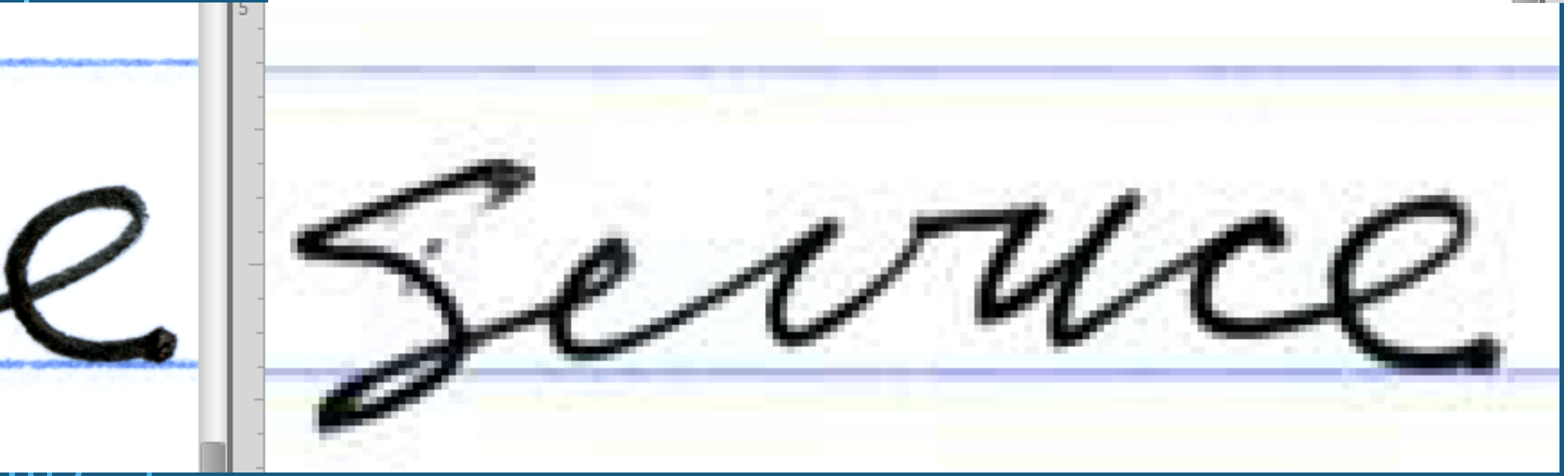


PDF Compression



PDF Compression





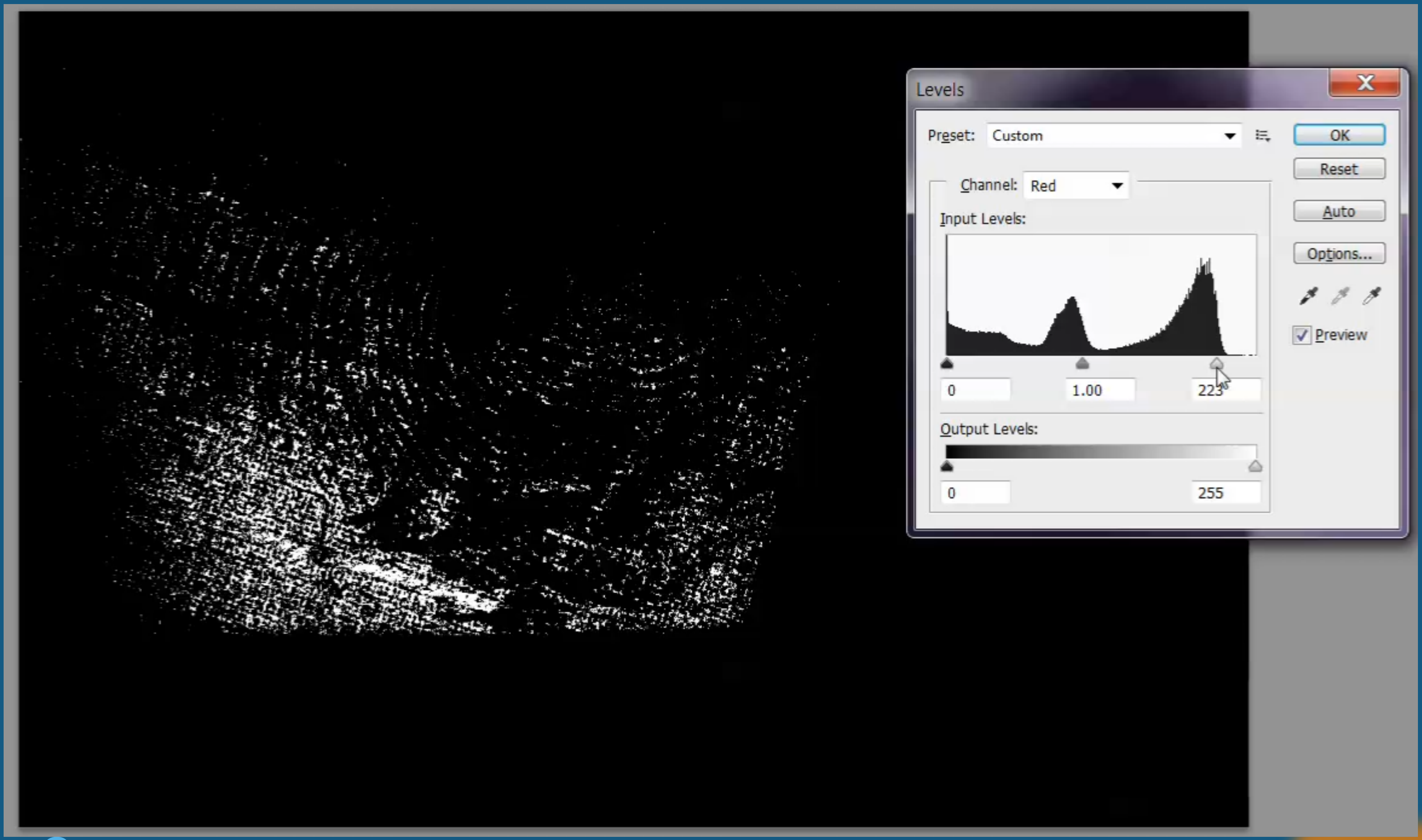
PROCESSING ISSUES

Use Non-destructive Techniques …

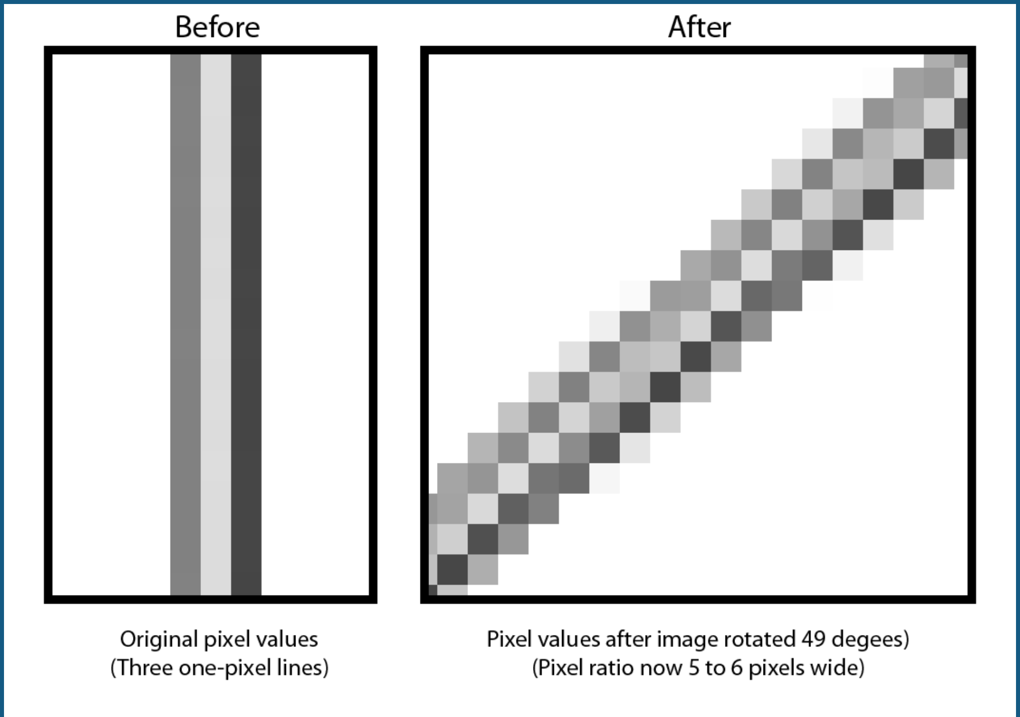
Use image processing techniques that are non destructive, such as:

- ***Black & White***
- ***Curves***
- ***Shadows/Highlights***
- ***Camera RAW Filter***

Use Image Processing Techniques Properly …



Don’t get frustrated ... or rotated!



Rotating an image at any degree other than 90 degree increments causes a number of artifacts that can affect digital image processing.

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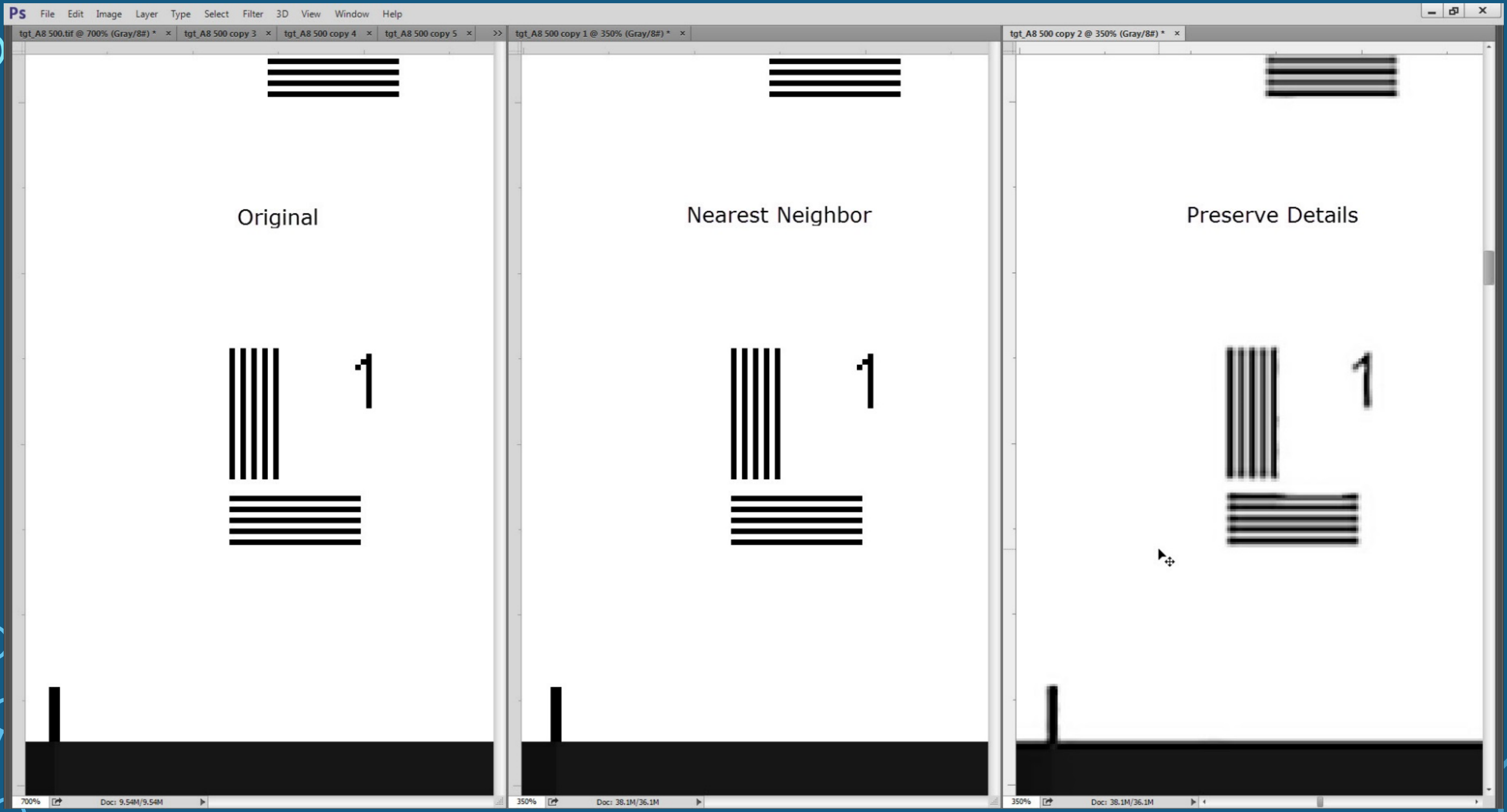
Verify your computer and software settings…

Image > Image Size > Resample

- ***500 PPI to 300 PPI***
  - ***Automatic***
  - ***Preserve Details***
  - ***Bicubic Smoother***
  - ***Bicubic Sharper***
  - ***Bicubic***
  - ***Nearest Neighbor***
  - ***Bilinear***

Verify your computer and software settings…



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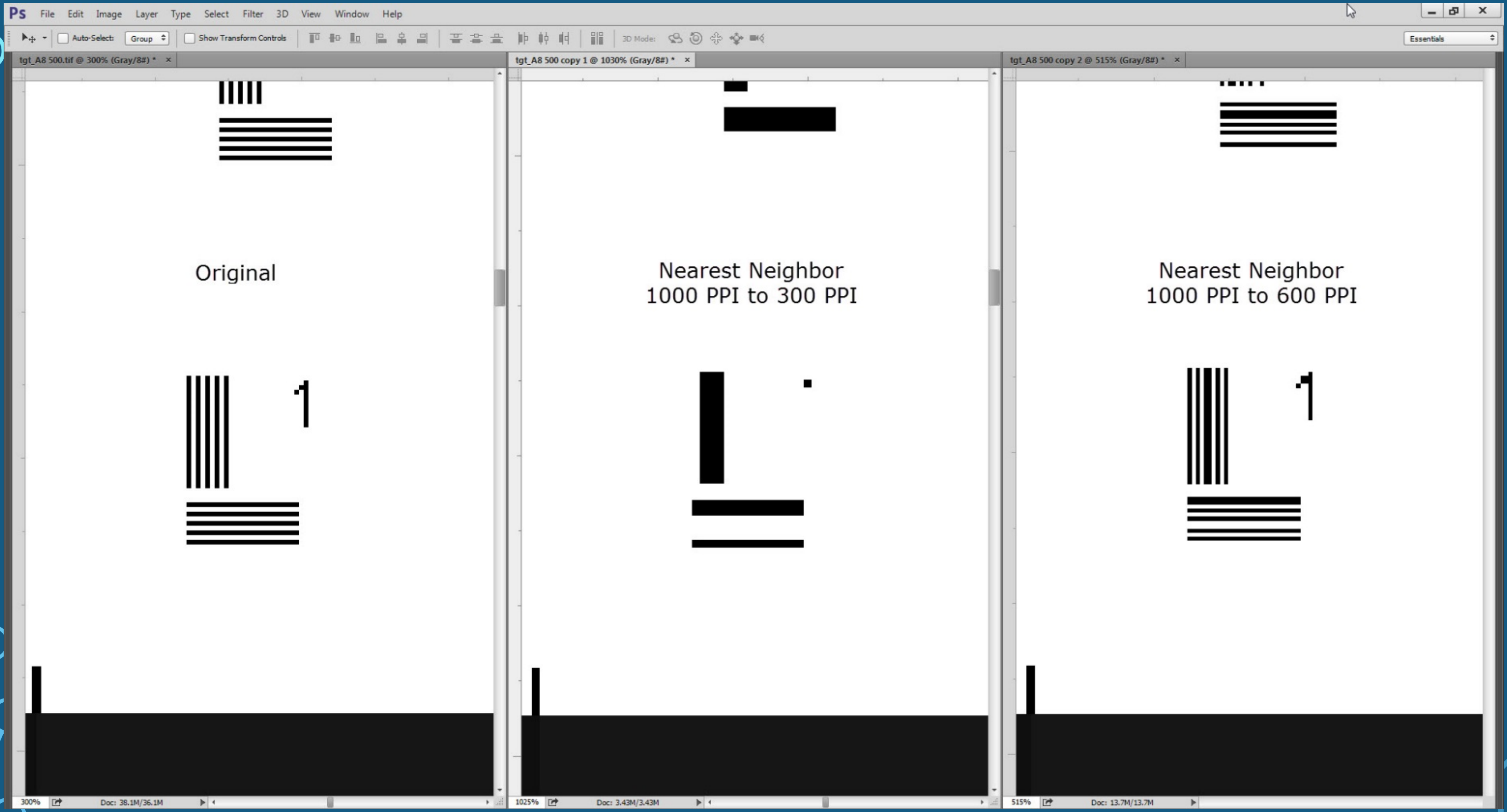
Verify your computer and software settings…



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OUTPUT ISSUES

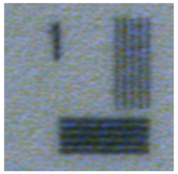
Validating your computer and software settings …

What potential issues that you must consider when validating your output devices:

- ***What output device are you using:***
  - ***Dye sublimation printer***
  - ***Ink jet Printer***
  - ***Laser Printer***

A true and accurate representation?

The original image



An accurate representation

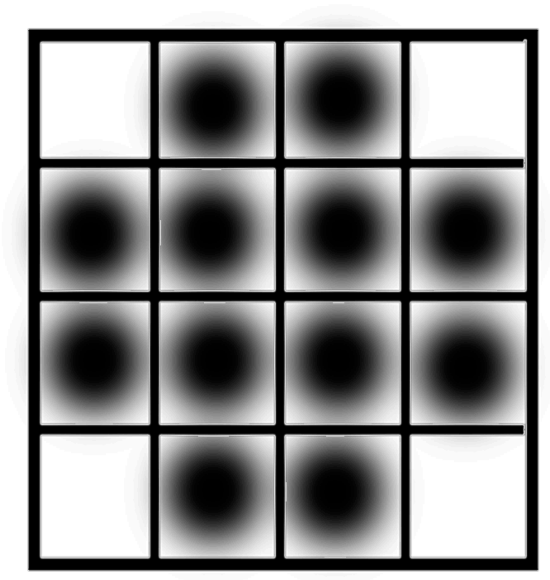
A not-so accurate representation

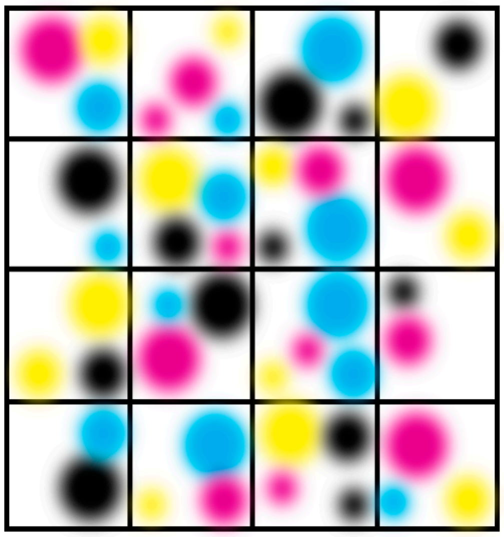
Validating your computer and software settings …

What potential issues that you must consider when validating your output devices:

- ***What are the specifications of your output device:***
  - ***Number of dots, nozzles, droplets***
  - ***Size of droplets (picoliters)***
  - ***Number of Inks***
  - ***Type of paper used***

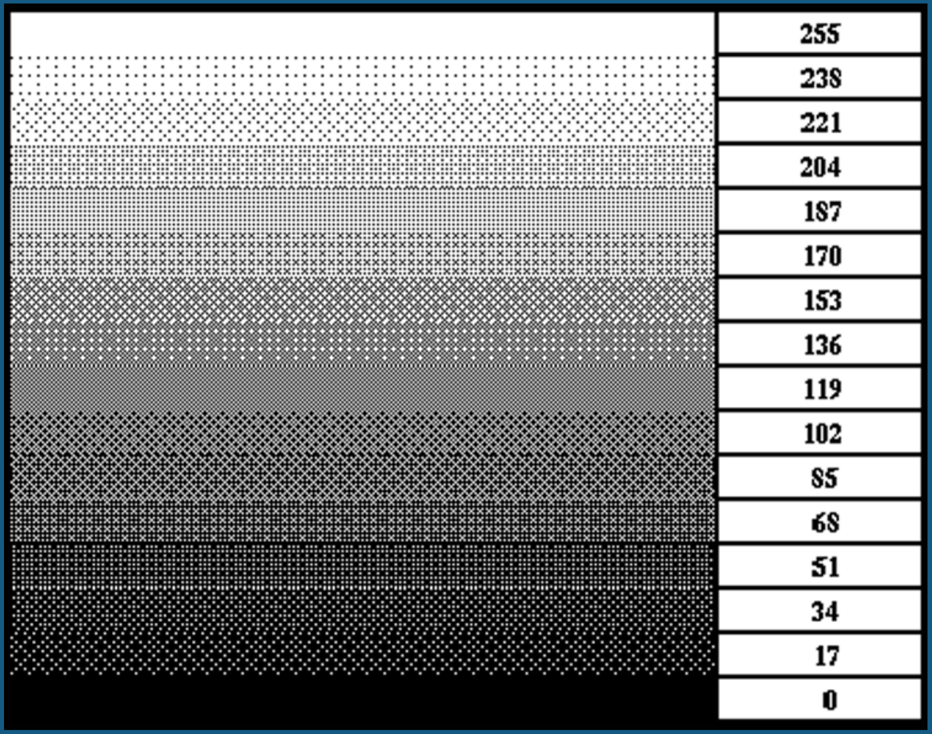
Device dot clusters





The number of dots …

change what we "see" in the printed image!



Thank you very much for your attention and for your interest!!!

For free ACE-V annotation tools, please visit
www.foray.com
Solutions > Photoshop Tools > Latent Print Actions

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