Mixed Media

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Unfurling and Preserving: Using Photogrammetry to Digitize Oversized Materials

By Crystal Heis, University of Kentucky Libraries Special Collections Research Center

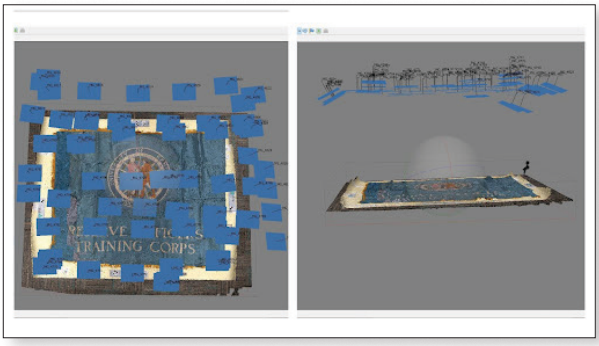
As a cultural heritage imaging specialist at the University of Kentucky Special Collections Research Center, I frequently like to paraphrase the unrelenting optimist Forrest Gump by saying that digitizing archival collections is "like a box of chocolates; you never know what you're going to get," because any given day will surprise and present unique challenges. This holds true for subject matter, media, and even determining how to get clear, reliable images. A recent project to digitize the University of Kentucky Department of Military Science Collection spurred some creative DIY innovation, lots of trial and error, and an eventual across-campus collaboration before we achieved successful results.

This project originated when the commander of the University of Kentucky (UK) Air Force ROTC unit requested to view items from our collection in the Special Collections Research Center. The artifacts included a variety of materials such as pennants, flags, and two very large banners that we believe formerly hung in the historic Buell Armory on campus. When pulling the materials, we discovered that they had not been stored properly; the two large banners, one dating from World War I and the other from World War II, had unfortunately been rolled up into a ball and stuffed in a box. Some of the items made of silk had become extremely fragile, and even minimal handling would cause further damage. Due to their fragile and deteriorating nature, plans were made to rehouse and document these items before placing them back into storage.

Unboxing and imaging preparation of WWI and WWII banners from the University of Kentucky Department of Military Science Collection. Photos courtesy of Ruth Bryan, UK Libraries.

Digitizing these items presented several challenges. The first and most obvious challenge was the oversized dimensions of the two larger banners, which were each approximately 14 feet by 8 feet. While digitizing oversized materials is not uncommon in our digital lab, we traditionally use a wall-mounted vacuum easel with a stationary camera meant for digitizing paper objects. We capture multiple photos by repositioning the artifact and then digitally stitch the images together using Photoshop. However, due to the fabric media and decorative elements, such as fringe, on the banners and flags, our established approach was not going to work for these items. Repositioning the item while the camera remained stationary was not an option for oversized fabric with fringed edges that was difficult to lay completely flat. But, most important, handling these large pieces of fabric was going to be unwieldy and likely to cause further damage. We needed a way to digitize them that would keep them stationary while the camera could be repositioned. Enter photogrammetry.

Oversimplified, photogrammetry is a technique that involves taking a series of carefully captured, overlapping images. The photos are loaded into Agisoft Photoscan software that looks for corresponding points between the images, creates geometric coordinates, and builds a point cloud that creates a three-dimensional representation from two-dimensional images. While creating 3-D models for these artifacts wasn't the primary objective, once a model is generated, a 2-D (orthomosaic) image can be easily exported. In short, photogrammetry is basically a way to digitally stitch images together using computational photography.



Photoscan interface. Photo courtesy of UK Libraries.

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Since the software uses geometry to align the images, there is a greater tolerance for minor irregularities in the camera positioning compared with more traditional stitching practices. The camera doesn't need to be perfectly aligned or level to the subject. In the photo, you can see a demonstration of this with one of the smaller artifacts, where the camera was simply handheld. Each blue square corresponds to a photo and shows the camera placement for that image. Looking at the cross-section, you can see that the camera alignment isn't totally perfect, but still within the tolerance level for the software to align the images. This technique is simple and worked well for the relatively small items in the collection.

For the large banners, we needed to find a method to extend the camera out over the middle of at least an eight-foot span. Working with materials we had on hand, we created a basic DIY camera arm by mounting a camera bracket onto a wooden two-by-four and clamping that down to a staple found in every library, a book cart. To prevent the cart from tipping over, we counterweighted the cart with heavy sheets of masonite. A ring flash illuminated the objects, and the camera was fired by remote control. Not knowing how well this setup would work, we tested our camera rig on the sturdier WWII banner made of canvas.

DIY camera cart in action documenting WWII-era banner. Photo courtesy of Crystal Heis, UK Libraries.

This setup worked reasonably well, but it wasn't perfect. Maneuvering the book cart was cumbersome and required a lot of guesswork on the camera position. Frequently, the flash batteries exhausted before the entire capture process was complete. Certain photos could not be aligned within the 3-D software. In some cases, this was due to insufficient overlap between images or issues with specular highlights from the background material. Also, the cantilevered nature of the camera arm caused the wood to flex and a general lack of stability in the camera rig, which resulted in images that were out of focus. We performed several iterations using this setup, making various adjustments in the focal length of the lens and the lighting, shortening the camera arm, and working with smaller model sections that could be subsequently merged. After significant trial and error, we eventually established a technique that we knew would work, and we could attempt to photograph the larger and more fragile silk banner.

Our digitization process for these large banners sparked a lot of interest from coworkers within our department. One day, a colleague visiting our Digital Lab watched us struggle with our DIY setup and suggested reaching out to a unit on campus that provides media project support to students to see if it had any equipment that could make our process easier. The head of the Student Media Depot was rather intrigued by our unusual request and readily offered the depot's assistance. It turned out to have numerous pieces of camera equipment used in video production that could help us with our image capture issues. One item of particular interest was its camera dolly. A dolly is traditionally used to create cinematic effects, such as smooth panning shots, by way of a camera mounted to a cart, rolling along a dolly track. If we could position the dolly track above an object and reorient the camera so that it pointed downward, this would allow us to re-create a much more stable version of our DIY camera rig and allow for precise camera positioning. Working together with Student Media Depot personnel, we brainstormed a way to invert the mount for the camera so that it hung below the rail system. Then they lent us the dolly system to test our configuration on the fragile WWI silk banner.

Camera dolly with modified camera mount. Photo courtesy of Crystal Heis, UK Libraries.

Evolved digitization setup using a camera dolly and dolly track for documenting the fragile WWI-era banner. Photo courtesy of Crystal Heis, UK Libraries.

The addition of this tool was a game changer. It added precision to our camera placement and gave us more accurate results. We still had to overcome a few hurdles like devising a way to move the camera without disturbing the banner. This was accomplished by starting with the banner rolled on its storage tube and moving the camera with a push stick to photograph the unrolled portion. Then we carefully unrolled the fabric a little at a time during the image capture. This setup was relatively easy for one person to accomplish working alone, but a fair amount of manual labor was involved. After every pass, the carrier had to be removed for the rail system to reposition the rails and the lights, but this was significantly easier and much more accurate than our initial attempts with the book cart system. By applying the lessons learned from the previous banner and the addition of the new hardware, the resulting images provided the data necessary, and the entire process was accomplished on the first attempt.

The final 2-D renderings generated from our 3-D processing using photogrammetry are included here. (You can see both the book cart and camera dolly setups in action by visiting https://bit.ly/3DtXqML.) While both images took a considerable amount of ingenuity using unconventional methods and tools, both demonstrate that creative and collaborative approaches are often necessary to achieve goals that at first seem insurmountable. If your digitization project throws you a curveball like ours did, you just might find your magic tool in an unlikely place. Or, in other words, don't be afraid to think outside of that box of chocolates.

Final orthomosaic rendering of the silk WWI-era banner. Photo courtesy of UK Libraries.

Final orthomosaic rendering of the canvas WWII-era banner. Photo courtesy of UK Libraries.