IU DLP Use of Digital Imaging Standards and Best Practices
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This document attempts to provide information on how the Indiana University Digital Library Program has used published standards and best practices for digital imaging to determine specifications for individual projects, and to indicate possible future directions for this decision-making process.

CURRENT PRODUCTION DECISIONS

The DLP to date has primarily been involved with the digital imaging of photographic materials, archival documents, and printed texts on paper and microfilm. We are not currently digitizing maps or most other types of graphic materials. Current procedure is to develop imaging specifications for projects individually, using previous projects as rough models, while incorporating recommendations from newly published standards and best practice documents, and lessons learned from earlier projects.

Published Standards and Best Practices

These online and print publications have provided starting points for creating DLP imaging project specifications.

- Benchmark for Digital Reproductions of Monographs and Serials. A set of minimum capture requirements for monographs and serials, as endorsed by the Digital Library Federation. December 2002.
- California Digital Library Best Practices for Image Capture. Outlines the issues involved in digital image capture. February 2001.
- California Digital Library Digital Image Format Standards. Provides a table matching source materials to capture resolution, bit depth, and file formats. July 2001.
- Library of Congress Conversion Specifications. Three RFPs from the Library of Congress for conversion of text-based materials (including SGML encoding), microfilm, and pictorial materials. 1996.
- Library of Congress Digital Formats for Content Reproductions. Includes sections on Pictorial Materials, Textual Materials Reproduced as Searchable Text and Images, Textual Materials Reproduced as Images, Maps, and Headers for Computer Files. July 13, 1998.
- Moving Theory Into Practice. The full text is not available online. Edited by Anne R. Kenney and Oya Y. Rieger, this book discusses methods for benchmarking conversion requirements rather than listing specifications for classes of materials. April 2000.
- NARA Technical Guidelines for Digitizing Archival Materials for Electronic Access: Creation of Production Master Files - Raster Images. A complete overview of digitization issues for textual materials, photographs, maps/drawings, and other graphic materials. Covers metadata, workflow issues, digitization specifications, storage, and quality control. June 2004.
- The NINCH Guide to Good Practice in the Digital Representation and Management of Cultural Heritage Materials. Covers many aspects of digital projects, including planning, selection, rights management, capture, and quality control. October, 2002.
- Recommendations for Digitizing for RLG Cultural Materials. Guidelines for creation of digital objects to be submitted to RLG's Cultural Materials Initiative. January 25, 2002.
- TASI Advice Documents - Creating Digital Images. A series of documents on creating digital images. Topics range from choosing file formats, to color management, to file naming and quality assurance methods. Frequently updated.

- Visual Arts Data Service, Creating Digital Resources for the Visual Arts: Standards and Good Practice. Provides an overview of copyright, capture, metadata, storage and delivery issues for digital images.
- Western States Digital Imaging Best Practices. Outlines minimum digital image specifications for text, photographs, maps and graphic materials. Replaces the earlier guidelines developed by the Colorado Digitization Project. January 2003.

Photographic materials

Based on early published recommendations from NARA and the Library of Congress (listed above), the DLP has to date primarily digitized photographic materials according to the following specifications:

Master Files:

Pixel dimensions:	long side of 3000 pixels
Resolution:	sufficient to achieve desired pixel dimensions
File format:	uncompressed TIFF, Intel byte order
Bit depth:	24-bit color, 8-bit grayscale

Full-screen Files:

Pixel dimensions:	long side of 1000 pixels
Resolution:	72 ppi
File format:	JPEG
Bit depth:	24-bit color, 8-bit grayscale

Access Files:

Pixel dimensions:	long side of 600 pixels
Resolution:	72 ppi
File format:	JPEG
Bit depth:	24-bit color, 8-bit grayscale

Thumbnail Files:

Pixel dimensions:	long side of 200 pixels
Resolution:	72 ppi
File format:	JPEG
Bit depth:	24-bit color, 8-bit grayscale

“Master files” are intended to be archival-quality digital images. These files used to generate derivatives (“access” and “thumbnail”) files for present-day web delivery. They are archived and will be used to generate other derivative versions for future uses. Only for our most recent photograph collections have we have added the largest of the web derivative sizes, 1000 pixels on the long side.

The DLP’s approach to the tonal specifications of master images has varied according to type of material and project. One approach taken is described in detail in the documentation at <http://www.dlib.indiana.edu/dmic/projects/hoagy/photo_hoagy.html> for the Hoagy Carmichael Collection. Black and white and color photographic materials were scanned twice, once with pre-set values for shadow, highlight, and mid-point, and a second time to achieve a “visually pleasing” image. The rationale behind this approach was that any tonal adjustments should be done at scan time, through software with access to the higher internal bit depth of the scanner,

rather than after the image has been exported as 8-bit grayscale or 24-bit color, as tonal adjustments performed on the exported images result in a loss of image detail.

More recent approaches to tone reproduction of photographic materials in the DLP have treated black and white and color materials differently. Recent projects to digitize black and white negatives or photographic prints have used a procedure designed not to reproduce exactly the current tonal values of the source material, but instead to expand its tonal range for the purpose of capturing a greater amount of detail. The tonal range of the image is set at scan time to a grayscale channel shadow value 7 (97% black) and a highlight value of 248 (3% black). Grayscale TIFF images have a Gray Gamma 2.2 ICC color profile embedded in them. For color materials, the desire to reproduce the source material in its current state as an archival object takes precedence. Locally created ICC profiles for scanning equipment, rather than generic ICC profiles provided by the equipment manufacturer, are used to match the color of the image to that of the original. No tonal manipulations are performed on color images. Color TIFF images have the sRGB ICC color profile embedded in them. An example of specifications we created for a color slide digitization project can be found at <http://www.dlib.indiana.edu/aboutus/rfps/CushmanRFP.pdf>.

While the NARA and early LC recommendations specified the GIF file format for thumbnail files of photographic materials, the DLP uses JPEG for thumbnail images instead. We have found that while sometimes there is virtually no perceptible difference between the two formats at that size in a web browser, JPEG files of this size at approximately 5:1 compression tend to be smaller than GIF files of the same dimensions. JPEG files also allow us to embed the sRGB ICC color profile in the derivative images, while GIF does not.

Archival documents

The DLP has also digitized page images of archival documents, such as personal correspondence. These documents are generally of artifactual value and are not good candidates for optical character recognition. They often pose interesting digitization problems as they may be handwritten, on onionskin paper, or have watermarks of interest. While we may rekey the text from the document in order to make its contents searchable, we feel that the page images are of important to capture as well. With this in mind, we generally capture them with these specifications:

Master Files:

Pixel dimensions:	dependent on size of original
Resolution:	300 ppi
File format:	uncompressed TIFF, Intel byte order
Bit depth:	24-bit color, 8-bit grayscale

Access Files:

Pixel dimensions:	long side of 600 pixels
Resolution:	72 ppi
File format:	JPEG or GIF
Bit depth:	dependent on file format

Thumbnail Files:

Pixel dimensions:	long side of 400 pixels
Resolution:	72 ppi
File format:	JPEG or GIF
Bit depth:	dependent on file format

Grayscale scanning is most often done for these materials, unless the original document had important color information such as a seal, or if information best captured with a color scan, such as paper deterioration, is deemed important for a specific project.

The 300 ppi scanning resolution we use is a widely recommended specification (see standards and best practices listed above) for capturing text in grayscale or color. This resolution is generally sufficient to capture all significant details of normal-sized handwriting and printed materials.

As these images contain text, thumbnails like those generated for photographs are not very useful. Instead, we provide derivatives at 400 and 600 pixels on their long sides, intended to provide users with an image that has readable text and that fits on their screen.

Printed texts

Printed texts do not generally hold the same artifactual value as the archival documents described above. In projects where searchable full text is the primary objective, and page images are only secondary, we generally use the following specifications:

Master Files from paper originals:

Pixel dimensions:	dependent on size of original
Resolution:	600 ppi
File format:	CCITT Group 4 compressed TIFF, Intel byte order
Bit depth:	Bitonal (1 bit per pixel)

Master Files from microforms:

Pixel dimensions:	dependent on size of original
Resolution:	sufficient to yield a 600 ppi image at original paper size
File format:	CCITT Group 4 compressed TIFF, Intel byte order
Bit depth:	Bitonal (1 bit per pixel)

The 600 ppi scanning resolution we use is a widely recommended specification (see standards and best practices listed above) for capturing text in bitonal scans. This resolution generally results in an image sufficient for successful optical character recognition. Our specifications for one print scanning project in this category can be found at <http://www.dlib.indiana.edu/aboutus/rfps/LetopisScanningRFP.pdf> and for a microfilm scanning project at <http://www.letrs.indiana.edu/web/w/wrightmrc/librfp.pdf>.

We have no current standard way of delivering page images for projects where the primary means of access is encoded text. The method for the Wright American Fiction 1851-1875 project at <http://www.letrs.indiana.edu/web/w/wright2/> is to use the TIF2GIF utility to generate on the fly 2-bit grayscale GIF files in three viewing sizes.

Musical Scores and Sheet Music

Based on principles of image capture for other formats and procedures from other institutions' music scanning projects, the DLP captures 8-bit grayscale uncompressed TIFF images for musical scores and sheet music. Sheet music covers are captured in 24-bit color. Our current sheet music scanning is done at a resolution of 300dpi to adequately capture halftoned graphics of cover art.

In the past, other specifications, such as resolution, have to date been determined by testing the material at hand rather than copying specifications from another source. Sheet music in the Hoagy Carmichael Collection <http://www.dlib.indiana.edu/collections/hoagy/> was scanned at 250ppi and 300ppi, with the Photoshop Unsharp Mask filter applied to the master images, and is delivered over the web in JPEG format with 400- and 600-pixel long sides. Musical scores in the VARIATIONS Online Score Prototype <http://www.dlib.indiana.edu/variations/scores/> are scanned at 400ppi, and are delivered over the web in GIF format in a large size image 650 pixels wide, and in a screen-sized image 656 pixels tall.

FUTURE DIRECTIONS

Determining Capture Specifications

Best practices for digital imaging have evolved over the five years that the DLP has been actively digitizing materials. While early recommendations such as the NARA guidelines suggested that photographic materials be captured with a 3000-pixel long side, more recent documents have shown that some formats, primarily film, contain detail not captured at that resolution. Newer recommendations such as those from Western Trails <http://www.cdpheritage.org/westerntrails/wt_bpscanning.html> advocate capturing photographic materials at spatial resolutions up to 5000 pixels on the long side.

At the same time, the digital imaging world has generally moved away from broad statements of standard specifications such as resolution and bit depth to a benchmarking model such as that advocated in *Moving Theory into Practice*[1]. This model involves calculating needed resolution based on the size of a smallest character, stroke width, or significant detail. It also puts forth methods of measuring other "adequate" specifications such as bit depth.

We feel it is important both to benchmark specifications for individual projects and to standardize specifications across projects. We have too often simply copied procedures from old projects onto new, and, conversely, spent too much time testing materials from new collections. By carefully benchmarking and documenting the results for different types of materials, we can achieve both goals, along with better-quality and more consistent master images. With careful documentation, we can minimize the duplication of effort between projects and concentrate our efforts on solving the problems unique to each collection.

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[1] Kenney, A.R. and O. Rieger, *Moving Theory into Practice: Digital Imaging for Libraries and Archives*. Mountain View, CA: Research Libraries Group, Inc., 2000.

Photographic Materials

For photographic materials, we plan to carefully benchmark capture specifications for future projects, instead of relying solely on a 3000-pixel image to capture all relevant detail. Many film formats, for example, are likely to contain detail best captured in a 4000- or 5000-pixel image. Medium-format film requires specialized equipment to capture at this high resolution.

Another area of possible investigation for photographic materials is capture at higher bit depths. Our current philosophy leads us to use the internal bit depth of the scanner together with an ICC profile to create, export and save a digital image with a full 8 bits per channel of data. However, this method does not allow us to later make modifications to the master file without loss of data. If we were to export and save images with higher bit depths directly from the scanner, then we would be able to create 8-bit per channel images with a variety of different color profiles and rendering intents, such as faithful representations of an original, "visually pleasing" versions, and the like, while still retaining a full tonal range. Such a shift in philosophy would require us to entirely change our existing software and workflows. Careful analysis of the purpose of our master images, current and possible workflows for higher bit-depth images, and other practical considerations would all be examined when investigating this issue.

Many digital imaging projects and best practice guidelines recommend the inclusion of targets into master images. A target with known color values, such as the Kodak Q-13 gray scale, is often included in a digital image to aid in color processing. While theoretically including a target could supplement our reliance on accurate scanner profiling to achieve our goal of accurate color reproduction, there are many practical barriers to implementing target inclusion in our current workflows. Commercial targets are available on reflective material and as positive film, but the situation for negative film is much more complex. Certain formats, such as 35mm slides, also seem to preclude the use of a target included in the digital image. Our current imaging practices for color materials, where the goal is to accurately reproduce the color of the original, could benefit from the use of targets, but our procedures for grayscale materials that are meant to maximize the tonal range without regard to current actual values, do not seem to fit with their use. Other considerations include automatic cropping out of targets for deliverable versions of images, consistent and straight placement of the target on the scanner bed, and the requirement of higher bit-depth images in order to manipulate images using the target values.

A final area of investigation for digitizing photographic materials is creation of derivative images. An alternative to JPEG delivery is presenting zoomable image formats, such as Mr. Sid from LizardTech <http://www.lizardtech.com/> or JPEG2000 http://www.jpeg.org/JPEG2000.html, which use wavelet compression to achieve small but high-quality images. The implications of using proprietary or newer file formats for web delivery, along with the need for a web browser plug-in for viewing would be investigated prior to offering files in other formats.

Printed Texts

For bitonal text scanning, we have to date relied on imaging vendors to properly threshold capture settings for maximum capture of image information. For future text scanning projects, we plan to be more involved in this process. For uniform collections, specifying specific thresholds for capture may be appropriate. For non-uniform collections, specifying a method for determining the threshold for individual items may be appropriate.