Study of Shroud Feature Evidence Using Video and Photogrammetric Analysis Methods"
a.k.a. "The Halo Study"
By Peter Schumacher

In December of 2013, Dr. Petrus Soons and I began a study of the Shroud of Turin with a particular focus on the area around the face of the "Man of the Shroud". It had been observed by Dr. Soons that there appeared to be a difference in shading surrounding the face that was perhaps coincident with the Mandylion representations in artworks and that further study might provide a more conclusive determination as to actual Shroud image properties and such content in artwork representations of the Shroud.

The study was undertaken at the Shroud Exhibit and Museum located in Alamogordo, New Mexico. The museum and exhibit is presently in storage pending completion of relocation to a much larger facility in the shopping and entertainment area of historic downtown Alamogordo. We expect to reopen there by the end of November 2014.

The primary image used was the 1978 full-size color image on Kodak Duratrans film purchased from Barrie Schwortz in 2009. It is illuminated by proper color temperature diffuse lighting. The display fixture was custom designed for the specific purpose of image analysis.

A VP-8 Image Analyzer system was used in one element of the study. This is the same equipment used by Captains Jackson and Jumper in 1976 to make a model of the Man of the Shroud. However, this type of equipment is relatively inaccessible to other investigators. Furthermore, this is an analog system and tolerance variables are difficult to duplicate. Higher accuracy is now available through digital images and processes, though this does not negate the value and importance of proper analog analysis.

I used multiple digital and analog analysis methods to compare study results. I wanted to insure that it would be possible for others to duplicate the work, assuming they are experienced in the practices necessary to digitize images properly from photographs and to perform subsequent digital analysis. The digital capture process is critical and essential to the quality of the studies.

Dr. Soons provided some of the images used in the study. Others were provided by the Shroud Exhibit and Museum archives. The ambient room light was eliminated and reflections prevented by controlling the camera-to-image path, in the case of backlit transparency images, and the light source-to-print-to-camera path in the case of photographic prints. Images by Enrie, Schwortz, Miller, and Rogers were among the images studied. Not all are included here for the purpose of brevity.

The Schwortz flash photograph of the Barrie Schwortz image shows the "region of interest"(ROI) for the primary shading and features study. Note the reflection of the flash in the image. Obviously this would not be a good photograph to use for the study. It is simply used to record the ROI selected for the study. Room lights were turned off and opaque flat black panels and black foam rubber was used to block any light other than the transmitted light coming through the diffuser and the transparency.

The video camera automatic gain and black level functions were turned off and the linearity was set to gamma 1.0 in order to produce a linear image density (brightness) response from the camera. The resulting image was processed through the VP-8 Image Analyzer. Image 10 is a photograph of the orientation of the ROI as it appears on the color video monitor. The banding and discoloration results because the photographic camera shutter exposure is not synchronized to the video scanning of the monitor. It used only to record the current step in the process. The same is true of the isometric negative plot displayed on the X-Y-Z display (bright is down and dark is up). It is important to note the shading appears similar to a "dish" or "basin" surrounding the face.

Image 12 shows the profile of the VP-8 vertical cursor, a line selected from the image going from top-to-bottom across the TV screen where it crosses the top of the head. In this positive line plot it clearly shows a parabolic response with the darker segment (downward) in the middle being the image densities at the top of the head and the brighter (upward) densities being on either side of the Shroud head image segment.

Image 13 shows a density slice of another image with the ROI orientation with the top of the head toward the top of the video screen. Density slicing is a means to group a brightness range and assign a color to it. The "VP-8" is so named because eight different range groups can be selected and assigned one-to-each of eight different colors. Those can then be displayed or set-to-black using the level-slicing controls. In this case, the photograph of the monitor records a unique shading group that surrounds the facial area of the Shroud image. This repeatedly occurred in tests using various photographic and spectral images and dating from Enrie's photographs of the 1930's to STURP images from 1978. This shading is proven to be consistent and contiguous over a significant range of brightness and physical surface area surrounding the head of the image on the Shroud of Turin.

This image feature, extracted by image analysis, was then compared to Dr. Soons' visual observations to determine if what he had mapped with a paper circular cutout was coincident with the density analysis using the VP-8 Image Analyzer.

I generated a graphic circle and crosshairs and placed dots over the eyes and at the tip of the nose. These were grouped as single object which could then be overlaid onto other images and scaled to common size for comparisons, and even mirrored (flipped left-to-right) for use with photonegatives. As seen in image 18, the match is nearly perfect. Any errors in placement can be accounted by the lack of contrast in the paper-circle image and non-parallel

image surface to camera sensor (film) surface when the circular paper cutout image was made. Other examples are shown based on some of the other origin images tested. All produced significant demonstration of the ratio of shading above the face to the area of shading below the face and to the center positioning of the circular shaded area related to the position of the facial image within that circle.

Similar results were produced using "GIMP 2" an open source analysis application. Those tests led to other analysis using a digital image by Barrie Schwortz in addition to the photographic prints and transparencies tested.

I employed the Gaussian edge detection process in GIMP 2 to extract the edge features (transitions of brightness levels) within the ROI. I was amazed to find the outlined edge features below the face extracted from the surrounding image and features were consistent with the primary and other observations declared by Dr. Soons.

Final graphic overlay tests: I ran comparisons using two additional target markers. I found the features to be consistent with the analog and digital density slicing studies and all the observations of Dr. Soons concerning the circular "HALO" area relative to the face; the "double edge" line; and, the "object below the face". The graphic target was then used to compare Shroud features within artworks (Icons) as declared in the works of Dr. Soons. These were demonstrably accurate and identical by relative size, angles, and positions, and exactly as predicted and described by Dr. Soons.

Using a TV Waveform Monitor, an instrument common and universal to video signal standards testing, I ran a series of tests to plot the brightness (density) of images one-line-at-a-time. This resulted in a line-by-line extraction of brightness variables similar to the output of the VP-8 Image Analyzer. It is also similar to the output of a scanning photo-densitometer.

The results were recorded in bit-map file format (.bmp). This clearly demonstrated the parabolic shape of the area surrounding the head of the Man of the Shroud. It will also make it possible to make a physical model of the brightness variations in a manner similar, though perhaps not equal, to the model made by Jackson and Jumper. While that is yet to be determined in further work pending the reopening of the Shroud Exhibit and Museum, it is certain that a video waveform monitor can be used with proper camera and image acquisition management to duplicate this particular feature of the VP-8 Image Analyzer.

The display is not an "isometric display" and it does not produce a real-time interactive "3D" display of image brightness as does the VP-8. However, it is common to the art of video and universal to applied signal standards.

Conclusion

"Using several Shroud images of different types and dates; various image analysis and measurement techniques; and, employing graphic overlays to compare extracted features to

various artworks and Icons, it is my conclusion that the statements made by Dr. Soons are demonstrated to be accurate beyond reasonable doubt.

Thus, the Mandylion and the Shroud of Turin are on and the same. Therefore, the Shroud of Turin existed at a time in accord with the known history of the Mandylion."

I defer to the considered works of Ian Wilson and other accomplished historians as to the impact of the results of this study, as I am not a historian.

While it is true that not everyone has a VP-8 Image Analyzer system available to them; and, while they may not have all the images available to them that I used in this study; I am convinced that this evidence is conclusive and can be readily duplicated by anyone reasonably capable in the disciplines applied while using a variety of easily accessible tools and even some readily accessible images.