Zooming In on the Big Picture: Digitization of Nitrate Panoramic Film

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Abstract

Library and Archives Canada (LAC) has made significant changes in the storage of the institution's cellulose nitrate collection and made great progress towards solving the problem of inaccessibility concerning nitrate panoramic film.

LAC's vast collection of nitrate material includes 600,000 photographic negatives of which approximately 4,000 panoramas have remained inaccessible to both the public and archivists. The panoramas had previously been stored in their original housings, often multiple negatives per metal canister, at an offsite storage facility that was not considered conducive for the long-term preservation of nitrate material.

As part of the preparations to move the nitrate collection to LAC's new state-of-the-art Nitrate Film Preservation Facility (NFPF) staff described, assessed, measured, and rehoused each panoramic negative by separating the panoramas, individually rolling, then wrapping them in bond paper and placing them in boxes in an upright position. In February 2011, the entire nitrate collection was relocated to this new facility, which includes a collection processing room and a digitization room.

Building on the initial research undertaken by Greg Hill and Tania Passafiume (presented at the IS&T conference in 2006[1]), this paper will outline how staff established a successful workflow to digitize a selection of 1,500 panoramas from the Merrilees collection. This collection is in high demand but the panoramas have been restricted in access due to the fragility of the material. The selected panoramas are mainly images of Canadian Expeditionary Force battalions from the First World War, with the negatives measuring up to 2.6 metres (9 feet) in length. After digitization the images will be uploaded to the LAC website. In light of the upcoming 100th anniversary of the start of the First World War it is anticipated that the public, through web-based crowdsourcing, will help in the identification of many of the soldiers in the panoramas.

This discussion will highlight several challenges such as the limited options of equipment and setup available when digitizing nitrate panoramic film, and dealing with a medium affected by deterioration. A complete review will also be presented of the new process developed to obtain a high resolution preservation scan thereby allowing public access to the panoramas while simultaneously preserving the original material in a secure and controlled environment.

Introduction

It would be in unfortunate to hide away the invaluable historic treasures held on a roll of nitrate panoramic film in cold storage leaving it inaccessible to current and future generations simply because of the difficulties in handling and working with this material, when instead it could be digitized and shared with the world. For this reason Library and Archives Canada (LAC) was committed to further advancing an earlier research project in the digitization of nitrate panoramic film.

After the completion of LAC's new Nitrate Film Preservation Facility (NFPF) the nitrate motion picture and photographic film collection was moved to this new location from a facility with inadequate work space to a modern facility that met the National Fire Protection Agency Standard #40 (NFPA40) [2] but also had extra rooms added for collection processing and digitization purposes.

Due to their inherent properties (dimension, previous housing and handling issues) approximately 4 000 nitrate film panoramas dating from 1900 to 1947 have been inaccessible to the Canadian public and many archivists. Access to these panoramas in digital form has long been a goal for the institution but such a project was postponed due to technical shortcomings of hardware and existing procedures. It was not until the nitrate collection was being prepared for the move to the new purpose-built facility that the idea was revisited. The goal was to digitize the panoramas with the least amount of stress on the material while creating high quality digital copies. The digital copies would be made accessible while the nitrate panoramas would remain preserved in proper storage conditions.

The Scope of the project

To start, archivists selected just over 1,500 panoramas from the Merrilees collection (group portraits of Canadian Expeditionary Force battalions from the First World War) for digitization. Imaging staff began by testing possible digitization solutions while creating a standardized workflow for digitizing this extraordinary material. While many different types of imaging equipment and techniques had been previously tested in 2006, none seemed suitable to undertake a project of this scope. Many techniques were considered; including copy stand single capture, copy stand single scan and flatbed scanning. Staff also looked towards other institutions that had already undertaken the digitization of panoramas but decided to proceed in a different direction in order to create a high resolution image. The workflow evolved throughout the life of the project and resulted in the creation of a few different techniques and setups to accommodate for the size and physical state of the film.

The following includes all of the tested equipment options including an explanation as to why some of the techniques were rejected as well as the final techniques developed to create high quality preservation scans.

Copy Stand Single Capture

This technique was used by Archives of Ontario [3] to digitally capture their 297 nitrate panorama collection. As part of

their preservation effort the panoramas were first cleaned and then digitized. To digitize, the panoramas were captured in sections using a light box table with four 200 Watt tungsten light bulbs through opal glass and a Hasselblad camera body with a Phase One P45 digital back mounted on a copy stand setup. The sections were then merged in a post processing software (Photoshop) resulting in a 1:1 ratio, 300 DPI image.

Though this technique looked very promising at first, since the final image would be restricted by the 300 DPI 1:1 ratio dimensions, it would not be possible to enlarge the image and still be able to get further (useable) detail for future identification of the individuals. During planning and discussions, it was decided that every effort would be taken to ensure the best possible scan and resolution now, so that future rescanning would not be necessary and avoid unnecessary manipulation of the negatives. Additionally, the temperature of the light box was a concern to the photo conservator. Unless an alternative way was found to allow the use of a single capture technique (e.g. build a soft-box underneath the table using flash heads) imaging staff would not be able to use this setup.

Copy Stand Single Scan

Similar to the above mentioned technique, this setup would consist of a light box and a copy stand but would have a 4x5 view camera equipped with a Phase One PowerPhase FX Scanback camera mounted above the light box. It would create the same 1:1 ratio, 300 dpi images. However with each scan taking around 20 minutes, such a setup would prove too slow.

Flatbed Scans

It was quickly realized that the best option would be a flatbed scanner. Since professional scanners can scan film at much higher resolutions than 300 dpi, this would provide the best solution in providing high quality images and would alleviate the necessity of rescanning in the near future. The location of the calibration area on the scanner continued to be an ongoing challenge. To ensure evenly exposed scans, the calibration area could not be covered or blocked with the opaque panoramic negatives (see figure 1). The location of the calibration area, present on all large-scale flatbed scanners on the market today, prohibited the capturing of the entire panorama when three or more section scans were required

The design of the scanner lid and hinge and the placement of the calibration area, prevented staff from rotating the panorama 90 degrees (feeding the panorama through the opening between the hinges of the scanner lid) in order to scan section by section. The conservator's recommendation was that amount of stress on the film could have detrimental effects.

Figure 1 *Left, calibration area covered. Right, calibration area not covered*

The Epson Expression 10 000 XL (our top contender) has a pin that cannot be removed, located between the two back hinges, making it impossible to feed the film through in the preferred manner (see figure 2). Though this limited the scanner, the overall size of the scanning area made it possible to capture any panorama up to 80 cm in length and 32.5 cm in height and thus made it very feasible to scan the shorter specimens in our collection.

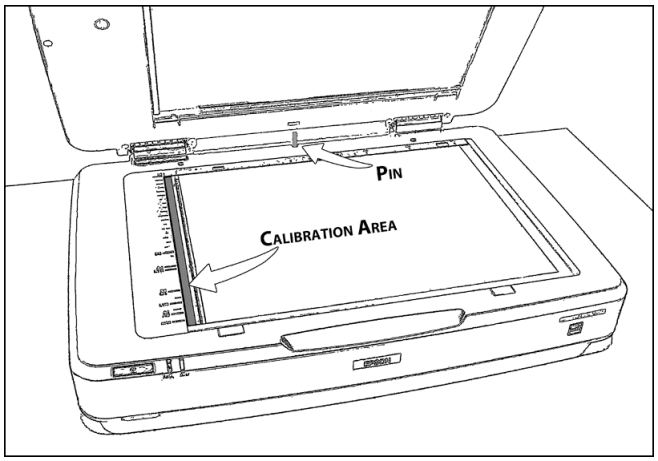

Figure 2 *Calibration area and pin locations on Epson Expression 10 000 XL*

One professional flatbed scanner that did not have its calibration area in a very inconvenient location was the Epson Perfection V750-M Pro (see figure 3).

Though the scanning area was much smaller the position of the calibration area made it possible to scan panoramas of any length in as many sections as needed. The bed did not have any raised edges on it that might harm the film so creating an elongated table and mask around the scanner to create a smooth work area was feasible and simple. A few minor issues, however, made it necessary to create two different setups.

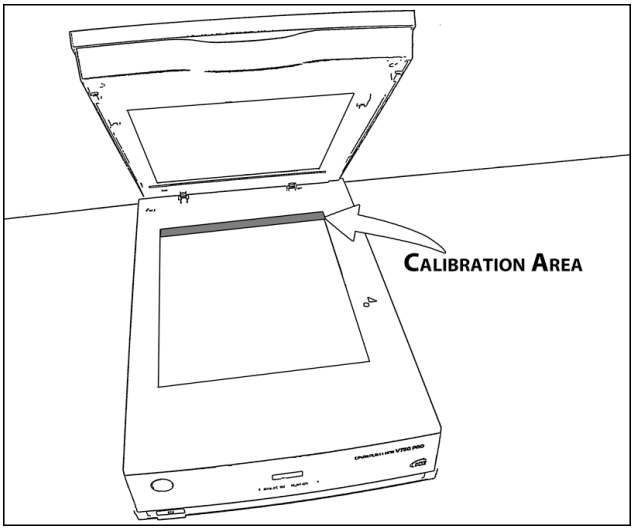

Figure 3 *Calibration area on Epson perfection V750-M Pro*

Unlike the Epson Expression 10 000 XL which has a manual focus setting, the V750-M Pro only has 2 focus settings, one for scanning with holders (of a specific thickness) and the other for scanning directly on the scan glass. The raised focus (for scanning using film holders) is limited to scans of 14.5 cm wide by 24 cm high, while the surface focus is able to scan images 20.3 cm wide by 25.4 cm high. The majority of panoramas selected were scanned directly on the glass, emulsion side down and held flat with Anti-Newton glass. However, when the emulsion side was too thin, Newton rings would appear on the image; it was therefore necessary to sandwich the film between two pieces of Anti-Newton glass to create a usable image. Panoramic film under 24 cm in height could be scanned in one pass but panoramas measuring over 24 cm in height would need each section scanned multiple times, once to capture the upper area and a second to capture the lower area of the film section, creating many more sections scanned compared to panoramas of under 24 cm in height.

All candidate panoramas had previously been measured and their dimensions recorded during the re-housing project. It was therefore possible to determine which setup to use for each panorama before starting the scanning procedure.

Epson Expression 10 000 XL Setup

For all panoramas of 80 cm wide or less, the Epson Expression 10 000 XL was used. To restrain the film, staff used Anti-Newton glass, etched side facing down, that was larger and thicker than what was used for the Epson Perfection V750-M Pro, with dimensions of 32.5 x 44 cm vs. 20.4 x 25.5 cm and 3mm vs. 2mm thick glass; consequently, the Anti-Newton glass was heavier. The extra weight raised the risk of Newton rings forming between the scanning glass and the film, making it necessary to insert Anti-Newton glass under the film, etched side facing up. Additionally, thin small pieces of paper of identical thickness were inserted between the Anti-Newton glass and the scanner lid or transparency unit and the Anti-Newton glass and the scanner glass. These paper spacers aided in alleviating Newton rings developing during the scanning process.

To create a successful scan, the following setup was used. The paper spacers and Anti-Newton glass were placed on the scanner glass. A section of the panorama was then unrolled on the Anti-Newton glass with the excess film being supported by custom-built extensions that fit seamlessly to the scan bed, keeping the film level and protecting it from having any undue pressure. The second or top Anti-Newton glass was then placed onto the section of the film for scanning. Paper spacers were placed between the Anti-Newton glass and the transparency unit. (See figure 4).

Once the best focus setting had been found, this same setting was applied to all scans done on this setup as the bottom piece of Anti-Newton ring glass would never change in height.

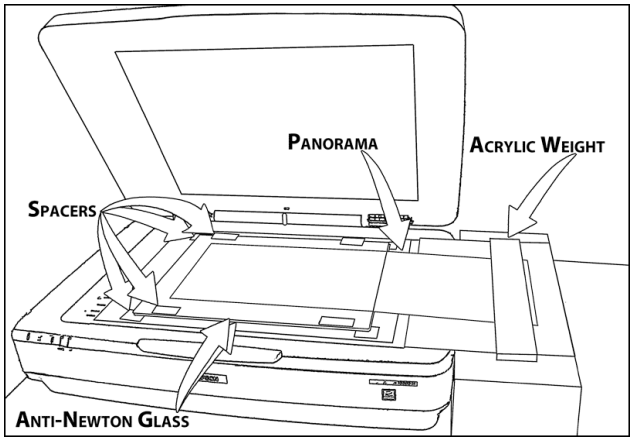

Figure 4 *Epson Expression 10 000 XL setup*

Epson Perfection V750-M Pro Setup (a)

For all panoramas wider than 80 cm, The Epson Perfection V750-M Pro was used. When possible, the panoramas would be scanned directly on top of the scanning glass being gently flattened by a single piece of Anti-Newton glass (with etched side down). Since no contact would be made with the glass in the lid, no spacers were needed. Acrylic weights prevented the panorama from rolling back while keeping the film in position during the scan (see figure 5).

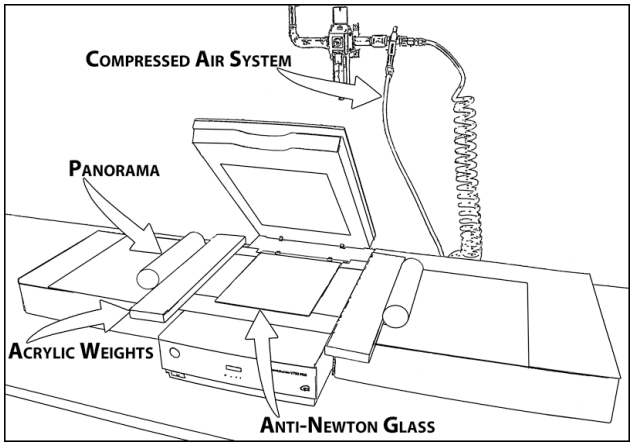

Figure 5 *Epson Perfection V750-M Pro setup (a)*

Epson Perfection V750-M Pro Setup (b)

In the event of Newton rings forming or film not being conducive to being placed emulsion side down, a second piece of Anti-Newton glass (with etched side up) needed to be placed between the scanner glass and the film. Due to the limited ability to set the focus, a custom made setup needed to be created using a mask made of acid free mounting board to fit between the scanner glass and the Anti-Newton glass. The board was made to the exact height needed to bring the custom scanning plain in focus. This was done by measuring the exact height of the film holders and matching that height using spacers. This setup completely eliminated any chance of Newton rings being created, but since the scanning area was slightly decreased, this meant that some panoramas which surpassed the maximum height of 24 cm would need each section scanned twice.

Scanning Settings

All scans were performed at 1 000 dpi, capturing much of the important information found on these panoramas and therefore making it possible to zoom in more than three times the original size, which would make identifying people or other information more feasible. No sharpening or other adjustments were done during or after the scanning other than exposure adjustments to get the best possible scan without any clipping. The best exposure setting was found for each panorama which was applied to each section to ensure even digital scans. The images were scanned in 8 Bit greyscale mode. When scanned emulsion side down, the scanned image would be flipped horizontally to ensure the right orientation was depicted (not mirror image). A museum crop (close crop to the artifact without cutting into artifact, showing full rebate) was used to ensure all information was captured. The raw files had no retouching, exposure correction or size adjustment applied to them, they were saved as is and given a 9 digit alphanumeric e-copy number with a suffix added _a1, _a2, _a3,_b1, _b2,_b3, etc., per each section, consistent with LAC's naming convention, e.g. e-010932020_a1.tif, e-010932020_a2.tif, e-010932020_a3.tif etc.). The final merged and corrected image was saved using the same 9 digit e-copy number (e.g. e-010932020.tif). All files were saved as uncompressed TIFF images.

Post-Scanning

Once a panorama was fully scanned (anywhere from one to forty sections, but averaging 7-8 sections), the Photomerge tool in Adobe Photoshop CS5 was used to merge the sections together using the *Auto* layout setting.

If a panorama had considerable buckling, the digital sections could slightly differ in size because the scanned sections were not scanned completely flat. The *Reposition* layout setting could be used instead of the *Auto* layout setting to prevent Photoshop from transforming the sections and therefore eliminating any changes that were untrue to the original. The *Blend Images Together* setting option was always unchecked. The resultant image of the Photomerge tool was one image with all of the individual sections saved as layers but overlapped at the right locations to create an almost seamless image. The technician would;

- Manually blend the layers together
- Flatten the image
- Perform an exposure correction using curves
- Save the image

This allowed the creation of a single final corrected digital copy of the panorama.

Equipment and Materials used

Epson Expression 10 000 XL Setup

- 1 Epson Expression 10 000 XL with transparency unit
- 2 Pieces of Anti-Newton glass (32.5 x 44 cm, 3mm thick)
- 8 Paper spacers (identical thickness)
- 1 Cover weight paper mask (25 x 35 cm)
- 1 Level platform (18 x 35 x 13 cm)
- 1 Acrylic weight

Epson Perfection V750-M Pro Setup

- 1 Epson Perfection V750-M-Pro
- 2 Pieces of Anti-Newton glass (22 x 26 cm, 2mm thick)
- 1 Height adjustment mask for Anti-Newton Glass
- 1 Cover weight paper mask for scanning table (100 x 32 cm)
- 2 Level platforms (35 x 35 x 10 cm)
- 2 Acrylic weights

Other Materials Needed

- Powder free nitrile gloves
- Anti-static cloth
- Compressed air system
- 2B pencil
- Ventilation system
- Macintosh or PC system with Photoshop CS5

Challenges *and* Operational *Requirements*

Newton Rings

Newton rings were one of the biggest challenges faced during the project (see figure 6) This phenomenon, named after Sir Isaac Newton who first studied them in 1717, is an interference pattern caused by the reflection of light between two surfaces (usually shiny surfaces). The rings might be minute in size and difficult to detect when scanning in greyscale mode. It is sometimes not possible to see the rings unless the image is viewed at 100% magnification. The rings may resemble and sometimes be mistaken for fingerprints. It was found that scanning at higher resolution would increase the appearance of Newton rings.

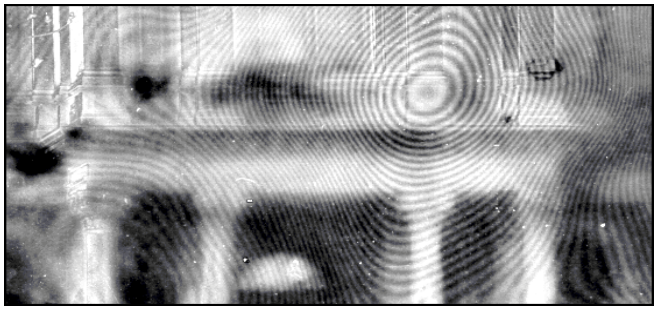

Figure 6 *Newton rings*

Buckling

Due to shrinkage of the film base caused by deterioration, some panoramas buckle when unrolled making it very difficult, if not impossible, to lay them completely flat on the scanning plane. The buckling made it challenging to obtain edge-to-edge focus during scanning and difficult to align overlapping sections during post-scanning. The resulting digitized images are therefore not exact duplicates of the image portrayed on the negative. The shrinkage is unfortunately irreversible therefore the technician worked with the buckled material to create the best possible capture for each panorama. Often, more time was required during the post-scanning stage (the merging and blending process) to correct for the buckling, which required the expertise of an experienced technician. As a result, the size of the overall final digitized image may vary slightly from the original negative.

White Film and Mould

Other deterioration issues also affected both the panoramas and the digitization process. During the initial rehousing project, dormant mould and a "white film" anomaly were noted. Conservation staff determined that the mould was dormant, but precautionary measures were nonetheless required. Since mould could be transferred to other material or surfaces, the affected panoramas were scanned on a separate setup to avoid cross contamination. Rather than using compressed air, as was the usual dust cleaning process, the technician used a gentle air blower to limit the disturbance of mould spores. Staff implemented a daily cleaning regimen of the area and they were provided N-95 masks. The "white film" phenomenon was believed to be a reaction caused by the plasticizer inherent in some film. Preservation and digitization staff decided that panoramas affected by the white film would not be scanned until the nature of the film could be properly identified and further research undertaken to determine a possible treatment. In both these cases, poor or improper environmental conditions contributed to the development of the mould and white film.

Ventilation

Nitrate film is unstable and the deterioration process can begin soon after manufacturing especially under poor environmental conditions. As part of the building requirement, the facility is equipped with a superior ventilation system and multiple air exchanges. The processing and digitization labs are further equipped with fixed fume-hoods and moveable exhaust systems, "elephant trunks," that exhaust externally ensuring safer indoor air quality. Technicians worked on one panorama and one container at a time. The elephant trunks were placed directly over the box to remove any potential off-gassing fumes.

Compressed Air

Compressed air, at a maximum of 20 PSI, was used to gently remove dust from panoramic film and equipment prior to scanning.

After the installation of compressed air lines at NFPF staff noticed minute amounts of oil and debris coming from the lines, and this caused concern since the film should not be subjected to foreign substances such as oil. To resolve this issue, a high quality filtration system was installed; staff bled the lines and performed numerous tests to ensure that no oil or debris remained.

Training and Handling

The imaging technicians were provided with panorama handling training by a photo conservator prior to the start of the project. Though always extremely careful when handling nitrate panoramas, extra caution and care was given to panoramas that were brittle, torn or prone to losing small pieces along the edges. When needed a second technician assisted with the handling of the film. The photo conservator was contacted for any further information when needed.

Acclimatization

The long-term storage vaults at NFPF are maintained at 2 degrees Celsius (+/- 2 ºC) with a relative humidity level of 25 percent (+/- 5%); whereas the working and living spaces within the building have an ambient environment set at 22 degrees Celsius (+/- 2 ºC) and a relative humidity of 40 percent (+/- 5%) for staff comfort. When retrieving material from cold storage for processing or digitization, the collection was first brought to an acclimatization vault with set points of 10 degrees Celsius (+/-2 ºC) and a relative humidity of 25 percent (+/- 5%). This process was an essential step to avoid condensation forming on the film and ensuring safe preservation practice. To comply with NFPA40, nitrate film was not stored in the digitization room overnight but returned to the acclimatization vault for overnight storage.

Future of Project

The selected digitized panoramic images and the accompanying metadata will be made available on the LAC website (www.collectionscanada.gc.ca); preliminary testing is underway using JPEG 2000 files that will enable staff and clients to zoom in on the various details. Although Regimental name and numbers were often written on the film, the identification of each person is unknown without further research. JPEG 2000 technology will enable crowdsourcing and assist LAC in making known this amazing and rich Canadian documentary heritage material.

Preservation staff at LAC is seeking advice from the Canadian Conservation Institute to research, treat and stabilize the "white film" thus enabling the digitization of the remaining pre-selected panoramas.

There remain still approximately 2000 additional panoramic negatives from several collections. Every year, digitization projects are brought forward but resources are limited to undertake each proposal. Planning and prioritization are the next steps before digitization staff can continue scanning and processing these important and fragile negatives. For now, they are held safe in their preservation vaults

Conclusion

The nitrate panorama digitization effort is a success on several levels. Digitization staff learned, through experimentation, to overcome issues in digitizing nitrate panoramic negatives, and all of its inherent handling and deterioration concerns, using the existing equipment on-hand. The expertise they have gained enabled them to develop a methodology for LAC and to share with other institutions tasked with safeguarding documentary heritage.

The success of the project rests largely on the collaborative efforts between Digitization, Preservation and Acquisition sections

within LAC, as well as the knowledge shared by colleagues at the Archives of Ontario.

The greatest success of this project is that both images and metadata will be made accessible to all and are preserved for future Canadians. The opportunity for collaboration from the public to provide insight into Canada's documentary heritage is an exciting prospect.

References

[1] Hill, Gregory J., Janet Kepkiewicz, and Tania Passafiume, "The Long and the Short" of Copying panorama Negatives at Library and Archives Canada (IS&T Ottawa, ON, 2006) *pg. 236.*

[2] NFPA publications, NFPA40 Standard for the Storage and handling of Cellulose Nitrate Film (Quincy, MA, 2007)

[3] James Bowers and Dee Psaila, Archives of Ontario (personal communication. February 18, 2011)

Author Biography

Carla Klück graduated from the Photography program at Algonquin College of Applied Arts and Technology in 2004 and in 2005 gained employment at Library and Archives Canada where she works as an Imaging Technician in the Imaging Services Division, Analog Preservation Branch.