# What to Look for in a Scanner :

## Tip Sheet for Digitizing Pictorial Materials in Cultural Institutions

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This tip sheet summarizes the issues most relevant for selecting scanning systems to digitize photographic prints, negatives, and transparencies in collections at cultural institutions. Keep in mind that once digital images are available, many different uses will likely arise. Consider choosing a scanning system that provides the best digital images possible within the limitations of your resources. For example, creation of a rich digital master[1] image permits many kinds of reproductions and facilitates preservation of the digital images of your photographs. For more information on digital image characteristics, see Library of Congress, Prints and Photographs Division, "Introduction to Basic Measures of a Digital Image for Pictorial Collections," http://www.loc.gov/rr/print/cataloging.html.

To create digital images that have multiple reproduction uses and can be preserved through time, select a scanning system that can both handle your photographs safely and capture digital images of the photographs at your specifications. Benchmark the capabilities of the scanning system to ensure that it meets your digitization specifications and to create quality control criteria. Use the resulting quality control criteria to regularly test your system so that it continues to produce digital images at the same quality level during its lifetime.

The key criteria for selecting your scanner system are the:

- type of scanner appropriate for your materials,
- technical capabilities of a scanning system, and
- budget for scanning equipment and software.

### Types of Scanners

Of the five common types of scanners, three are well-suited for the safe handling of historical or heritage photographs: a flatbed scanner, a digital camera, and a film scanner.[2] The first step in choosing among these types is to evaluate which scanner is most appropriate for the materials that you plan to digitize. Consider future collection possibilities in your choice.

*Examples:*
- Can curved photographic prints, or flaking emulsions on a glass plate negative, be placed safely on a flat bed scanner? Answer: No—consider a digital camera.
- Will the level of light exposure from a particular scanner system put certain items at risk? Answer: Many light source exposures during digitization are minimal. Certain digital camera light systems can generate bright light and heat. Prolonged exposure may be problematic for particularly fragile objects and should be reviewed for appropriateness.

[1] A digital image of sufficiently high quality to capture the essential physical and subjective visual elements of an original photograph.

[2] The other two types of scanner are sheet-fed and drum scanner. For an excellent summary of scanner types, see Don Williams, "Selecting a Scanner," in *Guides to Quality in Visual Resource Imaging* (Mountain View, Calif: Research Libraries Group, Council on Library and Information Resources, and Digital Library Federation, 2000), chap. 2, http://www.rlg.org/visguides/.

## Technical Capabilities — Benchmarking Key Elements

Once the appropriate scanner type (camera, flatbed, film) has been determined, a few key elements in a scanner define the quality of the resulting digital images. You can benchmark[3] these equipment elements with your own evaluation and start-up tests. Benchmarking helps you to understand the strengths and limitations of your system and provides your quality control criteria. When scanning new kinds of material, explore several scanner settings to ensure that your selections accurately capture the different types of photographs that you digitize.

Targets and analysis of the target results, sometimes available in software, provide objective tools for this process. A keen eye and knowledge of photographs provides the subjective criteria for determining the level of quality that is acceptable for the digital images being created. The elements to consider in both the objective and subjective processes of testing and review are outlined below.

## Spatial Resolution (detail and edge reproduction)

### Spatial Resolution: Optical not Interpolated

The scanner you choose should be able to achieve the desired spatial resolution for a digital image at the level of its optical resolution. The optical resolution of a scanner is the actual resolution the scanner can capture. The interpolated resolution is the result of a scanner mathematically filling in pixels up to a specified resolution instead of actually capturing that number of pixels during scanning. Select a scanner based upon its optical resolution specifications.

Verify how accurately the scanner samples information at the spatial resolution that it claims. Don Williams offers good advice on interpreting manufacturer claims of scanner specifications in "Interpreting Digital Scanner/Camera Specifications" within the Digital Benchmarking Chapter of *Moving Theory Into Practice: Digital Imaging for Libraries and Archives*.[4]

> *Example:* If the manufacturer claims a 600 dpi optical resolution for 8 x 10 in. objects, is the scanner actually ***capturing*** at that resolution?

Targets can test the spatial resolution capabilities of a scanner, usually through visual inspection of scans of high contrast bar patterns, or preferably by determining the capabilities of a scanner mathematically by measuring a scanner's Modulation Transfer Function (MTF). Some targets have accompanying software available for objectively interpreting the results.

> *Example:* Software that measures and interprets the MTF using an edge target to determine the spatial resolution of a scanner (ISO 16067-1).

[3] Benchmarking sets a standard, achievable value for particular combinations of equipment and processes.
[4] Don Williams, "Interpreting Digital Scanner/Camera Specifications " in *Moving Theory into Practice: Digital Imaging for Libraries and Archives*, eds. Anne R. Kenney and Oya Y. Rieger (Mountain View, Calif: Research Libraries Group, 2000) 40-41.

## Tone Reproduction

The reliable capture of tone in a digital image of a photograph is influenced by more than one element within the scanner. All of these elements should be reviewed and, if possible, tested to determine the capabilities of a scanning system.

### *Bit-Depth Capture and Output*

Check that the scanner is capturing a higher bit-depth than the bit-depth specified for the digital image. This capability ensures that all of the relevant information is captured, whether or not the scanner allows you to output (save your file) at that higher bit-depth. Embedded image processing functions that are part of the scanner software almost always perform processing on an image at a bit-depth higher than the desired bit-depth. The most accurate capture of tonal values occurs if the image is scanned at a higher bit-depth and then scaled down, internally or externally, to the desired bit-depth.

### *Dynamic Range / Flare*[5]

The dynamic range of a scanner affects its ability to accurately represent the full tonal values of a variety of photographs, most notably the dark regions. The scanner should meet or match the dynamic range of the photographs being copied. Additionally, excessive flare can reduce the scanner's dynamic range. When evaluation tests reveal "clipping" in the highlights or shadows (loss of tonal values), the cause could be a mismatch between the dynamic range of the scanner and that of the original photograph. If that occurs, the range of tones in the original cannot be captured despite a scanner's bit-depth capabilities. Targets can test the dynamic range and flare in a scanner. For more information on the dynamic range of photographs, see Library of Congress, Prints and Photographs Division, "Introduction to Basic Measures of a Digital Image for Pictorial Collections," http://www.loc.gov/rr/print/cataloging.html.

### *Signal-To-Noise Ratio (S/N)*

In a digital image of a photograph, noise is the unwanted variation of data (bits) in the signal. Random signal variations within the scanner create digital image noise during the scanning of a photograph. Just like film grain can degrade the utility of a photograph, so too can electronic fluctuations in a scanner degrade the digital image by disrupting the tonal values that the scanner is supposed to capture. The key element to remember in understanding the S/N is that digital images are captured and exist as electronic code. Once displayed they become decoded analog entities and are no longer digital. The data that defines the digital image can therefore be influenced by electronic variations.

How much real data exists compared to electronic noise data determines how many bits in an image actually represent the original photograph. A scanner's S/N should be monitored to ensure that it does not change.[6] Targets can test for noise in a scanner.

### *Color reproduction*

Accurate and controlled color reproduction has not become any simpler with the advent of digital technology. Generally, color management during production should remain simple and well documented to help you maintain color digital images through different display and printing systems and over time.

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[5] Flare is stray light.

[6] "The noise of the hardware used should not change unless the scanner operator changes the way he/she works or dirt is built up in the system." Franziska S. Frey and James M. Reilly, *Digital Imaging for Photographic Collections Foundations for Technical Standards* (Rochester, NY: Image Permanence Institute, Rochester Institute of Technology, 1999), 26. Also available online at http://www.rit.edu/~661www1/sub_pages/digibook.pdf.

When selecting a scanning device, choose one that supports and accurately represents the color space choice for your digital images. Color space for color digital images should follow the same principles established for file formats.[7] The color space should be:

- cross-platform compatible,
- open and well-documented, and
- widely implemented and supported.

## Targets

Incorporate the use of targets in your scanning program to ensure that your system is maintaining its benchmarked quality control criteria. For additional information, see the "Targets" section of Library of Congress, Prints and Photographs Division, "Standards Related to Digital Imaging of Pictorial Materials," http://www.loc.gov/rr/print/cataloging.html. It includes a list of resources for learning more about benchmarking the above elements objectively (targets).

> *Examples*: There are targets that determine the accuracy of the reproduction of color during scanning. Targets also can serve as a tool for digital image preservation if they are included throughout the digitization project. Targets can either be scanned with individual images or associated with a batch of images.

## Budget

Compare scanning systems within your price range. It is often helpful to consult with other institutions to learn from their experiences with particular equipment and software. Explore the cost effectiveness of outsourcing your digitization needs to imaging vendors or through cooperative projects. To preserve your investment in the creation of the digital images, benchmark the capabilities of the scanner system whether digitization occurs in-house or it is outsourced.

## Related Resources

For more information on digital image characteristics, see Library of Congress, Prints and Photographs Division, "Introduction to Basic Measures of a Digital Image for Pictorial Collections," http://www.loc.gov/rr/print/cataloging.html.

For more information on standards, including a section on "Targets," see Library of Congress, Prints and Photographs Division "Standards Related to Digital Imaging of Pictorial Materials," http://www.loc.gov/rr/print/cataloging.html.

[7] "Having to communicate only one color space (or profile) to the end user would facilitate optimal rendering of all images across all platforms and devices. If the color space is standardized and universally recognized, it would eliminate the need to embed a profile into each image file. Embedding profiles into each image file creates too much of a data overhead when delivering preview files over the Internet. There would also only be one "profile" that needs to be updated when color management specifications evolve in the future." Franziska Frey, *RLG DigiNews*, December 15, 1997, Volume 1, Number 3, ISSN 1093-5371 http://www.rlg.org/preserv/diginews/diginews3.html#com.