A Proposal for Mapping the Turin Shroud Body Image Picture Elements

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Abstract: A method is proposed to scan high gradient areas of the image on the Shroud of Turin, under computer control, to study the distribution of the picture elements and correlate them with the full body image. It is suggested to use a lightweight digital microscope-camera unit that can be stabilized with the cloth and read through a USB (universal serial bus) interface and a laptop computer to a high volume storage device.

Introduction: Ever since the first photographs were made over 100 years ago, detailed study of the Shroud of Turin has shown that the body image is very unique. In 1989 the Holy Shroud Guild, of Esopus, NY, working with Kodak planned an electronic Atlas of the Shroud with 9 categories of files, that would include map locations and data as follows:

1. Body images, front, back
2. Blood images
3. Dust, dirt, pollens
4. Biological, bugs, plant parts
5. Fluid stains
6. Inert objects, coins,
7. Burns, pyrolized fibers
8. Paint, rust, modern inert materials
9. Cloth structure, thread statistics, C-14 samples, sewing

Several test Photo CD's were made but the work was not carried out because of the high costs seen at the time. Today costs are less and better equipment is on hand, so this program should be reconsidered.

Last year the late Alan Adler presented a report, at the Richmond Virginia Shroud of Turin Conference, that all theories to date fail to account for what is known about the properties of the image (1). More work must be done to document the basic picture elements that make up the actual body image. Guilio Fanti and others have proposed more detailed studies to scan the cloth and log data to electronic databases(2) (3).

Examination of the Turin Shroud by the Shroud of Turin Research Project team, STURP, in 1978 (4) and study of the Max Frei samples taken at the time, have shown that the body image, on the cloth, is made from uniformly darkened segments that reside randomly in single 10 to 20 micrometer diameter fibers of the top crowns of the linen threads that make up the cloth (5). The darkened sections appear to have unique boundaries with the unmarked fiber. They are the picture elements, or pixels, that make up the visible image grayscale seen in photographs.

They are unique in their distribution and formation mechanism so much so that, if they are carefully mapped, they could reconstruct the type of radiation that made the image. This paper will address some of the problems.

Hypothesis: Unlike the uniform picture elements seen in printed pictures or those made by modern electronic devices, like computers or television screens, the Shroud picture elements are random in size and distribution. They appear to be the result of particle radiation rather than continuum radiation. They seem to be impacted on the fibers by radiation moving parallel to gravity upwards and downwards. The pressure wave transferred the wound marks precisely to the cloth(7). The marks are not dye, paint, ink or photo emulsion. To examine this in more detail, STURP planned to examine the cloth again in 1986. A computer positioned X-Y servo table was built to scan the image area to be sampled. A fiber with image mark was to be removed and then the area was to be scanned again. This would give scientific record of the nature of the picture elements, directly to an electronic database (8).

Discussion: Mark Evans who was associated with Brooks Institute, working with Sam Pellicori,(4) took the best pictures that I could obtain from their caretaker Barrie Schwortz. Mr. Schwortz has carefully kept the pictures from the 1978 STURP studies to make them available for researchers the world over.

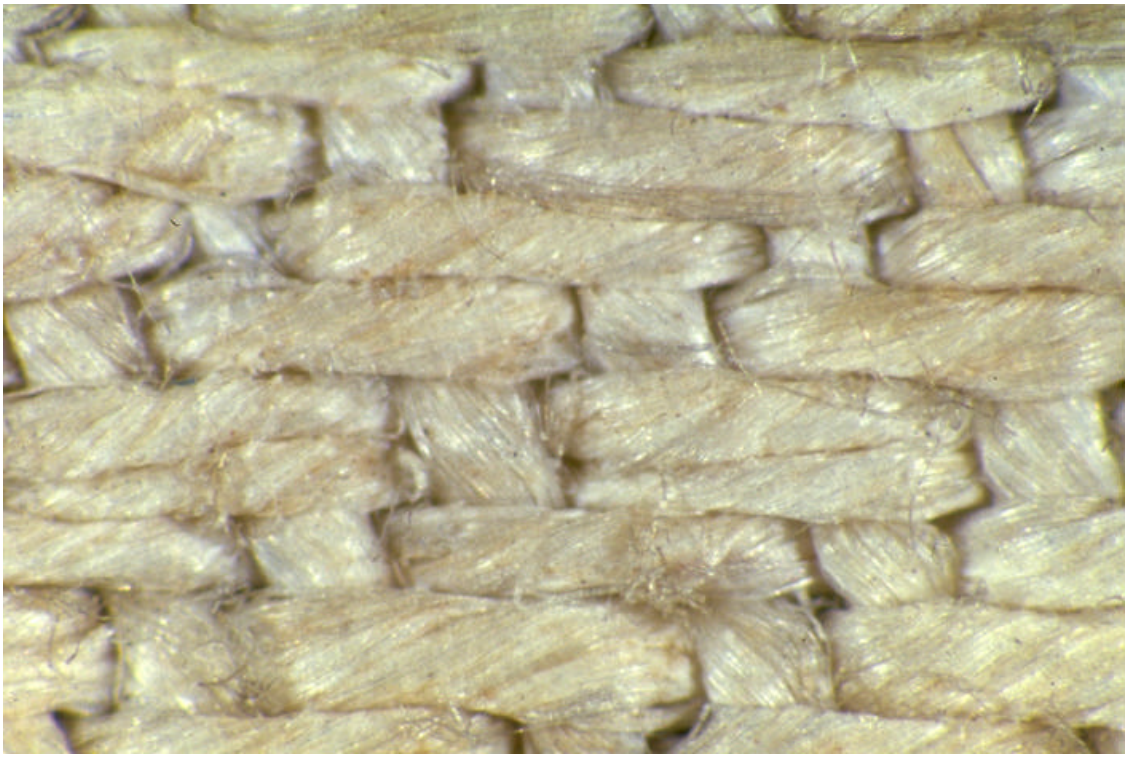


Figure 1. Eye Image Area, 32x, recorded by Mark Evans in 1978.
Courtesy of Barrie Schwortz

The individual fibers that make up a thread are darkened in such a way that an adjacent fiber is not darkened. This can be seen somewhat in the 1978 Mark Evans' macrophotograph image taken over the eye area as seen Figure 1. When this 35mm film image was digitized to give a 17-megabyte file size, the computer pixels are smaller than the grain limit of the film. So the computer can enlarge these threads a little further.

In Figure 2. The center of this photo is enlarged by a factor of 2. This is the limit of resolution of many of the 1978 pictures because the room vibration and air currents moving in the area caused small variations in focus between the cloth and the objective lens, thus preventing higher magnification. Nonetheless, the human eye can see that there is a clear space of non-marked fibers between marked fibers.

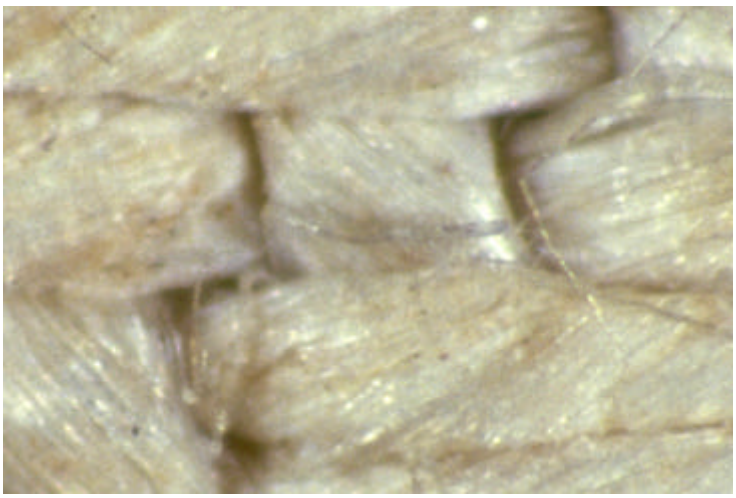


Figure 2. Enlarged area showing small stray fibers and larger thread fibers.

The detail in the picture elements can only be distinguished by mapping them with magnification over 200x, or using a camera system employing a 20x objective lens. To do this, on the Shroud itself, a special fine instrument is required that can be stabilized while recording the image. In conventional microscopes at 200x (20x objective with 10x eyepiece) the depth of focus of the objective lens is only 5 micrometers. If an automatic scan is to be used, an electronic auto focus must also be employed to resolve the top fibers of the thread, as well as the fibers on the sides, as the scan moves over the whole thread.

In Figure 3.two examples of fibers, from the image area over the arm, show what these pixels may look like. I took this 200x microphoto from sample 4bd, one of the 27 that Max Frei removed from the Shroud in 1978. Dr. Alan Whanger, in Durham, NC, USA, takes care of these sample fibers, at present.

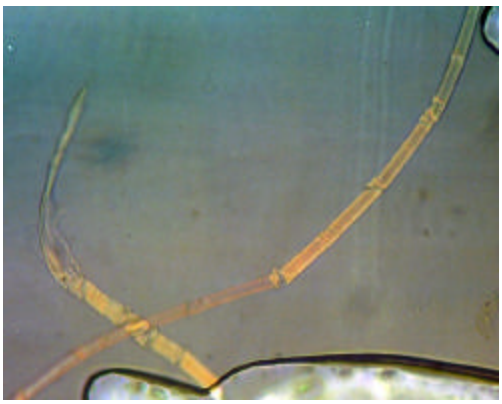


Figure 3. Microphotograph 200x from 1978 Frei sample 4bd taken from the image area of the Turin Shroud

Note that the fiber running from lower left to upper right is lying on top of the fiber running from the lower center to the middle left. This is shown by the cylindrical lens effect that the clear part of the fiber has on the imaged area of the fiber beneath it.

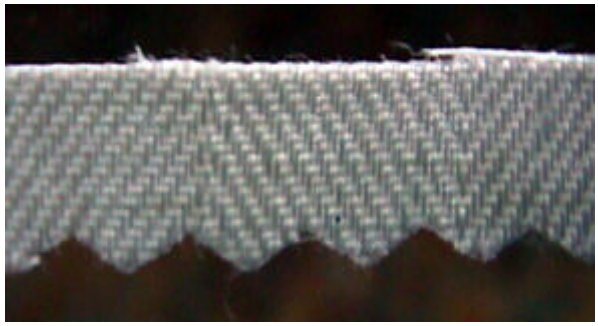


Figure 4. Replica 3to1-herringbone linen cloth similar to the Turin Shroud

To learn about the problems of resolving a 15-micrometers fiber on a 300 micrometers thick cloth, we used a small piece of cloth that is a replica of the Shroud cloth. The sample was obtained in Italy and supplied by Richard Orareo. It is not as tightly woven as the Shroud.

Figure 4. is a front-lit 10x macrophoto of the pattern of a 3 to 1 herringbone linen twill replica of the Turin Shroud cloth. In the picture the sample is about 8 mm high. To scan 20 mm across this specimen, the optical focus would only have to move about 75 micrometers in and out of the page because the cloth shown is so nicely flattened. But on the full cloth, the surface is not flat. As shown in the crossection view in figure 5. There is a good 100-micrometers depth around the crowns of the thread, alone, that could have image pixels. Some means is required to hold the cloth still and flat in front of a 20x objective lens.

Figure 5. Crossection of replica Shroud linen taken at 60x

The replica cloth sample, when measured by calipers, appears to average 300 micrometers or 0.3 millimeters thick. But the irregular surface of the Turin Shroud is more like 3 millimeters, considering the wrinkles and the effect of the backing cloth. Any given thread may be smaller than 300 micrometers and the fibers that make up the threads may be less than 20 micrometers. The fibers we saw in the Frei samples actually range between 12 and 22 micrometers in diameter as individually measured. With 20x objective lens, the depth of focus is about 5 micrometers, so the scan servo must focus vertically over a range of 300 to 1. This is calculated based on the fact that only the top half of the thread is observed or imaged.

The auto focus range of a lens system in a modern digital camera is capable of handling such a 300 to 1 spread. But some external means must be provided to position the camera. It is desirable to use a computer driven servo system to provide the gross transport system on which the camera is mounted.

Figure 6. Replica 3to1-twill linen marked by felt-tipped pen, 10x.

Depending on the feature chosen on the Shroud, the length of a given scan should be adjusted to run from the darkest to the lightest point on the cloth. If the area of the fingers were selected to be scanned, then 10 mm would be sufficient to go from the densest part of the image to the background or the least dense part of the image. If a larger area over a longer slope, such as on the facial area, were chosen then the scan servo requirements become more difficult. Wrinkles in the cloth may not be able to be leveled and more auto-focus range may be required.

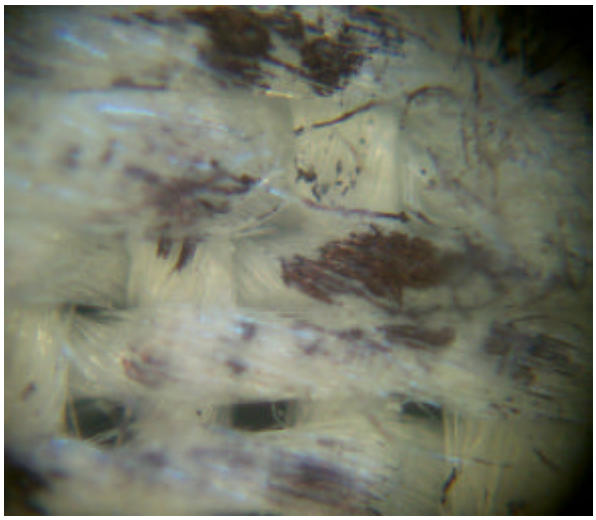


Figure 7. 60x image of felt-tipped pen marked replica cloth

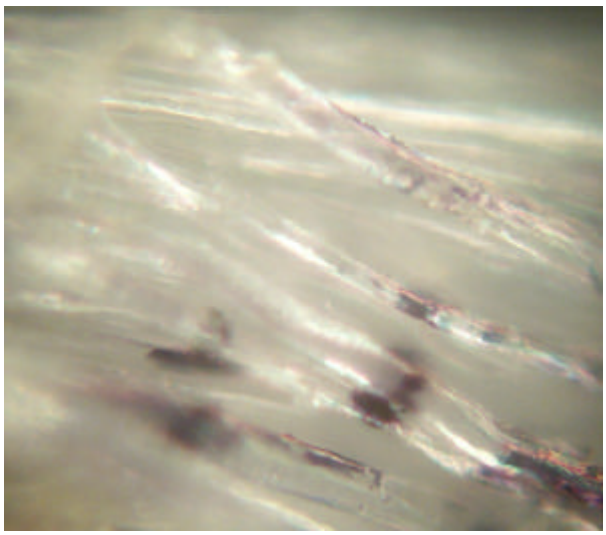


Figure 8. 200x image of marked threads in replica cloth

As can be seen from figure 7. and figure 8. gentle marking of the upper fibers of the thread occurs when the crowns are touched, and some individual fibers are marked. There is a certain amount of wicking of the ink into the threads. But this is not seen in the image area on the Shroud.

The black ink from the pen hits the high points of one thread as it goes over another thread. It is clear that the ink can hit just the tops of the fibers, but on a macro scale it shows the pattern of wicking the ink to adjacent fibers.

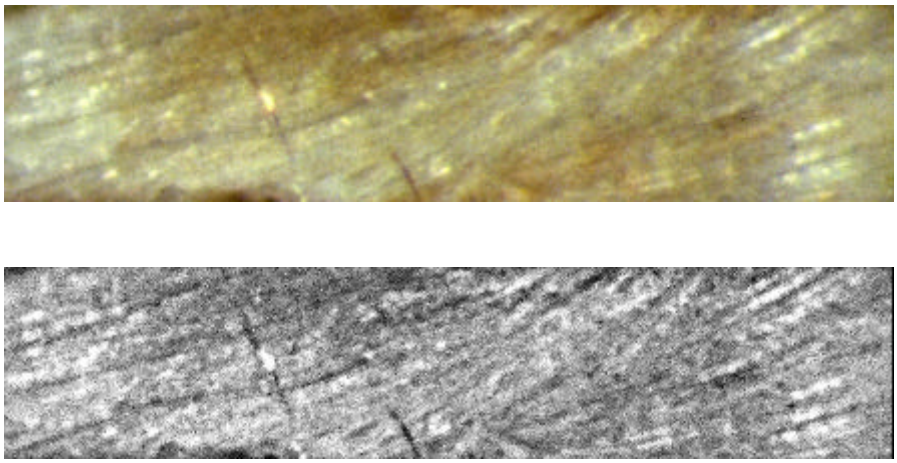


Figure 9. Detail of an image thread from over the eye on the Shroud

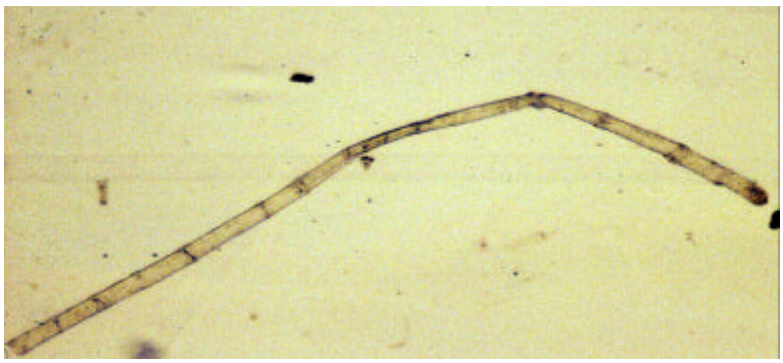
Figure 9. shows a single imaged thread from over the eye. It has been contrast enhanced in color and then spatially filtered in black and white to show how the darkened image sections follow the fibers that make up the thread. It does seem that there are spaces in between adjacent darkened fibers.

It appears that the image is made by collimated radiation, with a short life, acting over a short distance, and not modeled as the inverse distance squared, as normal light or heat. It is believed that particles that made the energy transfer were moving parallel to gravity, up as well as down. They appear to have struck the fibers at very high speed so the energy moved out in any one fiber, as it would in an optical fiber. The chemical change is so uniform in the cellulose fiber, that there is no fluorescence when the image is exposed to ultraviolet excitation. A thermal scorch would fluoresce. It has been reported that the chromophore, or darkened section, is cellulose that has been dehydrated and carbonyl conjugation has occurred to make the imaged fibers brittle (6).

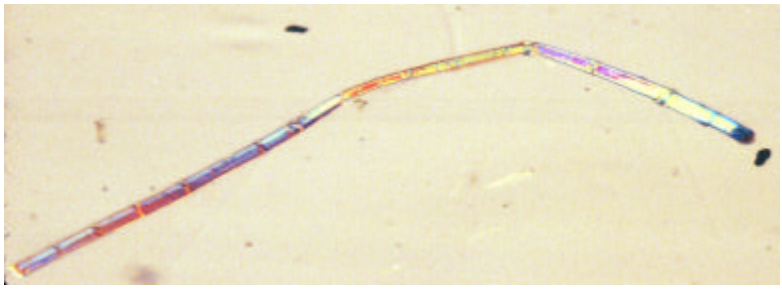
To enhance seeing any optical change in the cellulose, polarized filters can be placed in the microscope's illuminating light source and in the viewing optics. Then any change in the rotation of the light by the fiber will be more visible.

In the following figures a fiber from the Frei image area sample is shown without polarization and then in two different polarized settings.

No polarized filters



Polarized setting 1



Polarized setting 2

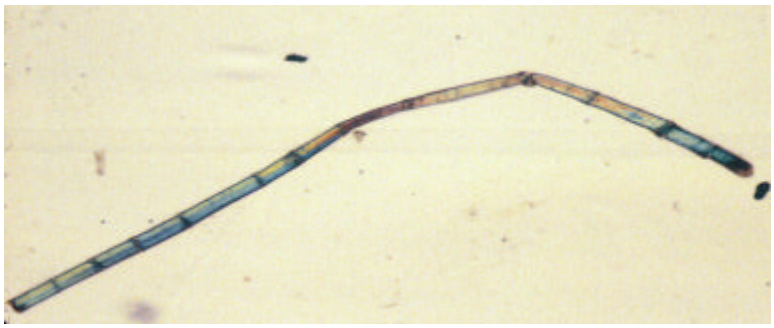


Figure 10. Three 200x views of the same non-imaged fiber

It can be seen that orientation as well as thickness variables change the apparent color of the fiber section in what appears to be an non-imaged fiber. In 1978 STURP researchers showed that the body image, when viewed with UV light, does not fluoresce as do other parts of the Shroud(6). Today, special filters may be made, using thin dielectric layer coating, so only the spectrum of the desired chromophore would be rejected or passed, as desired, to the camera. A

low-light sensitive camera would be used with such a filter so that high intensity light will not be needed and to prevent any further darkening of the Shroud.

Practical Demonstration: In current markets, a very inexpensive QX3 Intel/Mattel camera microscope is available that communicates to PC computers via the USB (universal serial bus). It is very useful to demonstrate a technique to capture fiber details on the cloth (in-situ). A commercial version of this camera could be fitted with a scanning foot that would rest on the cloth, and weigh less than 350 grams. It could be programmed to scan a 5-mm area and take 200x microphotographs. A test unit, as shown in figure 11, has been successfully used at 200x by adding a foot piece, to control the focus, and allowing the unit to rest on the cloth being imaged.

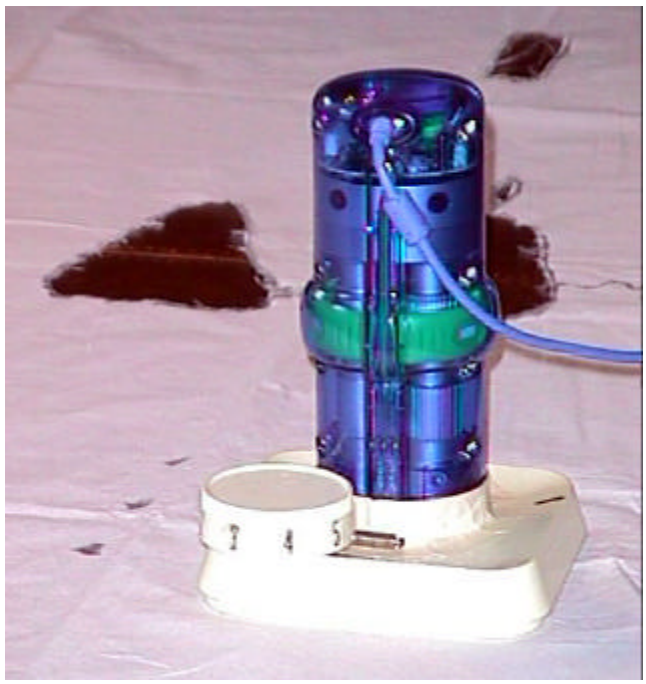


Figure 11. 350 gram USB Portable Microscope Camera, QX3

Figure 12. Base Detail of QX3 Lightweight Microscope Camera

Image analysis software, for use in PC's such as National Instrument's IMAQ product, can perform BLOB (binary large object) statistics to count number, size and location of image-like marks that could be correlated to the image as seen by human eye, or camera, at a normal viewing distance.

Conclusions: In order to obtain good 200x resolution, or higher, a light weight digital camera fitted with microscopic objective lens could be placed in contact with the Shroud, without disturbing the cloth. It would be fitted with auto focus and a limited horizontal scan ability. The instrument would be controlled, and images downloaded, by PC computer. A laptop size computer connected to a JAZ gigabyte storage drive would complete the equipment requirements.

There are other procedures that can be used with this camera as well, such as the direct viewing of the cloth weave by lower power lens. The unit pictured in figure 11. can be operated at 10x and 60x as well as 200x. The photos of the replica cloth used in this report were imaged through this camera.

(This work is being conducted in cooperation with Mr. Paul Maloney, Dr. Alan Whanger, Mr. Barrie Schwortz and Mr. Richard Orareo. It was supported, in part, by the Holy Shroud Guild of Esopus, NY, USA. Reference can be made to the website of the Guild at: **http://www.shroud.org**)

Appendix: Nine (9) Categories to Microscopically Map on the Shroud

These areas require database entry based on position and so they should be handled by an appropriate X-Y servo carriage attached to the examination table.

1. Map the pixels that make up the image in small areas with steep gradients such as the nose and fingers. This will document the statistical distribution of the darker pixel segments in the linen fibers if the scans can be done in the 200x or more visual microscopic levels.

2. Locate and map blood areas in a separate database from burns, pollens and other materials, so that a good picture of the mortal death image of the crucified man can be imaged separately from the resurrection image.

3. Pollens and materials such as travertine aragonite should be located in separate databases to distinguish the geographic identity of the cloth and show its historic background and provenance.

4. Bugs and microbial items likewise should have their own section in the study to account for the general fiber conditions, and damage or preservation problems that have to be addressed for the future.

5. Fluid stains should be mapped to a separate database to show the fire damage and other contaminants as different from the blood and body fluids.

6. Hard items should be mapped closely to see how their image differs from the main body image. The coins on the eyes theory should be easy to study, because some mechanical residue of copper may be present.

7. Burns are especially important to map to their own database because it will show how the cloth was affected by the molten-silver pyrolysis of the cellulose in the fire of 1532. There is an important question to answer here, because of the effect it had on the carbon 14 dating assumptions.

8. Paint pigments should be logged into another database because of the question artistic works that have been touched to the cloth over the years to see if a contact pattern results. Iron particles and full paint chips should be noted to give further forensic and historic basis for the cloth's whereabouts.

9. The basic cloth weave and it's flaws should be mapped to try to further identify its origins. The patches must be properly labeled so the cloth-fold model for the fire data can be more closely shown. Also the places where samples have been taken must be kept in a separate file to append results.

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2) Fanti, G: " A proposal for high resolution colorimetric mapping of the Turin Shroud: analysis of metrological problems". Actes du IIIeme Symposium Sientifique International du CIELT sur le Linceul de Turin "non fait de main d'homme", Nice, Francia, Giugno 1997.

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