Appendix 2

Photography Recommendations for Historical Glass Plate Negatives

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One of the cardinal rules of museum and archive management is that objects should only be altered or modified using methods that are reversible. Occasionally, this rule may have to be disregarded. When these rare circumstances occur, collection managers are obligated to ensure that any information that will be altered or removed is preserved beforehand in the best possible manner available at the time.

In regards to glass photographic plates that contain potentially significant astronomical data, there are times when historic annotations (usually made in India ink) may need to be erased before that data can be accurately extracted from the negative. This report offers advice on how to digitally capture these markings before they are permanently destroyed. Methods for capturing handwritten documentation from the paper jackets that protect glass plates are also addressed.

Workstations

Documenting the annotations on glass plate negatives and their jackets requires ergonomically-designed workstations, with two cameras and different lighting setups: one for capturing the ink markings on the plates via transmitted light, and the other for shooting the plate jackets with standard illumination.

Camera height should always be adjusted to ensure that the image of the plate to be photographed fills the camera frame. This practice maximizes the amount of detail captured by the camera for each plate.

When setting up the copy stands for the first time (and every time camera height is altered thereafter), it is crucial to ensure that the plane of both the camera sensor and light box are parallel. This can be checked via a bubble level.

Plate Jacket Station

A copy-stand setup with two lights (one on either side) should be used for this station. It can be custom-built, off-the-shelf, or refurbished equipment. Bencher of Antioch, IL makes high quality units with interchangeable lighting fixtures. Refurbished darkroom

enlarger stands fitted with aftermarket lighting setups are sometimes a more affordable alternative. LED studio lights are becoming more commonly used; one maker is IKAN.

Plate Marking Station

To reduce operator eye fatigue the light box used at this station should be high quality. At the time of this writing, some of the best on the market are made by the German company JUST Normlicht, who produce a range of light boxes that use electronic dimming control and ballast to eliminate flickering. LED light boxes with ground glass tops are becoming more popular and allow long-term color temperature stability.

Black window or L-shaped mats can be made in different sizes to fit around plates as they are photographed. These can be inexpensively made at any picture framing shop out of acid-free cardstock, but these wear out often. A custom black plastic guide is more durable.

The surface of the light box must be kept clean, as dust from degrading jackets and flaking emulsion can scratch the emulsion surfaces of the plates. Short blasts of clean, dry, compressed air (not "air-in-a-can") are recommended for this. This station should be cleaned daily to ensure safe working conditions for all plates for the duration of any project.

A sheet of 3-mil archival-quality polyester film should be placed between the emulsion side of the plate and the surface of the light table during shooting. This will protect both surfaces from scratches. These sheets should be discarded when they are scratched or otherwise dirtied. This material comes in many different sizes and is available from museum conservation supply firms.

Computer Workstation

A powerful computer with more than 16 GB of RAM and a 2 GB graphics card is crucial for digital image processing and management. A DVD or Blu-ray drive will be useful for burning read-only copies of the files for long-term storage. Common software used includes Adobe Bridge, Photoshop, and Lightroom.

Monitor quality is important. Since computer monitor color temperatures vary widely (for example, Windows monitors range between 7300-9300K), the workstation monitor must be calibrated. This process works by setting the monitor to a neutral output based on the lighting in the workspace. It also measures the monitor's native imperfections and produces a filter to compensate for those imperfections. Since these values can vary over time, many professional photographers recalibrate their monitors monthly. A wide range of tools for this process exist. As of this writing, a well-regarded system is the X-Rite i1 Display Pro.

Figure 1. At Harvard College Observatory, the DASCH photography station features two Nikon DSLRs with 60mm macro lenses on height adjustable pillars. The LED lights used for reflective photography are also height and width adjustable. To move a camera vertically, the operator loosens a hand screw. When the tension is released, the camera's position is maintained by a counterweight located in the pillar. This prevents an operator from dropping the camera and allows for easier use. A measuring tape permits the camera to be reset to a specific location. Both cameras are positioned over the center of the light source. *On the left*, the transmission photography station features a 16" x 20" lightbox that uses LEDs with a ground glass top, which evenly disperses the light. *On the right,* the reflective media station features two IKON LED lights, which are used to illuminate the jackets. (Not shown are polarizing filters over both lights and a rotating polarizing filter on the camera lens.) Both the plate and jacket stations have accompanying laser-cut plastic guides, which allow for easy positioning of each jacket and plate for high-throughput photography. The monitor on the left shows each image captured by the plate camera; the central monitor shows each jacket image. A pair of solid state relays (not visible) turn off the monitors during capture. Additionally, as one camera is taking a photograph the other camera's light source is off to ensure a singular, even color balance for each picture.

Cameras and Lenses

Each copy stand should be equipped with the highest-quality cameras that the project can afford. For this type of project, good-quality results can be had using consumer to professional-level SLR cameras. Minimum camera resolution should be no lower than 25 megapixels. At this time, the highest resolution consumer cameras available are Nikon's D810 (36.3 MP) and Canon's EOS 5Ds (50.6 MP). For plates larger than 8x10, a medium format camera is recommended.

For documenting plate markings, the highest resolution achievable within the budget of the project is recommended (600 PPI is a good value to aim for).

Whatever the camera used, it should be equipped with a fixed focus lens with a focal length longer than 50mm. This type of lens displays less barrel distortion than other lenses, particularly zoom lenses, which should absolutely be avoided for copy stand work. If the copy stand is tall enough and the room height allows it, the use of a short macro lens such the Nikon 60mm f/2.8 will reduce edge distortion to a minimum.

If a macro lens is available or affordable, it can be used for close-up shots of faint or otherwise hard-to-distinguish historical markings. If using a Nikon camera body, the AF-S 105mm f/2.8 VR Micro-NIKKOR lens is recommended.

To minimize digital noise from the camera's sensor, the ISO setting should be kept as low as possible. A range of 64 to 140 is ideal.

Exposures should be adjusted via changes in shutter speed. Bracketing tests should be used to make sure that the correct exposures are used for different media. If your lighting system produces enough wattage, f-stops should be kept in the f/8 range.

A tethered capture system, wireless trigger, or a cable release should be used to minimize any chance of images blurring from the motion of the photographer. Shutter speeds should be shorter than 1/30 of a second.

Camera lenses should be outfitted with UV filters. These are inexpensive and protect front lens elements from dust and scratches.

If in constant use, cameras should be cleaned and serviced at least once a year by a shop authorized by your camera manufacturer.

Lighting, Color, and White Balance

Copy stand lighting

For even illumination, copy stand lights should be aimed so that the right-hand fixture illuminates the left-hand side of the jacket to be photographed and vice versa. Strive to eliminate glare. This can be done by keeping the lights lower than 45° from the vertical

and by using polarizing filters on the lights in concert with an adjustable polarizing filter on the camera lens. If a polarizing filter is used on a camera, it should replace the UV filter.

Color Balance

It is important that the plates and jackets documented via this archival process are photographed in a manner that strives for accuracy, both in detail and color. With this in mind, it is ideal for the work to take place in a darkened room or a room where the lighting can be controlled from a single source. Daylight is to be avoided at all costs as it will make color balance impossible.

Within this space, a single *type* of light source (i.e., LED, incandescent, fluorescent, etc.) should be used to illuminate the plates at both workstations. Doing this will insure consistency in *color temperature* across the span of the project. This value, measured in degrees Kelvin, refers to the hue of a light source, which is directly related to its wavelength. Different types of lighting can have a wide range of color temperatures. Here are a few average values:

- Incandescent 2,900°K
- Fluorescent 5,000°K
- Daylight (overcast day) 6,500°K
- Daylight (sunny day) 8,000°K

Images photographed in longer-wavelength, low-temperature light will have a "warm" yellow-orange cast, while those taken in shorter-wavelength, high-temperature light will have a "cold" bluish cast.

The goal with color balancing is to ensure that any hue imposed by lighting can be accommodated by the camera (it is very difficult, if not impossible, to compensate in the camera for mixed color temperature lighting). This calibration process only works well if the same type of lights or lighting with the same color temperature is used across the entire workspace. In the end, incandescent, fluorescent, and LED lamps can all be used, just as long as all sources emit light at the same color temperature.

Most lamps come from the manufacturer with reliable listed color temperatures. To check whether these values are correct, a camera can be used to measure the color temperature of any light source. This can be done as part of the white balancing process (see below).

If possible, the monitors should be turned off during the capture of the image as that adds a light source that varies during shooting. This can be done with simple electronics and solid state relays such that when the camera trigger is activated the monitors will switch off.

Color targets should be included in all reflected-light photography, as recommended by the American Institute for Conservation's Guide to Digital Photography and Conservation Documentation.

White balance

Once the workspace has been color balanced, the next step is to set the white balance for each camera. Different camera manufacturers allow this to be accomplished in different ways, so it's best to consult your user's manual for details. General guidelines are as follows:

- *Standard copy stand illumination*: One of the simplest methods is to use a gray card. This is an inexpensive flat card printed with an 18% neutral gray on the front and 80% white on the back. With the copy stand lights on and adjusted to the correct brightness, place the card gray side-up on the copy stand, fill the camera frame with card, and shoot with the camera in white balance mode. This will create a custom white balance setting for that camera and that particular lighting setup. Depending on your camera's options, it is usually possible to use the same process to manually measure the color temperature of a single light source.

- *Transmitted light*: The simplest way to color balance a light box setup is to create a custom white balance setting that matches the light source. Instead of using a grey card, one can simply use the light source as the target. The light source should have even illumination and a ground glass top such that the light is dispersed and there is a color neutral and even illuminated surface.

The image processor should keep an eye out for pictures with noticeably warm or cold color casts. These images are a good indicator that the camera white balance or lighting setup needs adjustment.

If bulbs are replaced or any other changes are made to the lighting setup or the workstations or the workspace, cameras should be re-white balanced.

Image Capture

At the moment the standard for storing archival-quality digital images is the uncompressed TIFF. This file format contains a large amount of data in a stable format that is predicted to be supported long into the future.

A standard high-resolution workflow is to shoot in RAW mode, which prevents the camera from doing any in-camera processing to the image. Images can go directly to a tethered computer workstation or to in-camera SD cards. Depending on circumstances, a record of the objects shot can either be kept in a logbook, spreadsheet, or database automatically synced to the camera's actions. One program that can assist with the capture of images on multiple cameras is digiCamControl.

When a session has finished, the photographer then processes the RAW images using programs such as Adobe Bridge and Photoshop. The following conversion settings are recommended before basic adjustments (exposure, contrast, etc.) are made:

- Color space: Adobe (1998). This provides a larger range of color than sRGB and is more universally supported than other color spaces.

- Color depth: 16-bits per channel. A 16-bit image takes up twice as much storage space than its 8-bit counterpart but is recommended when the objects being photographed show large ranges of color.

- Output size: Best practice is to use the size native to the camera used – avoid extrapolating image data.

- Resolution: Values in the range of 600ppi are acceptable.

The image is further adjusted in Photoshop (rotated, cropped, etc.) and two copies – one of the processed file and one of original unprocessed image – are saved as TIFF files onto the processor's computer. Filenames are assigned sequentially using rendition numbers, which allow the photographer to assign as many images to a single object without resulting to awkward filenames.

Metadata, including object inventory number, a brief description, information about the institution, and a copyright tag, is then added to the files via Bridge.

If needed, the processed TIFF files can then be batch-processed via a Photoshop action into lower-resolution JPEGS for web use. Recommended JPEG parameters for screen use are a 50% reduction in physical size from the parent TIFF, a step down to 8-bit color, and a shift to 72ppi.

Metadata

Metadata is extremely useful for identifying and tracking archival images. These XMP sidecar files can be imbedded directly into the image and stay attached unless forcibly removed. At a bare minimum, image metadata should include the name of the project, the object inventory or other identifying number, and, if warranted, a copyright tag containing the phrase "© [date], Institution Name".

Metadata templates are easily created, edited, and applied in programs such as Adobe Bridge, Photoshop, and Lightroom.

Archival Data Storage

The *3-2-1 Rule* is a rule-of-thumb used to describe the current best practices for archiving digital image collections. It refers to the fact that there should always be at least *three* identical copies of each image, stored on *two* different types of media, with *one* copy always stored off-site on a remote server or storage system.

Even with the best equipment, digital archives can be lost or damaged without proper precautions. The most common dangers are hardware failure and user error (i.e., accidental erasure or dropped drives). Hardware failure is by far the most common threat. According to many sources, 3.5" disk drives have an average expected lifespan of only 3-5 years. These drives can last longer if not continuously powered, though it becomes more difficult to monitor drive and data health if they are stored off.

To combat this – keeping the 3-2-1 Rule in mind – a digital image archive should be stored on a working "live" hard-drive system that is backed up daily to a similar set-up (preferably in a different physical location). This data should be frequently backed up to an off-line read-only product such as DVDs or Blu-ray discs. At this time, the archival community does not recommend cloud storage as a long-term storage option for digital images, though the astronomical community has been moving in this direction for some time.

Current recommended hardware setups are:

- POD (*Pile of Drives):* Fills the two of the three stipulations of the 3-2-1 rule. Can be a drain on a computer's operating system as each drive needs its own unique connection. Advantages: cheap, easy to add capacity. Disadvantages: can be awkward to manage and maintain as a permanent archive.

- JBOD (*Just a Bunch of Disks*): A collection of hard drives in a secure enclosure that simplifies computer-to-drive connections and allows the combination of several drives into one volume (concatenation). Concatenated drives are often referred to as SPAN sets. Data can be backed up on drives within the same enclosure or to independent drives in another enclosure via Ethernet. Advantages: cuts down on the amount of electrical and data connections, easy to maintain. Drawbacks: no automatic mechanism to repair drive errors, though this can be organized via third-party software.

- RAID (Redundant Array of Independent Disks): A collection of drives configured as one volume. Data is written to multiple drives with redundancy. Mirrored (RAID 1) or double parity (RAID 6) setups are a good choice for storing working files in critical situations, such as projects with hard deadlines. Network Attached Storage (NAS) drives have become quite popular and reduce the knowledge needed to set up an array for a large amount of storage. Advantages: "self-healing," fast data access and saving. Disadvantages: complex to setup and manage. Note that a *single* RAID unit cannot be seen as a backup system as any changes made to the root data are quickly made to the copies.

Read-only options are:

- Optical storage media (including Blu-ray, DVDs, and CDs) and tape drives. These forms of media do not suffer from hardware or software problems and, because they are not rewriteable, are immune from user error such as accidental deletion.

Physical media can suffer from age-related decay ("bit-rot"), though this can be mitigated by using high-quality recording media. As of this writing Delkin Gold and Taiyo Yuden gold foil discs are recommended. Burned discs should be stored in jewel cases, or in archival-quality plastic sleeves stored in notebooks. Discs should never be marked with anything other than archival solvent-free marking pens.

Digital Photography Resources for Archives

1. *Dpbestflow.org* (Library of Congress and ASMP clearinghouse for standards and best practice).

2. Bigras, Choquette, and Powell. *Lighting Methods for Photographing Museum Objects*, Canadian Conservation Institute, 2010.

3. Hunter, Fil. *Light: Science and Magic: An Introduction to Photographic Lighting*, 2007.

4. Krough, Peter. *The DAM Book: Digital Asset Management for Photographers*, 2009.

5. *https://cloudharmony.com/status-1year-group-by-regions-and-provider* (a comparison of the stability of different cloud storage services.)

Notes on Contributors

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