

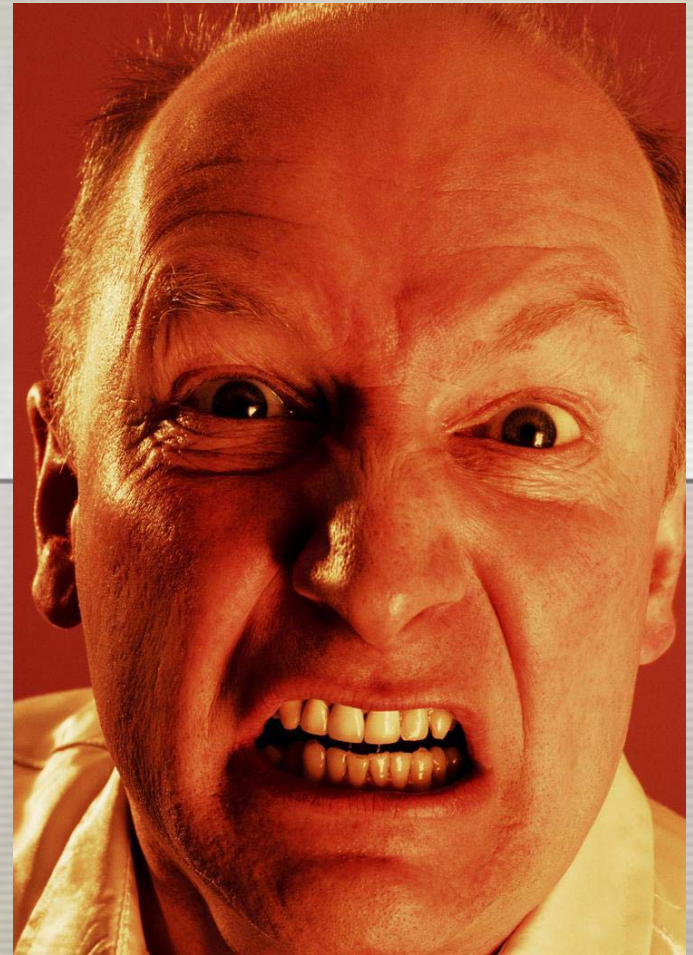
# STANDARDS?

***We don't need no  
stinkin' standards!***

David "Ski" Witzke  
Vice President, Program Management  
**FORAY** Technologies

[www.foray.com](http://www.foray.com)

**1.888.849.6688**



# What's the big deal?

*In the beginning was the image,*

*and the image was good!*

*But then there were attorneys ...*

*OK! Just kidding!!! I mean you have  
to deal with more issues that just  
defense attorneys!*





# What kind of standards?

*So perhaps we DO need standards!*



# Imaging standards include:



*Image processing standards include:*



*Input options*



*Capture devices*



*File formats*



*Color management*



*Image processing options*



*Storage*



*Access management*

# Imaging standards include:



*Image processing standards include:*



*Output options*



*Electronic*



*Paper types*



*Archiving*



# What goes in must come out!



## ***Standards for storage formats***



***Compression versus Non-compression***



## ***Standards for printer output***



***What types of inks (quantity and type)?***



***What type of paper?***



## ***Standard for archival media***



***CD versus DVD, etc.***

# What is a "reliable" image?



## ***Standards for capture***



***Resolution***



***Color management***



***File format***



***Cameras***



***Lenses***

# Capture Standards



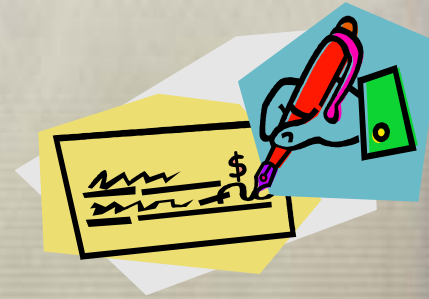
## **Minimum NIST Requirements**



**1000 pixels per inch (PPI)**



**Grayscale**



## **REALITY CHECK**



**Maximize resolution WILL vary based on capture device used!**



**Color is ALWAYS better than grayscale!**



# Does "size" really matter?



***In addition to PPI and DPI, you have to understand***



***Size of the chip***



***Size and number of pixels on the chip***



***Size of the area (object) acquired, based on:***



***Optical resolution of the camera***



***Area of capture***



***Lens size***

# Capture standards



## ***Standards for camera input***



***Fill the frame with the image and scale  
(NO EXCESS WHITE SPACE!!!!!!!!!!!!!!)***



***No compression of images to be  
analyzed / compared***



## ***Standards for scanner input***

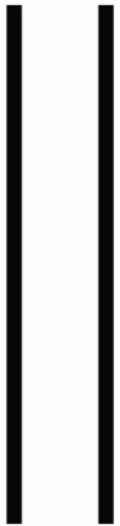


***Always use the true “optical” resolution***

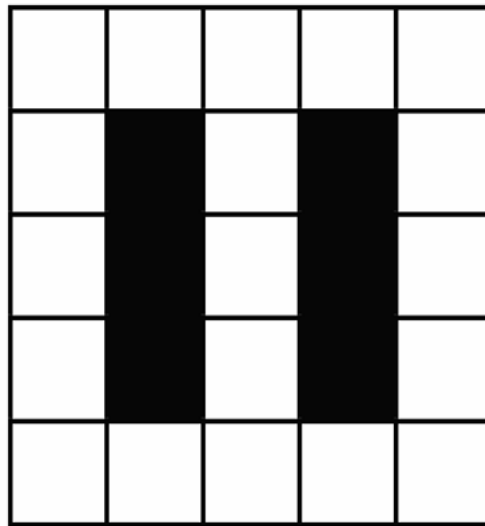


***No compression of images to be  
analyzed / compared***

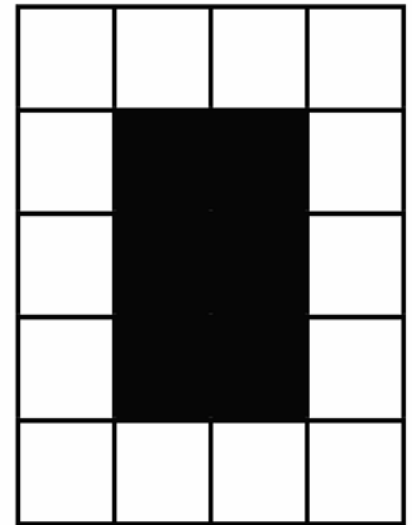
# What is enough resolution?



A pixel-wide  
pair of lines



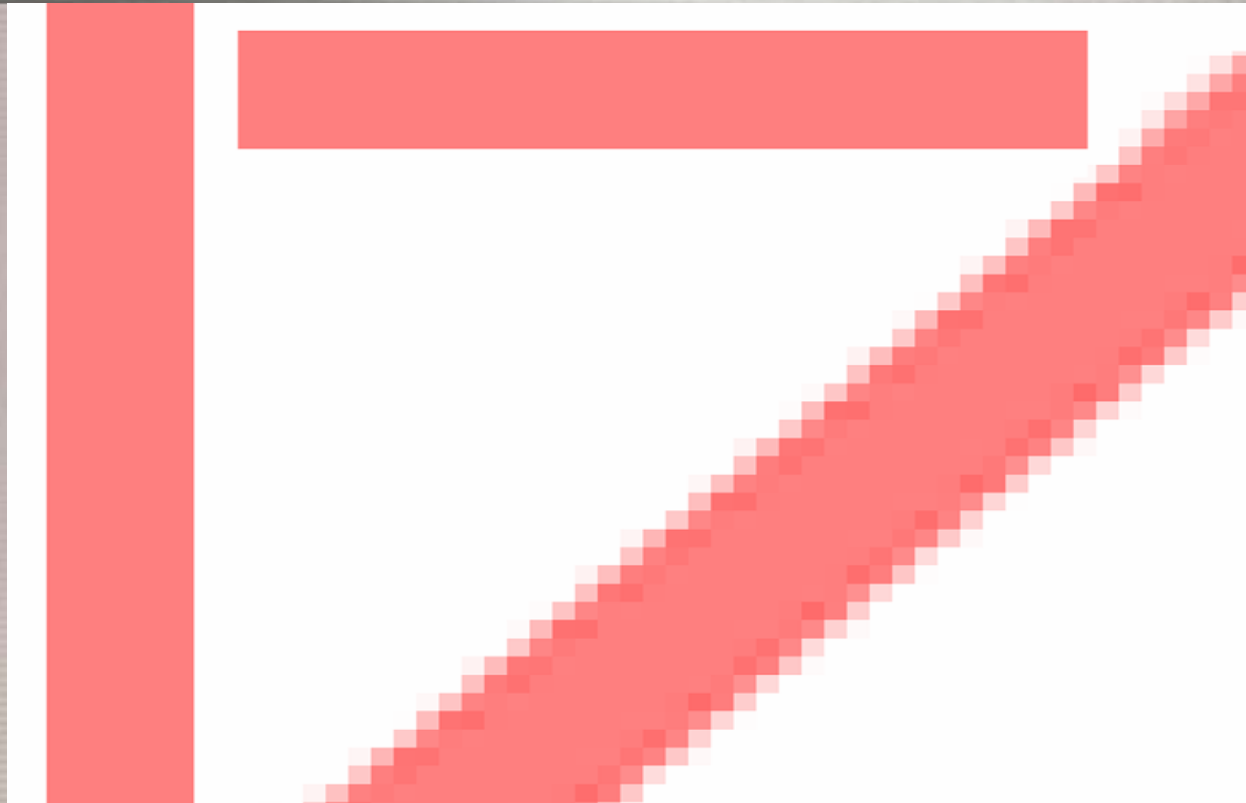
The line pair  
shown as pixels



The line pair  
shown with  
a resolution  
that is too low

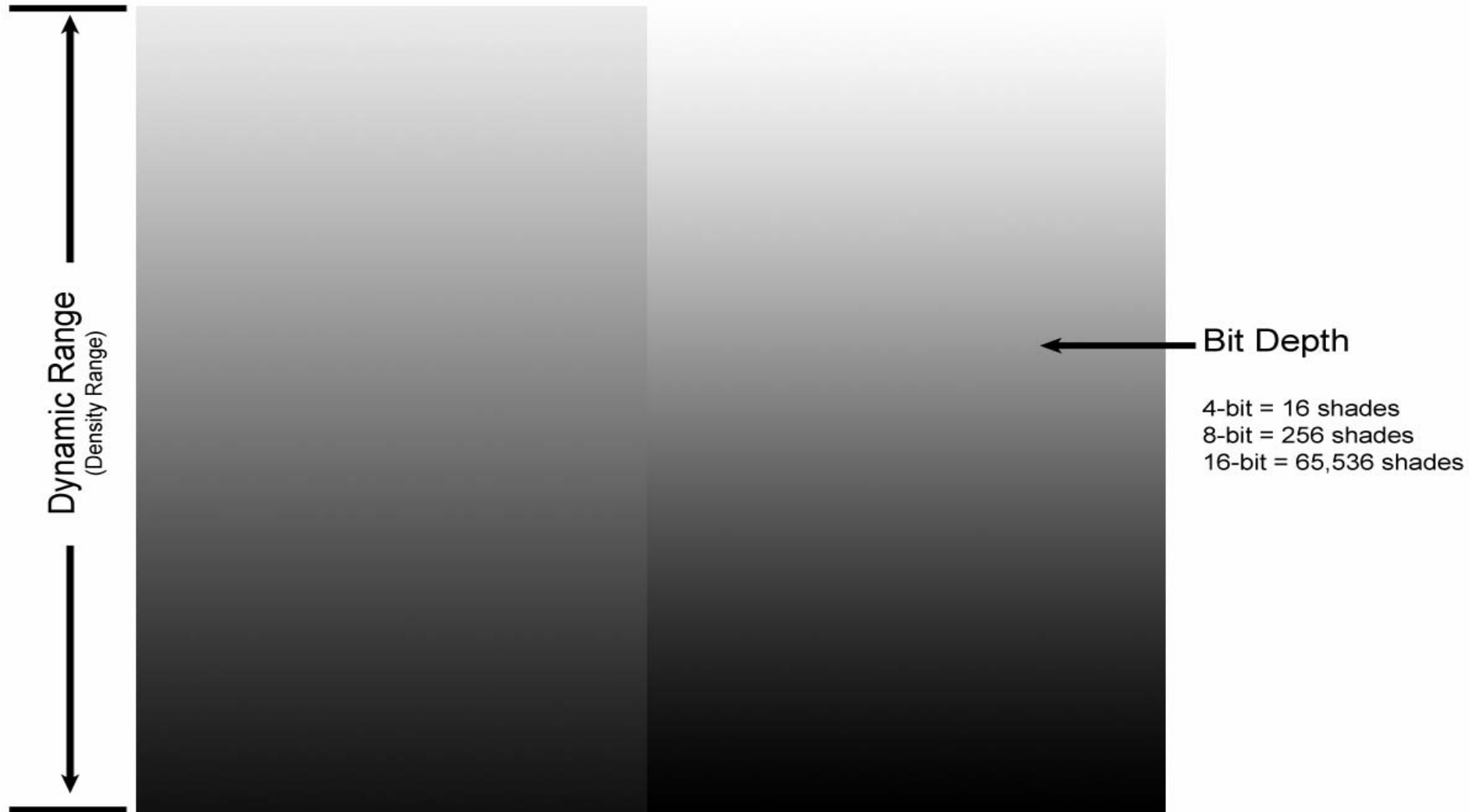


# Resolution artifacts!



Rotating an image can cause serious side effects. Notice the variation in color values along the edge of the rotated line as well as the change in the aspect ratio (i.e., thickness) of the line.


# And it just gets deeper!



# Color is a deep subject, 2!

In other words, color is 2 bit:

 One bit for black

 One bit for white

Therefore,  $2^8 = 256$  shades of gray

|       |                      |
|-------|----------------------|
| Bit 1 | $2 \times 1 = 2$     |
| Bit 2 | $2 \times 2 = 4$     |
| Bit 3 | $4 \times 2 = 8$     |
| Bit 4 | $8 \times 2 = 16$    |
| Bit 5 | $16 \times 2 = 32$   |
| Bit 6 | $32 \times 2 = 64$   |
| Bit 7 | $64 \times 2 = 128$  |
| Bit 8 | $128 \times 2 = 256$ |

$(2^{16} = 65,536 \text{ possible grayscale levels})$



# Image S & M

*(AKA Image Storage and Management)*

Most common camera formats:

✚ TIFF (.TIF) (Tag Image File Format)

✚ RAW (.RAW) (RAW Image File Format)

✚ JPEG (.JPG) (Joint Photographic Experts??? Group)



# Common camera formats ...



## TIFF (.TIF) (Tag Image File Format)



Non-compressed RGB encoded (24-bit color)



Run Length Encoded (lossless compression)



256 shades per color channel



"The truest interpretation of an image"



## RAW (.RAW) (RAW Image File Format)



## JPEG (.JPG) (Joint Photographic Experts Group)

# Common camera formats ...



**TIFF (.TIF) (Tag Image File Format)**



**RAW (.RAW) (RAW Image File Format)**



All tone mapping techniques are applied to a raw image.



Only a few rendering packages today offer the possibility for storing a raw image.



Most imaging packages apply a tone mapping, and only the final image can be stored--a lot of information is lost.



An image mapped once for a particular solution does not have to be the optimum solution for another application, and especially not for a printer or some other device. If a raw image is stored, mapping can be done for each particular device.



**JPEG (.JPG) (Joint Photographic Experts Group)**



# Common camera formats ...



**TIFF (.TIF) (Tag Image File Format)**



**RAW (.RAW) (RAW Image File Format)**



**JPEG (.JPG) (Joint Photographic Experts Group)**







**JPEG uses a lossy compression  
trade off file size for image quality**



**JPEG supports 24-bit color**

# Common camera formats ...

-  Don't use JPEG to save original images you expect to modify later.
  -  Every time you open one of these files, and then save it again, the image is compressed.
  -  As you go through a series of saves, the image become more and more degraded. Therefore, save your originals in a loss-free format such as TIFF at maximum color depth.
-  Also, when you save an image as a JPEG, the image on the screen won't reflect the compression unless you load the saved version.

# Compression vs Interpolation

*("Now you see it! Now you don't!")*

**Compression:** a process that is used to decrease the file size of an image for easier storage, where lower image quality is an "**acceptable**" tradeoff for smaller file size.



It does this by **removing** actual pixels.  
(*So you're doing more than just taking a  
"byte" out of crime!!!*)



These deleted pixels are replaced using an **average** of the adjacent "remaining" pixels.



# Compression vs Interpolation

*("Now you see it! Now you don't!")*

**Interpolation:** a process that is used to increase the **perceived** resolution of an image.

- ✚ It does this by creating **extra pixels** in between the ones actually exist.

- ✚ These extra pixels are an **average** of the adjacent pixels.

# Compression vs Interpolation

*("Now you see it! Now you don't!")*

## **Lossless Compression**

(Image quality matches the original source)

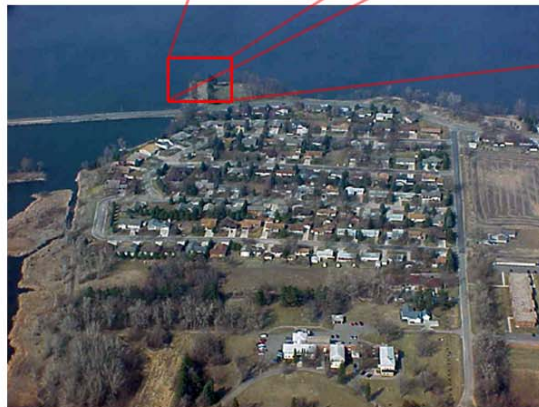
versus

## **Lossy (or Lousy?) Compression**

(Degrades images -- the more they're compressed, the more degraded they become)

# Compression vs Interpolation

*("Now you see it! Now you don't!")*



A closer look at the  
decompressed image

2.25 MP JPG image  
1024 x 768 pixels  
72 ppi



# Compression vs Interpolation

*("From now you see it to @\$%!&")*



*A single pixel saved as JPG (High) then JPG (Med)*


# Compression vs Interpolation

*("From now you see it to @\$%!&")*



*So when we take a closer look,  
is it a true and accurate representation???*

# Resolution and image size

 To make an image larger or smaller for a given output device, it must be resized.

 Resizing is done by interpolation:



When made larger, extra pixels are added and the color of each new pixel is determined by the colors of its neighbors.

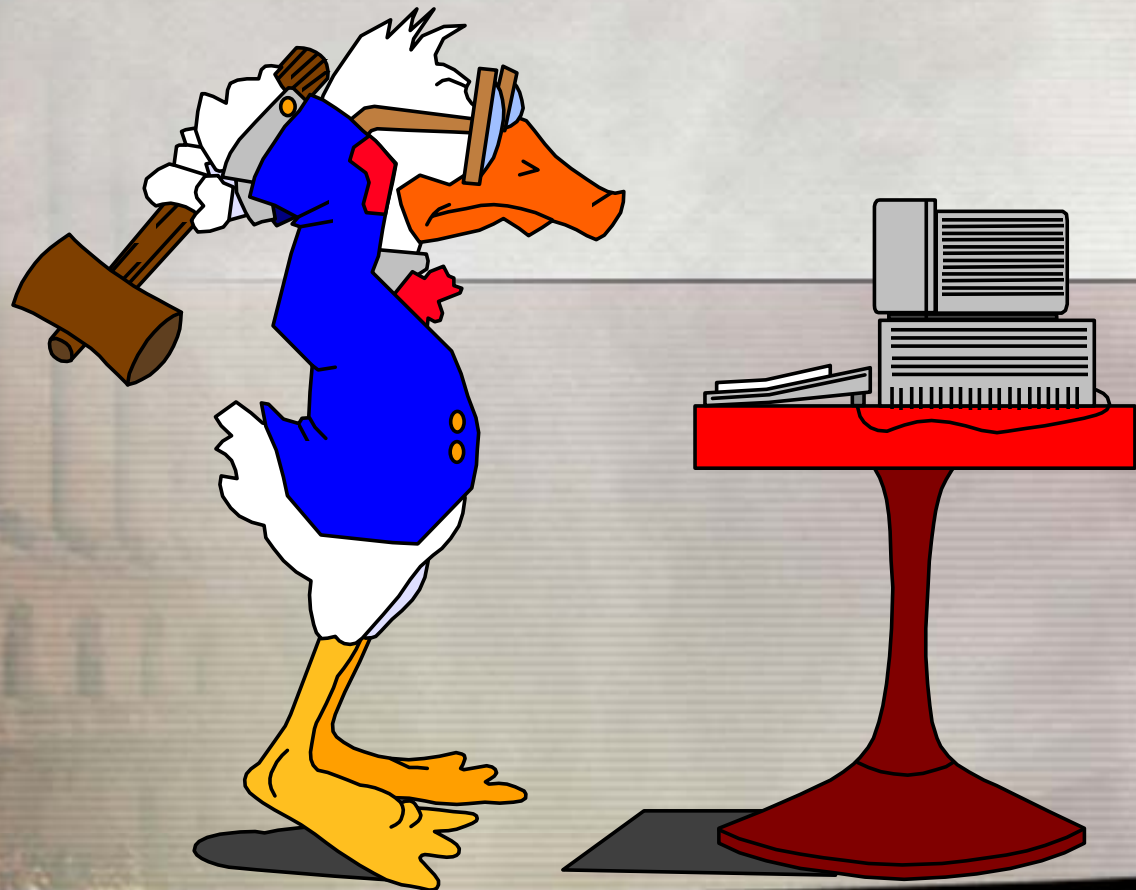


When made smaller, some pixels are deleted.



# *Image processing standards*

Hit any key to continue...



# Alteration vs Enhancement

*“ Fraud by conventional photography was difficult, expensive, and easily detectable ... contemporary technology has made manipulation of digital images easy, inexpensive, and seamless....”*

# Enhancement standards



***What application are you going to use?***



***Adobe Photoshop***



***Media Cybernetics Image Pro***



***Microsoft Digital Image Suite***



***Ulead PhotoImpact***

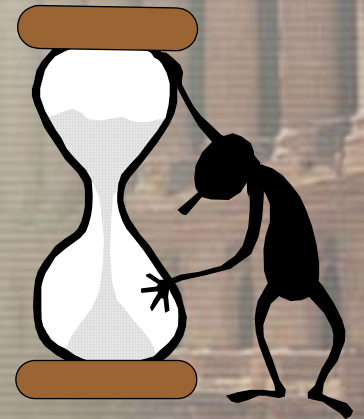


***Etc.***



# Process verification ...

*"should focus on **content** and **analysis** of the **content**, not the subjective choice of tools used to reach a particular result."*



# Color and image processing ...

*Most commonly used color “modes”  
(8-bit color values)*



*Grayscale (256 shades of gray)*



*RGB (16,777,216 colors)*








*CMYK (4,294,967,296 shades)*



*Lab Color (use three components to  
represent color)*

# Image processing involves ...

*Most commonly used color adjustment techniques:*

-  *Levels to adjust highlights, shadows, and midtones*
-  *Curves to create extraordinary contrast*
-  *Burn to darken an area*
-  *Dodge to lighten an area*
-  *Brightness and contrast to create contrast*



# Image processing involves ...

Basic area of interest tools:



Marquee



Rectangular



Elliptical



Lasso



Lasso



Polygonal Lasso



Magnetic Lasso (Exception)



Magic Wand (Exception)



Burn Tool



Dodge Tool

# Image processing involves ...

Dropping out unwanted backgrounds and removing unwanted background “noise”



Color channels



Calculations

(Color Dodge, Subtraction, etc.)



Hue & Saturation



Pattern removal filters (FFT)

# Image processing involves ...

Using filtering techniques



Blur



Noise



Dust and scratches



Despeckle



Sharpen



Sharpen



Sharpen Edges



Unsharp Mask



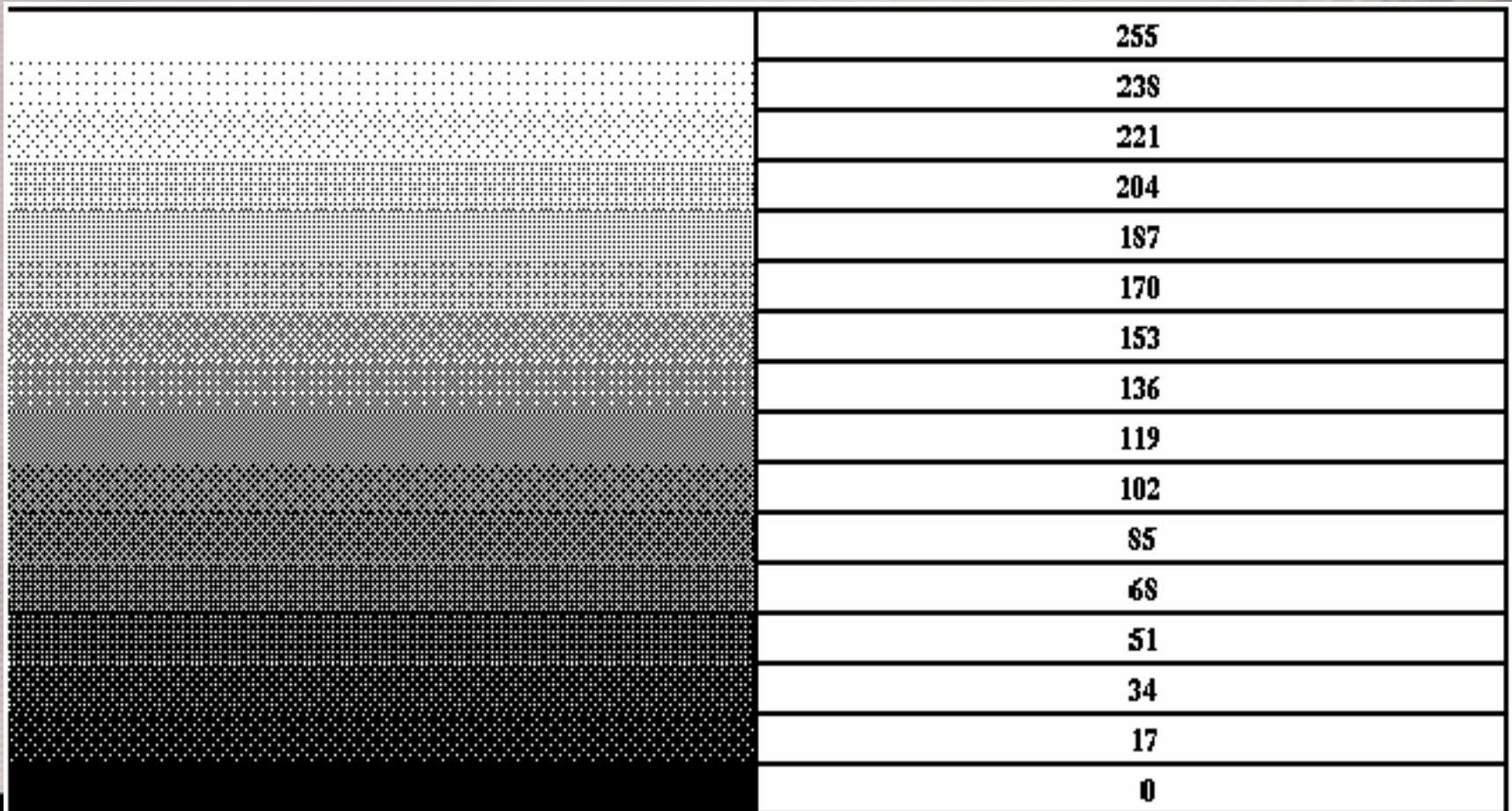
Pattern Removal Filters



# In the end ... there is output!


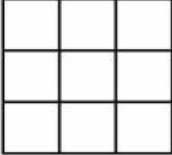

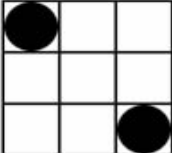

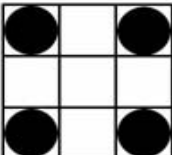

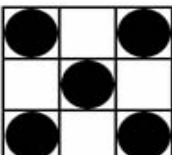

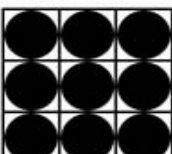
(or what goes in must come out!)

The dots can change the appearance of what we “see” in an image!

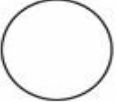




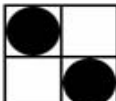

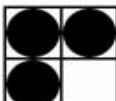

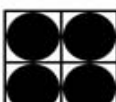


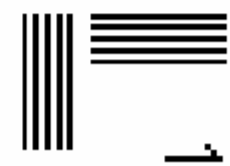
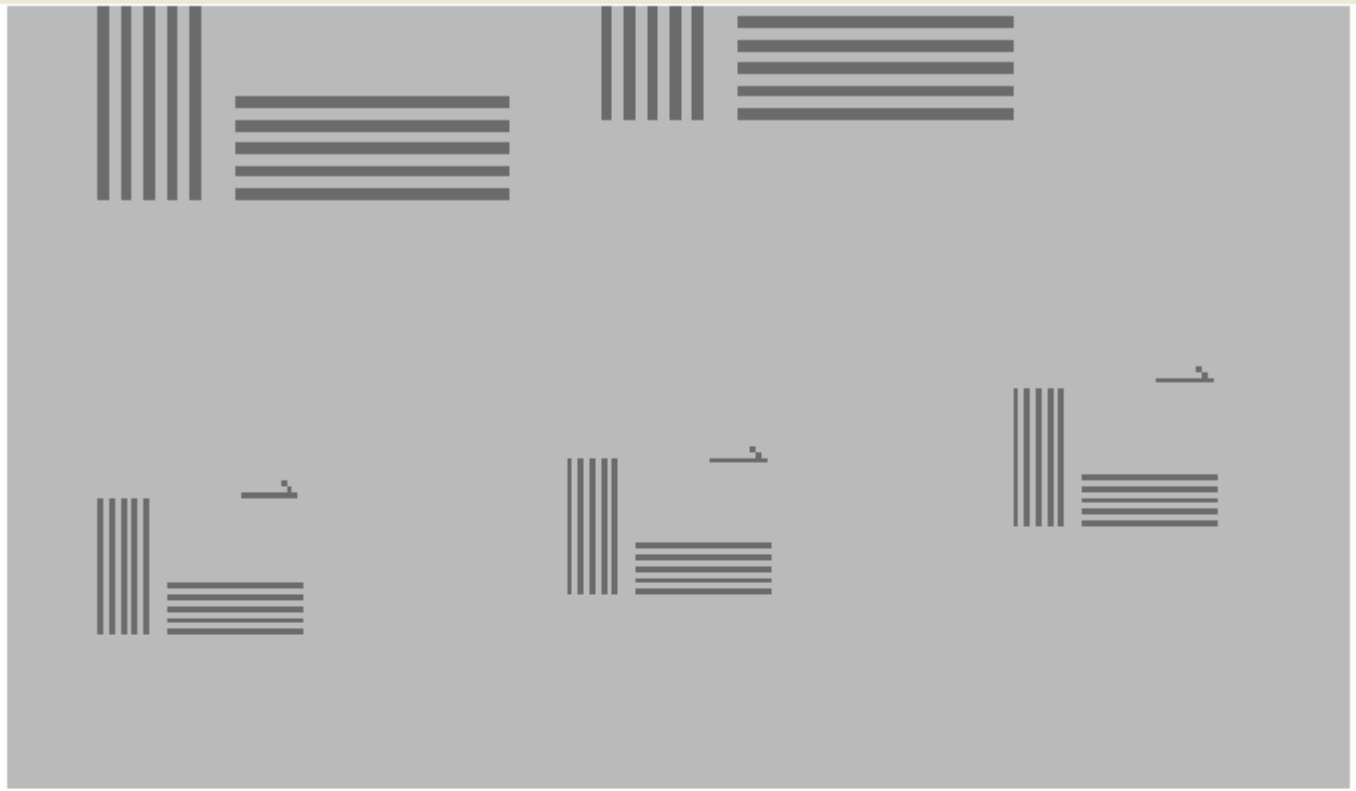
# How do we get it out?

*Pixels are first converted to a series of halftone dots*

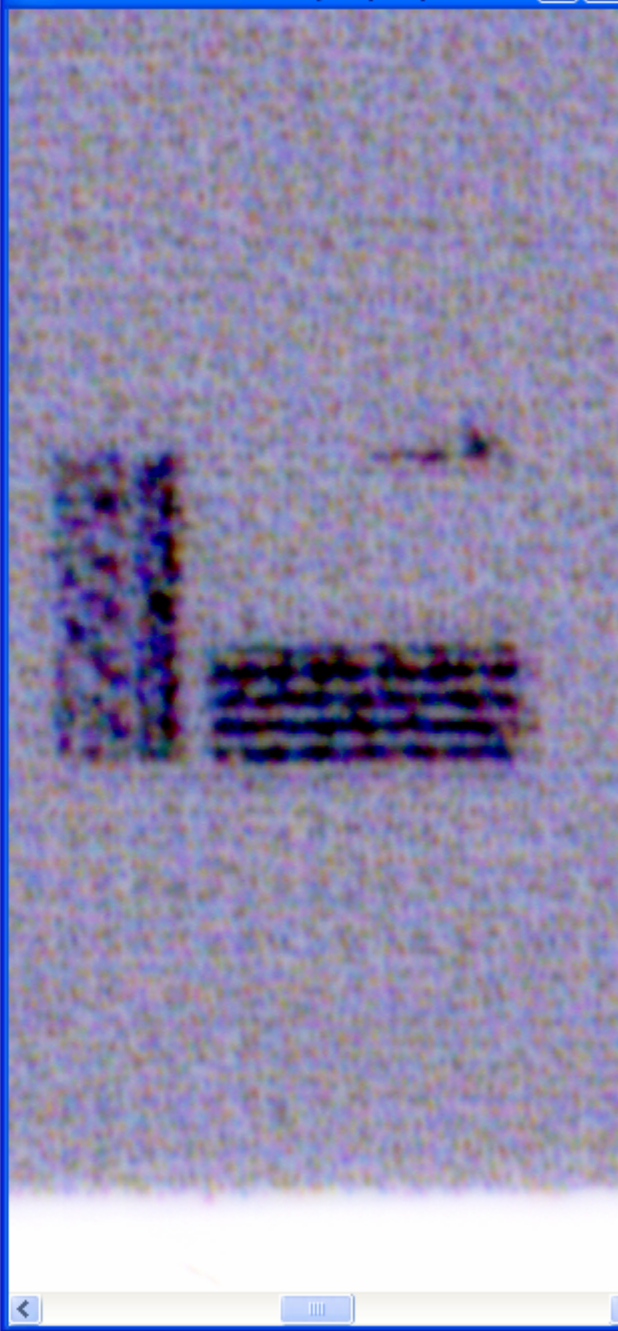
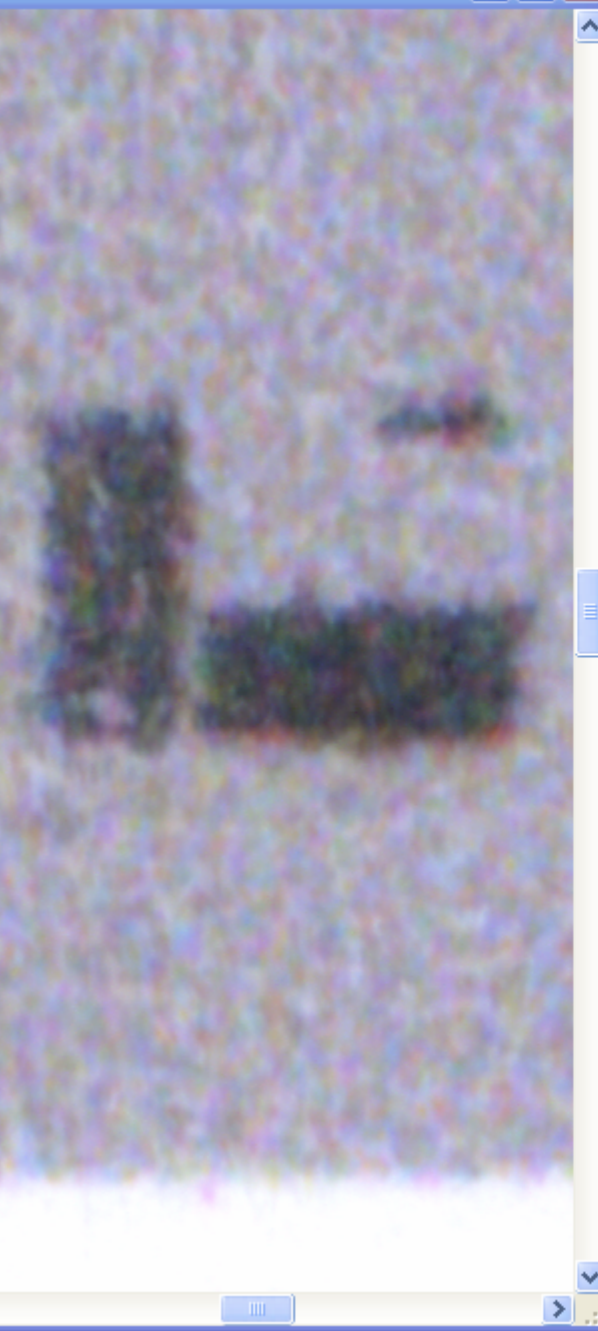
|                   | <i>Pixel</i>  | <i>Halftone Cells</i>   |
|-------------------|---|---|
| 0% Gray (White)   |    |    |
| 25% Gray          |    |    |
| 50% Gray          |    |    |
| 75% Gray          |   |   |
| 100% Gray (Black) |  |  |

*The halftone dots are then converted to a series of "printer" dots*

|                   | <i>Halftone Dot</i>   | <i>Device Dot Cluster</i>   |
|-------------------|---|---|
| 0% Gray (White)   |    |    |
| 25% Gray          |    |    |
| 50% Gray          |    |    |
| 75% Gray          |  |  |
| 100% Gray (Black) |  |  |







# Resolution and Image Size

## ***REMEMBER:***



Resolution by itself does not indicate sharpness or size.



The same number of pixels can occupy a small or large area on the screen or printout.



As they are spread over a larger area, the perceived sharpness falls (from the same viewing distance).



# Resolution and Image Size



Conversely, if they are squeezed into a smaller area, **perceived** sharpness increases.



The images on high-resolution screens or printouts look sharper only because the available pixels are grouped into a much smaller area — not because there are more pixels.



The smaller an image is displayed from a given file, the sharper it will appear.



# Resolution and Image Size



However, when enlarged too much, sharpness begins to fade and eventually the square pixels will begin to show — the image becomes pixilated.



***The final size and quality of an image depends on the resolution of the output device as well as the resolution of the original image.***

# FEAR FACTOR CSI:

## *The Digital Edition*

*The Defense Attorney's tactic:*

*Science without virtue is immoral science. - Plato*



# Junk Science in the Courtroom

<http://www.truthinjustice.org/junk.htm>

***Be a survivor, not a victim!***

# Standards for court

*The Connecticut State Supreme Court was the first court to set ground rules for the admissibility of computer-enhanced evidence to safeguard the right of defendants to challenge its reliability.*



# Standards for court

*In a 1979 ruling, the Court adopted a general rule that there must be:*

*" ... testimony by a person with some degree of computer expertise, who has sufficient knowledge to be examined and cross-examined about the functioning of a computer."*

# Standards for court

*The court ruled that evidence presented using state-of-the-art computer technology **must be accompanied by an expert's explanation of how the process works, and must allow for cross-examination on whether the evidence was in any way manipulated or altered.***

# What's an "expert" ?

- A. *The witness must be qualified as an expert by specialized knowledge, skill...*
- B. *The testimony must relate to matters beyond the knowledge or experience of lay persons.*
- C. *The testimony must be based on reliable scientific, technical or other specialized information.*



*Federal Court Rule 702*



# Admissibility of digital evidence

## Potential areas of attack include:



The digital image itself



The accuracy of the digital image  
displayed on the computer screen



The accuracy of imaging device



The enhancement software

# Admissibility of digital evidence

## Potential areas of attack include:

- + Accuracy of specialized software that is used to enhance the image on the screen
- + Ability to accurately account for multiple enhancements
- + Quality of the output (does it accurately represent the image?)

# Image processing is new, right?

- 🔒 Photographs have been retouched using a number of image capture, development and printing techniques since the 1800s
- 🔒 The first patent for airbrushing in the United States was registered to Mr. Charles Burdick in 1893
- 🔒 Until the 1920's, airbrushing was used primarily for photographic (color) retouching.
- 🔒 Airbrushing techniques were used to create "modified" pictures, such as the propaganda posters created by the US Army during World Wars I and II



# Your testimony...

Some questions that can be anticipated from the Defense are:

1. Was the conclusion based upon the original image or the “manipulated” image?
2. What software was used? Has it been appropriately validated?
3. What guidelines did you follow in enhancing the image?
4. Is the enhanced image different from the original?



It's only words ....

“The defense would *like* to have jurors think that enhance means to modify or alter.”

So the “standard” words of the day are:

“*Process*” or “*Develop*”

# Standards for court

The court also included a portion of the Federal Rules of Practice that states there must be sufficient evidence

*"... to authenticate both the accuracy of the image and the reliability of the machine producing the image."*



So what do  
*YOU*  
do for  
image security?



Just following regulations!



# Reliability

*Reliability must be the watchword in determining the admissibility of enhanced videotape and photographs, whether by computer or otherwise.*





# Repeatability

*Documenting the image enhancement process:*

*What constitutes sufficiency for the purposes of showing the process is repeatable?*



*"There seems to be a common belief that when an enhancement is done by one person and is then repeated by another, both images must be 'mathematically' equal. This has never been the conclusion of any court or legal precedent that I am aware of."*

*-- Erik Berg*

# Training, certification and proficiency issues ...

***Are you certified or certifiable?***

*Training, certification and proficiency testing are going to become focal points of future trials, where the use of image enhancement is being questioned.*

# Questions and Answers

