Rectifying the Past with Digital Historic Imagery

Scanning hard-copy data makes digital historic imagery accessible, virtually organized and easily distributed.

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Many government agencies and businesses have aerial photography prints and large map sheets that document the past, many of which date back to the early 1900s. These prints and maps are vital data sources often used to provide references for historical tracking, area growth or change detection over time.

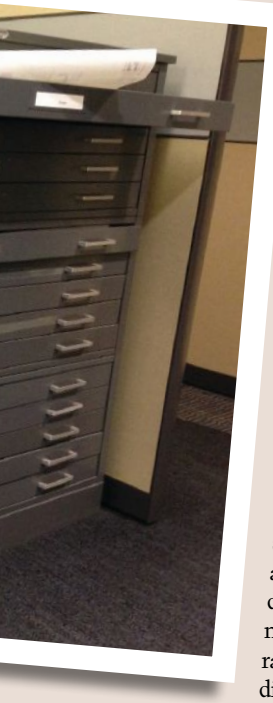
However, frequent handling of these aged prints and maps, constraints on physical storage and the arduous process of wading through hard-copy documents often lead to the end of the data's shelf life. At Woolpert, many of our clients have presented staff members with these data challenges over the years. Each client who approached our staff had a different situation, a unique reason for needing our help and a final desired product in mind. The common denominator among them was that they were looking for alternatives to store historic, hard-copy data and allow access to the data for internal and external use.

Addressing Client Needs

Our challenge was taking historic prints and maps made from different materials and in different sizes, many of which were of an extremely advanced age, and converting them into a digital format. No single tool could handle the scope of every project. However, because Woolpert is a geospatial company as well as an architectural and engineering firm, we had access to a variety of digital scanners that could handle different materials and sizes. We could also carefully scan documents too fragile for an automated scanner.

We used everything from a desktop scanner for hard-copy prints to a large-format scanner for various-sized Mylar plots. We also used a vertical film scanner to input rolls of film. Through it all, the company refined a process that converts hard-copy aerial photography prints and maps into a digital format that can be stored on a client server.

Scanning the data was only the first part of the challenge; organizing the various datasets was another. After the scans were made, Woolpert's orthoimagery group applied its experience and lessons learned on large statewide projects that often entail handling



Storing hard-copy aerial photography, film negatives and maps can compromise the quality of the documents as well as office space.

and organizing thousands of files. Methods for organizing the datasets varied from simple Word documents and Excel spreadsheets to digital layouts created in computer-aided design and geographic information system (GIS)-based formats.

After the projects were scanned into a digital format and organized, the next steps depended on the digital data needs of each client. Requests ranged from a simple one-to-one digital scan of a hard-copy print to a fully georeferenced and orthorectified database of historic aerial film negatives. Once client needs and budgets were established, multiple years of data could be processed and added to a geodatabase. Then the data could be presented to the public for easy download or viewed online within seconds.

Benefitting from Digital Imagery

On several occasions, Woolpert was asked to digitally scan hundreds of historic Mylar maps and tax map Mylar sheets and to georeference them based on their sheet coordinates. Digitally converting Mylar sheets can be difficult due to their large size and irregular shape. In addition, many of the Mylar plots had extensive information on them, such as first-generation orthoimagery, contour data and hydro features.

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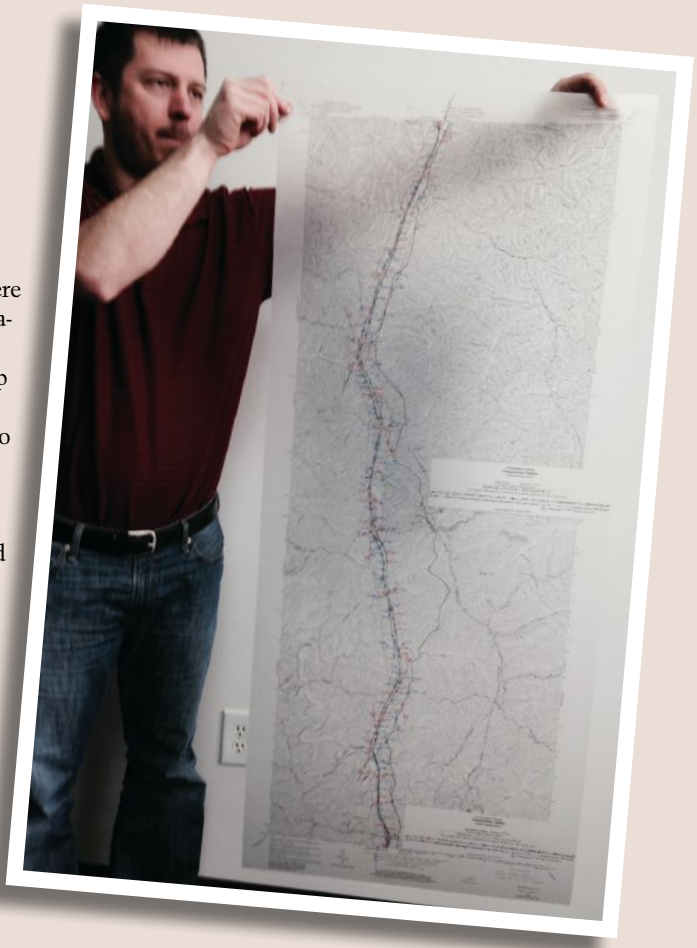
Woolpert used its large-format scanners, which are usually dedicated to scanning blueprints or architectural drawings, to handle these irregular Mylar plots. Mylar map sheets were scanned at 600 dots per inch. During the scanning process, each scan was monitored and adjusted as needed to maximize the detail shown in the digital file.

After the Mylar sheets were scanned, the corners and interior points were measured and the digitally scanned Mylars were rectified to the digitally measured points. This approach produced a nearly exact map location as the original map sheets, allowing the client to overlay these historic documents on current imagery and/or data sources. The same procedure also worked well with historic tax maps and land surveys.

Ann Burns, who manages the Data Analysis Department for the Southeast Michigan Council of Governments (SEMCOG), approached Woolpert about digitizing a large number of historic 9- by 9-inch contact prints. SEMCOG had seven file cabinets full of them.

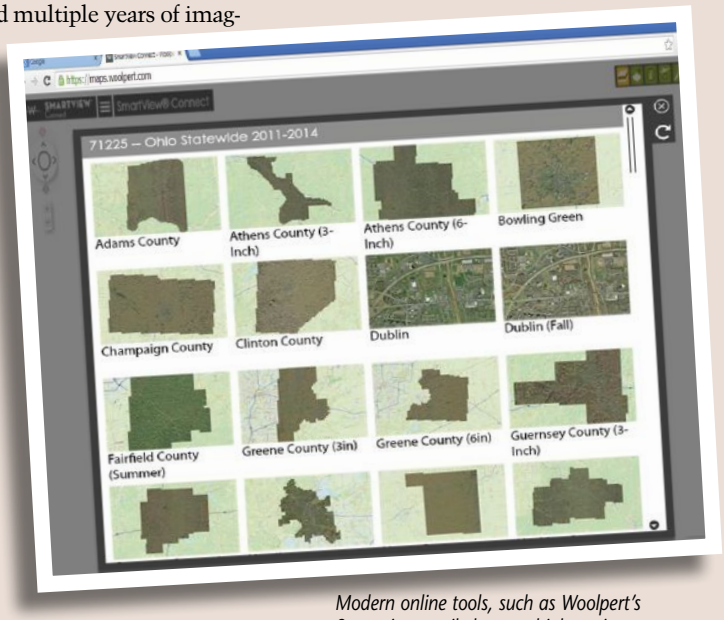


Large, D-size Mylar sheets also can be preserved as digital historic imagery.

"When downsizing our office space, we no longer had storage space of that magnitude," said Burns. "Knowing how valuable this imagery was, we didn't want to get rid of it. So it was the perfect time to have it all scanned."

The SEMCOG project included converting 14 years of hard-copy photographic coverage from 1949 to 1997. The imagery is useful to SEMCOG members to identify changes in land use, verify the existence of structures and see the larger picture of change in Southeast Michigan over time. Because SEMCOG had multiple years of imagery, four-corner georeferencing was introduced within each digitally scanned photograph. To accomplish this, known photo-identifiable features were chosen from SEMCOG's most recent, highly accurate digital orthophotos and then cross-referenced to the same point on the historic image.

Once the cross-referenced data points were collected, the new digitally scanned historic data were



Modern online tools, such as Woolpert's Smartview, easily host multiple projects.

Fayette County, Ohio, converted its scanned contact prints to digital orthophotos.

stretched to provide logical georeferencing for each image. This method is a time-efficient way to convert and store old hard-copy imagery into a modern format. Imagery captured during a specific time period, such as those taken in the aftermath of the 1967 Detroit riots and housed at SEMCOG, will be preserved for future historic evaluation.

SEMCOG'S 20,000 georeferenced images were loaded into several mosaic datasets, allowing staff to view the 14 years' worth of aerial photography in one place. Now all of the agency's historic imagery can be viewed alongside current geographic data and any future imagery, making change detection possible from aerial imagery collected for more than 50 years. According to Burns, having this wealth of data available digitally has made filling requests easier.

"In the past, individuals would come to our office, browse through the file cabinets, find the photo they needed, and then we would make a copy for them," she explained. "Now we can do everything via email."

For more information about SEMCOG's imagery program, visit *www.semcog.org/Data-and-Maps/Aerial-Imagery*.

Benefitting from Accessible Data

In Fayette County, Ohio, there was a need to look back at the county's historic imagery to identify drainage tile mains and to see where systematic tile had been installed. Like SEMCOG, Fayette County had built a library of contact prints stored in cabinets over decades. But in Fayette County's case, it was local residents and farmers driving the need to convert the outdated and cumbersome contact prints into digital images.

Now it's possible to convert historic documents into digital imagery that can be stored and referenced, ensuring these indispensable resources will be available for years to come.

"Agriculture is very important in Fayette County," said Scott Cormany, the county's GIS director. "I get requests from individuals and consulting firms conducting environmental studies, due diligence, (etc.), so they or their clients won't be liable for anything that may have previously been onsite."

The information also is important to homeowners, added Cormany, because knowing where the drainage tiles are located can help homeowners avoid a wet basement. In the past, getting this information was time-consuming for the county.

"We would get the index out of the drawer, find the area needed, then pull the corresponding photo from the hundreds in the cabinet," said Cormany. "And we would never seem to get the right one, or it would always be on the edge of two."

To expedite the process, Cormany contacted Woolpert about converting aerial photography contact prints from 1938, 1956, 1964, 1970, 1980, 1985, 1988 and 2000 into digital historic imagery. Fayette County's approach to archiving the imagery followed a more traditional photogrammetric method. Like SEMCOG's project, Fayette County's first goal was to digitally scan the hard-copy prints.

Besides the age of some of the prints, there was an added challenge of varying scales of aerial imagery. An aerial photograph's scale is based on the aircraft's height when the photo was taken: The higher the aircraft, the smaller objects appear; the lower the aircraft, the larger they appear.

Unfortunately, not all of the Fayette County contact prints included a labeled scale. So the Woolpert staff had to develop approximate scale-based measurements from objects within the imagery. This old-school method required using a ruler and measuring features such as cars, trucks, road widths, etc., to determine the approximate number of feet within an inch distance on the contact print.

Woolpert used a medium-format, high-definition scanner to scan the contact prints. Scans had to be adjusted, depending on that year's scale of photography, to produce a pixel size that was consistent with the photo scale.

After scanning was completed, Woolpert's orthophoto team made further tonal adjustments to the imagery to bring out the best detail in each image. Unlike SEMCOG's project, the client was looking for a higher accuracy digital product from which county and residents could accurately measure.

The team decided the best approach for this type of product would be aerial triangulation, a traditional photogrammetric method. The approach eliminated the random horizontal errors in each image and tightened the errors across the entire county, resulting in the most accurate georeferenced orthoimagery products possible.

Although more labor intensive, this photogrammetric method delivers what one would expect modern-day mapping to achieve. The range is horizontally correct from 2 feet to 10 feet to real-world locations, depending on the height of the aircraft taking the photo.

For the Fayette County project, aerial camera information was researched and obtained for each year's imagery. With the aerial camera specification, photo scale and a present-day ground-control network, the images were triangulated and orthorectified to the county's existing light detection and ranging elevation model.

The individual orthorectified photos were tonally balanced and mosaicked together to provide seamless orthophoto coverage. The orthophoto coverage then was clipped to match the county's current tile sizes and naming convention. The resulting product encompassed multiple years of countywide digital orthophotos. Each year was compressed into a single mosaic coverage and added to the geodatabase.

According to Cormany, the process of accessing information on drainage tiles has vastly improved since Woolpert converted the photos into a digital format.

"A customer asked if we had any drainage records of a development site, and we were quickly able to identify a tile main by looking over the multiple years of digital historical imagery," he said. "This information could have saved a day's worth of digging."

Cormany also told the customer he could give him the coordinates to the project, allowing the customer to access the information on his cell phone.

"Saving time and money, as well as being able to overlay multiple years and other GIS datasets, was something we couldn't do before," said Cormany. "And the referenced historical imagery lines up well with all of our existing GIS data and digital orthophotography."

For more information or to access Fayette County's online GIS interactive viewer, visit *www.fayetteauditor.com/map.aspx.*

Historical Relevance

Commercial digital orthophotography didn't exist until around 1992 and didn't become a mainstream product until 2000, meaning there are decades' worth of aerial photographs and maps taken beforse that time which exist only in hard copy. Now it's possible to convert historic documents into digital imagery that can be stored and referenced, ensuring these indispensable resources will be available for years to come. EIJ