

Scanning, Printing, and Preserving Digital Photographs

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Executive Summary

In recent years we've witnessed the burgeoning of digital photography technologies, fundamentally changing how we do photography and what we photograph. In a world where scanners, digital cameras, and inkjet printers are affordable to many, it is natural that we would want to apply these technologies to creating and preserving photographic records as part of our family histories. Scanning technology can be used to capture hardcopy prints, negatives, and slides and put them into the digital realm where we can enhance, repair, and further preserve yesterday's and today's photographs for tomorrow. Digital cameras are coming with ever more megapixels of resolution, rivaling or even surpassing the detail that can be captured with film. Printing technology has made tremendous strides in the last few years in achieving "photographic" visual quality. However, along with the improvements and conveniences of these new technologies come a number of trade-offs and decisions that affect the permanence of these digital records. This class explores the new technologies to learn about the vulnerabilities and trade-offs, so that we can make more informed decisions regarding how we buy and use these technologies for our genealogical records.

Fundamentals of Digital Images

1. Bits, Bytes, Kilobytes, Megabytes, Gigabytes, etc.
 - a. Bit is smallest piece of information
 - i. '1' == "On", '0' == "Off"
 - b. Each additional bit doubles the range.
 - i. Example: 2-bit numbers:
 1. '00' == 0, '01' == 1, '10' == 2, '11' == 3
 - c. Byte == 8 bits == 256 different values (0 – 255)
 - d. Kilobyte (KB) == 1,024 bytes
 - e. Megabyte (MB) == 1,024 kilobytes == 1,048,576 bytes
 - f. Gigabyte (GB) == 1,024 megabytes == 1,073,741,824 bytes
 - g. Terabyte (TB) == 1,024 gigabytes
 - h. Petabyte (PB) == 1,024 terabytes
2. Color Spaces
 - a. RGB == Red, Green, Blue
 - b. CMYK == Cyan, Magenta, Yellow, and Black
 - c. CMmYyK (and variations on that theme)
3. Bit Depth
 - a. 24-bit == 8 bits red + 8 bits green + 8 bits blue
 - b. Each additional bit (per color) doubles the number of shades of that color.
 - c. 24-bit and beyond is considered "Photo Realistic".
4. Pixel == Picture Element.
 - a. This is a little square, representing a "dot" in your picture. A pixel has only one color or shade of grey at a time.
5. Continuous Tone == Apparent smooth transitions from one tone to another.
 - a. Film can exhibit continuous tone.

6. Half Tone == Shades made up of dots of different shape, size, and distance from each other.
 - a. Screens
 - b. Newspapers, magazines, and photocopies are half-tones.
7. Resolution
 - a. “Optical” is real resolution
 - b. “Digital Zoom” is either larger (fat) pixels or interpolated – no new real information.
8. Bitmap, Raster, Discrete == array of pixels.

Scanning

1. Scanner Types
 - a. Flatbed
 - i. Good for scanning prints, larger negatives and transparencies
 - ii. Inexpensive
 - iii. Look for faster hardware interfaces
 1. FireWire (a.k.a. “iLink” or “IEEE 1394”)
 2. USB 2
 3. SCSI
 - b. Dedicated Film Scanner
 - i. Good for slides, negatives (35mm) and larger transparencies
 - ii. Expensive
 - iii. Higher resolution (up to 4000 dpi)
 - iv. Better dynamic range than flatbed
 - c. Drum
 - i. Excellent for film or paper
 - ii. Very Expensive
 - iii. Highest resolution
 - iv. Best dynamic range
2. Scan for Printing
 - a. 300 dpi (dots per inch) or more – for the desired print size!
 - i. Example: 2”x3” original, want 4”x6” enlargement, need $(300 \text{ dpi} \times 4”) \times (300 \text{ dpi} \times 6”) = 1200 \text{ dots} \times 1800 \text{ dots}$
 1. Implies need for 600 dpi scanning
3. Post-scan Processing
 - a. Descreening – removing the half-toning
 - b. Noise/Dust Removal
 - c. Equalization
 - i. Levels
 - ii. Histograms
 - d. Color Correction
 - e. Sharpening
 - i. Convolution Filters (Image Processing)
 - ii. Unsharp Masking
 - f. Digital ICE is for dust and scratches
 - g. Digital ROC is for color correction (undo color fading)
 - h. Digital GEM is for film grain
 - i. Digital SHO is for optimal contrast and exposure
 - j. Resizing
 - i. Bilinear and Bicubic Interpolation

Printing

1. Printer Types
 - a. Dot-Matrix
 - b. Laser
 - i. Black & White
 - ii. Color
 - c. Solid-Color (crayon)
 - d. Dye-Sublimation
 - e. Inkjet (a.k.a. “Iris”, “Giclée”)
2. Inkjet Types
 - a. Dye-based Inks — Better color
 - b. Pigmented Inks — Lasts longer
3. Paper Types
 - a. Inexpensive (cheap) is generally not archival
 - b. Manufacturer’s papers are often matched to their ink sets
 - i. Determines color balance
 - ii. Determines image permanence
4. Economics of Ink Jet Printing
 - a. Like Razors & Cartridges
 - i. Manufacturers deeply discount the printer, but make their money on consumables (paper & ink)
 - b. Generic Cartridges
 - c. Refillable Cartridges
 - d. Continuous Inking Systems
 - i. Large upfront cost, but economical with high volume printing
5. Traits of Inkjet Printer Brands
 - a. Epson
 - i. Dye-based and pigment printers
 - ii. Print-head part of printer, not cartridge
 - iii. Amenable to continuous inking systems
 - iv. Most accurate color
 - b. Canon
 - i. Dye-based printers
 - ii. Very fast printing times
 - c. Hewlett-Packard (HP)
 - i. Dye-based printers
 - ii. Best text output on plain paper
 - iii. Sharp U-turn on paper path

Preserving

1. Digital – Saving the Data Files
 - a. File Sizes
 - i. Ranging from Large to Huge
 1. Example: 8”x10” 300 dpi 24-bit color = 20+ MB
 - b. File Formats
 - i. Compressed
 1. Lossy
 - a. Decompressing does not reproduce the original.
 - b. Better than 10:1 compression possible
 - c. JPEG/JPEG2000 (Joint Photographic Experts Group)
 - i. Can produce unwanted “artifacts”
 - d. Every time you resave, you damage the picture more.
 2. Lossless
 - a. Decompressing does reproduce the original.

- b. Usually produces only slightly smaller file size.
 - c. PNG
 - ii. Uncompressed
 - 1. TIFF
 - 2. RAW
 - c. Media Types
 - i. Memory Cards (Flash Memory)
 - ii. Floppy, Zip, Hard Disc
 - iii. CDR, CDRW, DVDR
 - iv. Magneto Optical (MO)
 - v. Labeling Optical Disks
 - d. Availability of Media Readers, Software to Read, and Drivers to Enable Readers to Work on Future Computers
2. Analog – Saving the Hardcopy
- a. Cool, Dark, Dry, Sealed (Protected from Polluted Air)

Recommendations

- Scan at 300 dpi (per inch of desired print size).
- Scan in at least 24-bit color.
- Save the RAW output from your scanner, and work on copies.
- Scan black & white originals in color, then convert (a copy) to black & white on the computer.
- Reduce (a copy) to 72 dpi for on-screen (Web-based) viewing
- Unsharp masking should only be done as the last step.
- Print most important photos with either DuraBrite inks or pigmented inks (such as UltraChrome with matched archival paper) or take digital files to a lab for printing on Fuji Crystal Archive paper.
- Save image files in TIFF format.
- Burn image files onto highest quality CDRs (such as Mitsui Gold or Delkin eFilm Archival Gold) or DVD-Rs (such as Taiyo Yuden), at half the maximum rating of either the CD/DVD burner or the CDRs/DVD-Rs (whichever is slower).
- Copy data to backup hard drive (always have at least 2 copies)
- Have a data migration strategy — copy (reburn) your CDs/DVDs every 3 years
- Keep all of your originals!
- Make archival prints of your most important photos, and store those in a cool, dark, dry, and sealed environment.
- Use soft pencil or water-based ink to label CDs/DVDs. Avoid the Sharpie!

Resources and Additional Information

Scanner and Printer Manufacturers:

www.epson.com

www.canon.com

www.hp.com

Continuous Inking Systems:

www.inkjetart.com

www.mediastreet.com

General (and detailed) information on inkjet printing, including papers, printers, and inks:

www.inkjetart.com

Excellent Text on Digital Printing:

Harald Johnson, Mastering Digital Printing, Cincinnati, OH, Muska & Lipman Publishing, 2003. ISBN 1-929685-65-3. (See also new 2nd Edition!)

Independent Lab Testing Paper & Ink Fade Resistance:

www.wilhelm-research.com/

Slightly Dated Reference on “Archival” CDR’s:

www.silverace.com/dottyspotty/issue12.html

Reference on Phthalocyanine:

www.mam-a.com/technology/cd/organic_dyes.html

Source of “300-year” CDR:

www.delkin.com/delkin_products_archival_gold.html

Sources for Taiyo Yuden DVD-Rs:

www.meritline.com

www.supermedia.com

Sources for Inexpensive Online Printing:

www.costco.com (click on “PHOTO CENTER”)

www.samsclub.com (click on “Photo Center”)