

Abstract

The author will describe the attack tape portion of the Max Frei Collection which ASSIST acquired in July of 1988. He will discuss the nature of his work in preparation for a general report still in progress for the ASSIST.

THE COMPLEXITIES OF SHROUD AUTHENTICATION AND CONSERVATION AND SOME INSIGHTS ON THESE QUESTIONS

FROM THE MAX FREI COLLECTION:
THE ST. LOUIS PRESENTATION

are not sufficient to resolve the controversy surrounding the cause of the image on the Shroud. The concept of "significant particle distribution" is introduced. Based upon some further proposals for future work, will be offered.

Paul C. Maloney

Gen. Proj. Dir.

ASSIST

RUNNING HEAD: St. Louis Paper

Abstract

The author will describe the sticky tape portion of the Max Frei Collection which ASSIST acquired in July of 1988. He will discuss the nature of his work in preparation for a general report still in progress for the ASSIST Board of Directors. New information gleaned from studies of these tapes early in 1990 will be presented and a new hypothesis will be offered to explain the "missing blood" which has troubled some forensic pathologists who have studied the Shroud. Some of the problems researchers face will be defined. The conclusion offered here is that data collected to date are not sufficient to resolve the controversy surrounding the cause of the image on the Shroud. The concept of "significant particle distribution" is introduced. Based upon these studies some further proposals for future defining research will be offered.

THE COMPLEXITIES OF SHROUD AUTHENTICATION AND

CONSERVATION AND SOME INSIGHTS ON THESE QUESTIONS

FROM THE MAX FREI COLLECTION:

THE ST. LOUIS PRESENTATION¹

We are now in the "post-carbon dating" era and the conservation of the Shroud of Turin is much on our minds. But what are we conserving? That question cannot yet be answered. Hence, my purpose here is to point up the crucial importance of further research, a goal I know most of us agree with. I hope to demonstrate that despite the remarkable work done by previous scientists, particularly the data collected in 1978 by teams of researchers who went in blind, it is nevertheless understandable that details at many points remain unclear and inconclusive. Thus, while I will point to some of the weaknesses of the 1978 researches I do not wish to be misunderstood. My remarks should not be construed as criticism. The 1978 work must now be seen as setting standards not previously matched by researchers of the Shroud. It also provides the base upon which all future studies must be founded.

When we discuss the conservation of the Shroud we commonly think of the cloth, the image, the blood, and the interrelationship of the three to each other. But I wish to focus on an aspect of the Shroud that is not often included in discussions about conservation. My plea will be that a holistic approach be taken when we seek answers to the question, "What are we conserving?"

The Turin Shroud is an excellent example of an object which is so highly complex that it requires a widely defined approach and a multi-disciplinary team of specialists to address the many questions raised about it. We have a cloth that is either 600 years old or possibly as old as 2000 years. Therefore the fact

that there are textile technologists, textile historians, and textile chemists interested in studying examples such as this cloth will surprise no one.

However, there is a faint image on that cloth and that image is said by a majority of researchers, led by STURP, to be composed of two separate components: straw yellow dehydrated oxydized fibers and blood transferred to the cloth. In 1978 this battery of specialists (STURP), which included physicists, archaeological chemists, blood chemists, engineers, scientific photographers and others, addressed questions about the nature and origin of the body image that had been raised prior to the 1978 testing of the Shroud.

Microscopy was done in Chicago by Walter C. McCrone of McCrone Research Institute. His studies were done primarily using the light microscope on STURP sticky tape samples, taken from the Shroud by Dr. Robert Dinegar and Ray Rogers with a special torque applicator designed for this. This instrument removed samples strictly from the crowns of the threads on the surface of the cloth. Dr. McCrone concluded that the image was composed of two basic components: a reddish iron oxide in a very dilute mix of water and animal collagen.

Both STURP and Dr. McCrone agree on one point--that there is iron oxide on the Shroud. However, STURP has concluded that the iron oxide is incidental to the image whereas Dr. McCrone is convinced that it is the image. To this point in time no one really has an idea of the precise distribution of the particulate form of iron oxide--the main ingredient of the controversy--on the Shroud.

X-radiography, which could address this distribution on a broad scale, was done on the Shroud in 1978. But the lowest energy used to achieve it was about 15 kiloelectron volts (Kev). R. W. Mottern, who led the x-radiographic team, explains it as follows: Various materials have their own unique level at which they absorb energy. When x-rays, passing through the object are absorbed, then strike the film they leave a light image. Wherever such rays are not absorbed and strike the emulsion, they leave a much darker record. Hence, at 15 Kev the cloth is highly visible and even some of the water stains do show up. (Mottern, et al.,

1980). At this energy level there is no trace of the image and we might be tempted to assume that therefore iron played no part in its composition. However, as Mottern points out, the x-radiography is actually inconclusive about this question because the signature of iron is around 7 Kev. Therefore, a fresh attempt at radiography would need to be done to determine that distribution. (R. W. Mottern, personal phone communications, Feb. 18, June 17, 1991)

Whereas, x-radiography would address the question of wide-scale distribution of iron oxide, x-ray fluorescence addresses it by means of point-scans through a window approximately a square centimeter in size. Twenty-three such scans were taken from body and blood areas on the Shroud and analyzed by Morris, Schwalbe, and London to determine iron levels. And, while they did find substantial variances in iron levels, particularly in the blood areas, they felt their testing also was inconclusive and suggested that sensitivity ought to be increased five-fold before a firm position can be stated (Morris, et al., 1980, p. 46).

Nevertheless, STURP's own further laboratory researches with the Rogers tape samples strongly suggest that the currently existing trace levels of sub-micron particles of iron oxide would have been invisible to the naked eye and they therefore believe they have proven that iron oxide can not be the cause of the image. On the basis of the current accumulated evidence, there seems very little chance that the image can be composed of pigment. Whether or not higher levels of pigment existed on the Shroud in the past, which might have contributed to the image and which might have once been washed out, is a more difficult question to address.

Now what of the actual details in the image itself? Specialists from three separate laboratories in the radiocarbon field, who have tested one single sample from a controversial corner on the Shroud, have dated the cloth to the 14th century: AD 1260-1390 to be precise. For, after all, if the Shroud is indeed from the fourteenth century it really ought to be a painting. But all forensic pathologists and medically trained specialists, who have given serious depth study of the image, have concluded that it accurately

represents a crucified corpse. And STURP's physicists and chemists have supported the medical conclusion that an actual body was once wrapped in the cloth. Yet the time frame given the Shroud places it in a period long after crucifixion was practiced and the details of it were forgotten.

If we accept STURP's conclusion that the cloth wrapped a corpse but also accept the radiocarbon date we are forced into the very difficult position of proposing a crucifixion in the 14th century, a proposition not easy to maintain given the state of our current knowledge of medieval Europe.

If we accept McCrone's conclusion, that it is a painting, we are confronted with the question of why and how an artist so radically bucked the tradition and technology of his time in his portrayal of the crucified. How did he become so intimately familiar with the topic to accurately depict the proper mode of crucifixion used in the first century? How did he learn to render such subtleties as rigor mortis, and the differences between the blood flows of a living person versus those of a corpse (both of which are accurately shown in negative on the Shroud). How did he achieve the blood flows on the hair and down the arms without evidence of capillarity whereas the seepages on cloth such as the wrists and the feet do show evidence of it as we should expect of fluid in direct contact with a textile.

Therefore, it is clear that the data collected from the Shroud is still not sufficient to answer all our questions. Certainly, the artist vs. natural image controversy is not yet fully resolved. Dr. Eric Jumper has admitted that the random sampling taken in 1978--both photomicrographically and physically--was inadequate. (E. J. Jumper, public statement, Feb. 16, 1986). Forty-nine photomicrographs were taken of the Shroud in 1978. Twenty-six came from the frontal end and twenty-three from the dorsal. Most of these were photographed at 18x but none higher than 50x due to severe vibrations during the work. Of these only six were taken of the body-only areas on the dorsal end and, excluding the face where the highest concentration of work occurred, only three frontal body photos were taken. (Schwartz, 1982, pp. 546f.). Future on-site microscopy needs to address ways of dampening the

interfering vibrations so that photomicrography can be raised to higher powers.

The particular tape method used to sample the Shroud in 1978 may also, in part, be faulted for contributing to the problem since these represent material only from the crowns of the threads and, as noted before, some STURP researchers have accumulated some impressive material suggesting that here is where the image is confined. (Jumper, et al., 1984, pp. 450-458). Yet, Dr. John Jackson has recently proposed that there may possibly be image all the way through the cloth on the frontal end of the Shroud. (Public communication, Paris, Sept. 8, 1989).² But no tape samples were taken by STURP which enable researchers to make a laboratory comparison between the crown material and material more deeply embedded in the weave. As further research is conducted on samples now available the picture becomes clearer that there is much more information inherent on and in the Shroud that needs to be carefully addressed before an ultimate conclusion can be drawn and we can answer questions about conservation.

On July 15-18, 1988 the ASSIST Organization acquired the Max Frei Collection for Shroud Research (Maloney, 1989). Within that collection were 27 sticky tapes, 26 of which have been verified as having been taken from the Turin Shroud by Dr. Max Frei on the night of Oct. 8, 1978. (Flaherty, June 1989).

Let me say at the outset here that I present the following material strictly in my role as General Projects Director for ASSIST with a responsibility to present a final report to the ASSIST Board of Directors on the nature of the Max Frei Collection and its potential for future Shroud research. I am neither a microscopist, nor a pathologist or chemist, thus, I will not presume to draw conclusions here that I am not qualified to draw. However, during my work in the use of the microscope to develop the reports for ASSIST, certain interesting finds have been made and these have offered insights and suggested hypotheses for future testing by those who are the real experts in the field.

THE FREI TAPES

Already early in 1986, ASSIST had had a preview of the 1978 Max Frei tapes when Mrs. Gertrud Frei-Sulzer kindly made available on loan to us five of the tapes in the collection. Microscopic study of these may be said to have begun, even if briefly, at the Elizabethtown College Conference on the Shroud of Turin held Feb. 15-16, 1986 when various members of STURP, Dr. McCrone, and others viewed some of the particles and fibers on them. However, it can be said that my own work on the tapes began in earnest early in March of that year. It was clear then that pollen and such adjunct material as other botanical debris were among the most common classes of particles in the spectrum of material found. (Maloney, 1986, 1988, 1989, 1990).

Dr. Frei's singular goal for taking his samples in 1978 was to obtain fresh material from a larger area of the Shroud to continue his pollen studies begun when he took 12 samples from the extreme frontal end of the cloth in 1973. All other material which came up on the tapes were, for him, mostly incidental to his prime purpose.

His method was simple: using a hand held dimestore sticky tape dispenser he pulled out about 3 inches length and applied one end of it to the Shroud. While pressing down on one end of the tape on the cloth with his cotton gloved finger he tore the tape from the dispenser and ran his finger laterally along it with somewhat less pressure. Hence, the greatest concentrations of particles and fibers is at what I have termed the "lead" end of the tape where his finger created the greatest weight on the cloth (Maloney, 1990).

Despite Frei's main concentration on his study of the pollen of the Shroud, the manner in which he took some of his samples during the 1978 session provides a window to his mind. It is quite clear from such tapes as those taken from across the upper right arm (4 Bd), from the blood flow across the small of the back (9 Bd), and from the shin (2 Bd) that he was also curious about the nature of the blood markings and the image itself. Hence, the Frei tapes have important value, totally aside from the study of the pollen and

botanical materials, for the study of the blood flows and the image.

The immediate concern for future testing of the Shroud in the aftermath of the carbon date has been for the conservation of the cloth and the image. We wish to share a number of insights for future study of Shroud materials which have been gleaned from the Max Frei samples which should be considered in future testing of the tapes and of the Shroud itself.

One insight deals with the study of the Frei tapes themselves. Many may wonder why we might not successfully pursue the study of these tapes immediately and aggressively with chemical and other destructive analyses. The impetus to do so would be easier were it not for one basic problem inherent in all tape samples taken from the Shroud. Neither Dr. Frei nor STURP micromanipulated tiny individual reference fibers from any of the areas represented by their tapes.

The vacuum samples, taken by Dr. Giovanni Riggi from the backside of the cloth, also do not provide a resolution of the image controversy because they may be described as "macro" samples and therefore even less precise than the tape method of sampling. Some specific threads were actually removed by an Italian group headed by Dr. Pierluigi Baima Bollone but these were limited to blood studies (Bollone & Gaglio, 1984).

During the private examination session of the Frei tapes on July 23, 1988, held at the Philadelphia Academy of Natural Science, Dr. Stuart Fleming, director of the Museum Applied Science Center for Archaeology of the University of Pennsylvania, pointed out that without individual control samples from the image on the cloth, one could never really be quite sure what was an image fiber and what was a loose stray from somewhere else.

Joseph Kohlbeck, a chemist with Hercules Aerospace in Salt Lake City, and one who himself has also spent countless hours examining and testing the materials from the tapes has confirmed that he, too, was not always clear about what was actually an image fiber and what was not. (J. Kohlbeck, personal phone communication, Dec. 12, 1990).

Dr. McCrone's answer to this problem was to use a statistical approach. In his studies he discovered a high correlation between sub-micron particles of iron oxide and the image area tapes of the Shroud (McCrone, 1980). The problem with using the STURP tapes on which to base a conclusion that the iron oxide found there actually represents the image material is complicated by the Shroud's interesting history. Since the late 15th century some 52 different life-size paintings of the Shroud known today as "True Copies" (Fossati, 1984), were laid down cloth for cloth and image for image onto the Shroud. This means that we should expect to find a high correlation of iron oxide materials, the presumed common pigment of these paintings, with the image area of the Shroud. Dr. Fleming's observation, then, is quite apropos to the question: What was loose and what was adhering to the Shroud before the tape samples were taken?

Whereas the STURP tapes cannot easily address this question because they were taken with a very light amount of pressure and represent material only from the crowns of the threads, the Frei tapes are somewhat different in this regard. Though, for the most part, we may say that the spectrum of particles found on the body of the Frei tapes are quite similar to the STURP tapes, there are rare occasions where there is clear and indisputable evidence that specific material on these tapes clearly came from the Shroud. During the microscopy session of March 4, 1990 I discovered one such truly striking example. On the 'sticky tape labeled 9 B/d, which came from the blood flow across the back, pseudomorphs of several flax fibers were preserved in the form of tiny particulates which once heavily coated those fibers and the configuration preserved is of the exact shape of the fibers to which they were once attached. The only way we can explain this is to assume that this particulate material which is now on the tapes came away from the Shroud when fibers stayed attached to the cloth as the tape was pulled.

This sample, then, becomes an important but highly limited resource for the microscopical and chemical study of material from the blood flow across the back. Unfortunately, due to lack of controls, it cannot address the questions surrounding the image. Dr. Frank

Glassy, a blood pathologist in Sacramento, California, who has studied the Shroud for years and who has examined some of the data related to sample removal noted to me in a recent letter:

Judging from the way the various cloth fibers and the vacuum minisamples were obtained it appears that some unintentional errors or some misinformation may result because of the lack of precision or purity and appropriate controls. Here and elsewhere good controls are essential.

Therefore, the first insight from these studies is to strongly reinforce the suggestions already made by others such as Dr. Glassy, Dr. Alan Adler and Dr. Stuart Fleming: in any future serious attempt to resolve the question about what we are conserving on the Shroud, microfibers must be teased away from as many randomly selected images areas as possible to determine and/or verify the nature of that image. Such control samples should be removed by experienced textile specialists and the results would be completely invisible to the naked eye and present no evidence of damage to the cloth or its image.

"SIGNIFICANT PARTICLE DISTRIBUTION"

Now, I wish to introduce a new concept regarding the study of the Shroud. The conclusions I will suggest here cannot be said to be proven but they are consistent with the general hypothesis, proposed by STURP, that a body was wrapped in the cloth and deposited in a tomb environment. I intend the phrase "significant particle distribution" to refer to what I believe is a demonstrable non-random deposition of particles on the Shroud which code meaningful information, that is, to use an analogy from information science, they represent a "signal" as opposed to "noise". Two examples will illustrate my thesis.

The first relates to the image of the body and its interrelationship with the blood. A tape sample labeled 2 B/d has raised some intriguing questions about the distribution of blood on the Shroud. Originally I had

considered the possibility that the findings on this tape favored Dr. McCrone's hypothesis. In my micro-notes dated Feb. 17, 1990 I wrote:

I have found something very disturbing to the STURP image thesis: --At the end of the previous film--moments ago--I documented what appeared to be tiny particulates adhering to flax. Then I found another. They were close together. I wondered why these "coated" fibers were on this tape. I looked at my notes (the micro-summary sheet for 2 Bd) and found that this was the single image area Frei sampled--all others being a mixture of blood and/or blood image, [or off-image].

The very valuable documentation photographs taken by Barrie Schwartz of STURP during the 1978 session shows Dr. Frei removing this particular sample from the left anatomical shin on the frontal end of the Shroud parallel to the warp of the cloth. Ostensibly, this is a "strictly" image area. Unfortunately, since we lack any documentation showing the sample close up in situ we cannot define the exact coordinates any further than we have. Incidentally, this problem illustrates the need for precise documentation of all sample removal in any future testing.

My microscopic examination at 50x had shown that there were significant amounts of flax fibers coated with particulates along the entire 8.7 cm. length of this tape, some of them fairly heavily (though lighter than those found in blood regions).

For a long time Dr. McCrone has been saying he has found, at high microscopic powers, fibers with iron oxide particulates adhering to them. In any scientific project it is important to maintain objectivity and an open mind. I have therefore considered the possibility that these particulates may be iron oxide. I will discuss this further below. But an important recommendation for future testing in this regard would be to specifically re-examine the area from which 2 Bd was taken. What is the precise nature of the area from which this sample came? Only definitive chemical testing of the particulates will properly resolve the question.

Excursus: Reflectance and Transmission Photos

Now, permit me to digress for a moment. When researchers use published photographs to study the Shroud they essentially rely upon light reflectance photos. These are the photographs of the Shroud where the light is bounced off the front of the cloth. But there is another type of photograph which is not as well known. I refer now to light transmission photographs which are taken with the light in back shining through the cloth. These were taken quite literally during the waning moments of the 1978 work on the Shroud. Both the frontal and the dorsal light transmission views have been published in many different places. One may turn, for example, to Ian Wilson's The Mysterious Shroud (1986, plates 11, 12) to find excellent color photographs of these.

Since the particulates under discussion (on 2 Bd) are visible at a relatively low power and appear fairly concentrated in a small area they should therefore create some opacity or impedance to the light. Thus, I reasoned, they ought to show up in the light transmission photographs. But when one examines the published photos of these light transmission views one cannot determine whether or not there is evidence of opacity in the cloth except where the blood flows are clearly evident. This is because the lithographic dots which compose the photographs in the publication process lower the resolution and make them useless for research at the level required.

At my request, Barrie Schwartz kindly made 8 x 10 prints from his master slides. By March 8, 1990 I had received these prints from Mr. Schwartz and I had appended the following note to my sheet dated Feb. 17, 1990:

Note (3/8/90): Barrie's 8 x 10s of the light transmission photos arrived. The details are incredible--nearly everywhere in the image area one can see a "whisp-of-an-image" whereas the blood flows themselves jump out at you. But clearly something is impeding the light in the image area ever so slightly. But the incredible details seen in the reflectance photos are missing. At a micro-level 2 Bd is the only tape

that indicates what may be causing this "whisp-of-an-image."

So that there is no misunderstanding of my current interpretation of this data let me offer the following clarification: when the reflectance photographs are laid side-by-side with the light transmission photographs one is struck by the fact that the details so strikingly clear in the reflectance photos are gone in the light transmission photographs. I therefore conclude that in view of our current information the artist hypothesis is not as easily supported by this anomaly for if one would attribute the details of the image in the reflectance photos to an artist's pigment should not we also expect to find those details in the transmission photos where that pigment would impede the light? Nevertheless, since the naked eye is not always to be trusted when it comes to determining subtleties I believe computer enhancement is among the prerequisites for drawing further conclusions about the image information seen in the light transmission photos.

During discussions with Donald Lynn, formerly of the Jet Propulsion Lab in Pasadena, who did much of STURP's computer enhancement work, I learned that all such work was done on the light reflectance photographs, not on the light transmission versions.³ I am therefore pleased to say that plans are now in the works for computer analysis of the light transmission photos. The development of this tool would be important as a potential "map" of the above hypothesized particles in any future exam of the Shroud.

Significant Particle Distribution:

The "Missing" Blood

What are we to say about the presence of the "whisp-of-an-image" on the Shroud? To my knowledge this phenomenon has never before been noted in the literature.⁴ Perhaps it is because it is truly so very tenuous and vague that it is almost impossible to notice. And anyone studying published versions of this would find it impossible to see anything but the most

obvious blood flows. But it does suggest that there may be what I would term a "significant particle distribution".

While the artist hypothesis certainly should remain under consideration as a possible explanation for the findings on Frei tape 2 Bd, I wish to suggest that by placing the discovery in a larger context--the context of the light transmission photographs--another hypothesis emerges as an alternative which dovetails more easily with the broad array of information already accumulated by STURP and other researchers.

Most Shroud researchers have accepted the assumption, first explored in detail by Dr. Pierre Barbet (1963), that the clearly obvious blood flows on the Shroud represent a crucified man while he was still on the cross and that therefore the body was never washed. More recently Dr. Gilbert R. Lavoie and others have addressed this matter concluding that in accordance with Jewish custom the body was not washed. (Lavoie et al., 1982).

However, this has created a problem for some forensic pathologists. If the Man of the Shroud were beaten as severely as the evidence on the cloth would suggest, and if considerable blood exuded from the many wounds we see, then the body should literally have been covered with blood. But this is not readily apparent in the reflectance photos.

So, for example, Dr. Michael Baden, formerly chief medical examiner of Suffolk County, New York, observed that the obvious blood flows on the Shroud were too neat and he concluded that such "blood" flows were more likely the creation of an artist (Rhein, 1980; Nickell, 1983).

On the other hand, Dr. Frederick T. Zugibe, Chief Medical Examiner for Rockland County, New York, who for forty-three years has studied the Shroud and is an ardent proponent of its authenticity, resolves the problem by suggesting that the body was in fact washed (1988:138ff). In that view none of the blood flows we currently see would represent the vertical stance of the body while it was still on the cross.

There are two important points we must discuss to resolve the issues raised by these respected forensic

pathologists: first, the nature of the blood flows themselves and, second, the nature of the photographic tools we employ to study the Shroud.

I have discussed the matter of the blood flows with Dr. Isidore Mihalakis, noted forensic pathologist in Eastern Pennsylvania. It is clear that a corpse can bleed after death and if a victim of violence has been washed then a small amount of blood can flow from such wounds but the amount of bleeding may depend upon the location of the wound in relationship to the pool of blood inside the body. (Isidore Mihalakis, M.D., personal phone communication, March 8, 1991).

When we look at the Shroud we ask how the blood flow patterns were created. There are a number of factors which must be taken into consideration. Governing the flow of blood are the law of gravity itself, the viscosity of the fluid and the clotting factor. Investigators also must consider some of the rules of geophysics such as the incline of the plane and the fact that fluid will follow the path of least resistance.

If the crucified body is dead and has been hanging on the cross before its removal then the blood slowly begins to drain downward inside the corpse and there is pooling in the lower extremities.

Consider the wrist wound. A small amount of blood may be left in the hand but we must seek a way for the blood in the arm to seep out. If the arm is held up there is no internal pressure for that blood to secrete and create the pattern we see on the Shroud. If the arm is held down the blood can flow out of the wound but then the flow moves down the hand toward the fingers rather than down the wrist and the arm itself.

Only if the victim is still alive while hanging on the cross so that the heart is pumping can we understand that with every slight movement of the torso the clot breaks and a new emission of blood is discharged. Note that according to the pattern on the cloth repeated flows must have followed the same path along the arms and then veered off course at various points. This is entirely consistent with the laws of gravity.

The second factor we have mentioned above, the photographic tools, are of equal importance in understanding the object being investigated. First of all, many researchers may fall into an all too convenient trap: the use of published photographs. There is a basic rule of thumb I have applied to the use of such photographs: "The feature being studied should be several orders larger than the resolution achieved by the lithographic dots of the published product." Otherwise, these dots will interfere with one's ability to perceive features smaller than the dots resolve. The safest way to overcome this is to use original glossy prints from the masters themselves. Unfortunately, these are privately owned, may be expensive, and are not always available to the investigator. But for solid research they are an absolute must.

Secondly, we should not assume that what we see in the photographs of the Shroud represent what was there when the cloth was removed from the corpse. Pellicori and Evans (1981) have shown with photomicrographs of the Shroud that a fair amount of the blood materials from the crowns of the threads have been abraded away. This is a very important fact. It means that blood some distance from the most obvious wounds, which may have been less bonded to those crowns, have surely detached from the fibers over time and have been transported all over the cloth, but particularly at random throughout the image area as Dr. John Jackson once noted. These microscopic particulates cannot be seen in the macrophotographs of the Shroud and loose particles on the tapes are no longer scientifically viable to resolve the issue.

The new information I have presented here from Frei tape 2 Bd from the shin suggests our knowledge about the distribution of blood may be been insufficient. The "missing blood", if I may term it that, may not be missing after all! It may not have been wet enough to create a "blood stain" such as those of the actual flows, but only sticky enough to adhere to the flax fibers further into the valleys of the threads in tiny amounts sufficient to contribute to the "whisp-of-an-image" seen in the light transmission photographs.

I would summarize my hypothesis as follows:
Evidence from Frei tape 2 Bd correlated with the Barrie

Schwartz light transmission photographs suggests that there may be particles impeding the light promoting a "whisp-of-an-image". The lack of detail, yet apparent confinement to the image area, may suggest that these particles are blood. By this I also mean to suggest that the distribution pattern of such particles verified for Frei tape 2 Bd and possibly elsewhere in the Shroud image are coded with meaningful information for the study of the Shroud and ought to become part of what we seek to conserve.

Thus there may be an as yet scientifically undetected distribution of blood particles, not directly associated with actual blood flows seen in the reflectance photographs, adhering to the flax fibers in the valleys between the threads which attenuate the light in the light transmission photographs and contribute to the observed "whisp-of-an-image".

This study suggests that it is a matter which definitely needs to be cleared up in any future examination of the cloth.

Significant Particle Distribution:

Stratified particulates

While the foregoing study illustrates that there may be a meaningful distribution of particles horizontally across the Shroud, my second study will suggest that there may also be a significant vertical stratification of particulates on this cloth.

During the evening of Saturday, Nov. 21, 1987 I met with Prof. Luigi Gonella and Dr. Giovanni Riggi at the Ryetown Hilton, in Rye, New York. One of the points of discussion was the exact nature of the mineral coated pollen⁵ which Riggi had found in the samples he vacuumed from the Shroud. (Riggi, 1981). I wanted to expand my search for such pollen on the Max Frei slides and hence I needed to know which of my examples, in Dr. Riggi's opinion, represented such mineral coated pollen grains.

Over a period of time I have been creating a photo-inventory of each pollen grain discovered on the

Frei tapes. For example, the entire pollen photo-inventory of the Frei tape labeled 4 Bd, which he took from across the blood flow on the anatomical left arm, consists of 163 transparencies of pollen grains, each slide recording one pollen, photographed at 200x. Dr. Riggi carefully examined each of these photos in turn and then told me that in his opinion none of them were mineral coated pollen:

But you can imagine my surprise when I asked him how many of his samples were mineral coated and he responded with, "Approximately 50%". Dr. Frei's tape samples were taken from the image side of the Shroud. Dr. Riggi's vacuum samples were taken from the backside of the cloth from between the Holland backing which had protected it since 1534. Now why would there be no mineral coated pollen on the image side of the cloth and half of the pollen from the non-image side bear such a coating?

A possible explanation struck me two weeks ago while I was reading an unpublished manuscript by Dr. James R. Strange, an archaeologist with the University of South Florida. He was describing the nature of the tomb environment used in Jerusalem for some experiments conducted in 1986 by the Environmental Study of the Shroud in Jerusalem team. At one point he noted that the limestone benches were commonly wet so that when one sat down on them the seat of one's pants would be quickly soaked. That brief description immediately suggested to me that pollen grains deposited there might very well have gained their mineral coating from the environment of the bench in the tomb.

Tape samples removed from various tomb contexts by Dr. Eugenia Nitowski in the Spring of 1986 have demonstrated the presence of pollen on such benches--often in great numbers. Unfortunately, these tapes had to be returned to Israel before they could be adequately studied for evidence of mineral coated grains.

The matter surely merits further study. Riggi had expressed his opinion that the mineral coated grains were the older of the two types of pollen he had found. The presence of mineral coated pollen only on the side of the cloth that would have touched the bench is consistent with the burial shroud concept. But,

furthermore, if Riggi is right about these being older, then we have here, locked up in the mineral coating, pollen, all of which must have come from the burial environment in Jerusalem where the Shroud is proposed to have been. If that is true then these pollen ought to provide us with a more definitive statement regarding the geographic locale from which they originated. Thus they take on a new importance in our future studies and as such must be part of any consideration for the conservation of the Shroud.

CONCLUSIONS

The major concern I would voice here can be expressed with a series of questions: In our quest for the conservation of the Shroud, what, exactly, are we seeking to conserve? Are these particulates which Dr. Max Frei retrieved from the Shroud with his sticky tape from the shin, adhering very lightly to the fibers? If so are they still there? We must remember that Dr. Frei took his tape samples before the Shroud was vacuumed. I would therefore urge (as done privately elsewhere by Dr. Walter McCrone) that any future testing session involve both forensic pathologists and pigment specialists who would study the Shroud in tandem to determine if other randomly selected areas retain these same particulates glued to the flax fibers. If individual flax fibers can be micromanipulated from a large random sampling of the image area on the Shroud and microscopically and chemically determined as to whether they are iron oxide or blood exudate, it would not only bid fair to resolve the McCrone/STURP controversy, but it would also provide us with some of the information about what we are seeking to conserve.

I conclude here with a summary of the points I believe are pertinent in this study for future conservation testing:

1. Dr. McCrone's suggestion for a dual team of forensic pathologists and art conservators to study the image problem is excellent and should be given serious consideration.
2. Reference control samples must be micro-manipulated from the Shroud to enable scientists

to determine exactly what it is they are testing. Such controls will make future use of the STURP and Frei samples scientifically more rigorous and defined. The "whisp-of-an-image" hypothesis can be examined within the context of this proposal.

3. Development of a computer enhanced version of the light transmission photographs should provide scientists with a useful tool for the study of proposed areas of concentration of particulates on the Shroud especially the more tenuous aspects which I have termed here the "whisp-of-an-image".

4. Future photo-documentation should include long range photos such as those taken by Barrie Schwartz in 1978 and close up photos of the exact context from which samples have been removed. There needs to be a visual manner in which coordinates can be recorded on film to provide an accurate setting for each sample site to be used to precisely document a given sample in later laboratory work.

5. We must give careful attention not only to the preservation and conservation of the cloth and the image, but also to what I have termed "significant particle distribution" on the Shroud.

ENDNOTES

¹I wish to thank Samuel Pellicori for his thorough review of an early draft of this article and his cogent suggestions for improving it. I am also indebted to Dr. Robert Dinegar for his corrections. Both are members of STURP. The paper was rewritten in the light of their comments. But I remain fully responsible for any remaining errors in content or interpretation of the material here.

²Dr. John Jackson has hypothesized that if the frontal end of the cloth, covering a corpse in the supine position, fell through the body during the resurrection event, perhaps there may be evidence of image traces all the way through the cloth on that end of the Shroud.

³Most of the computer enhancement work was done by Donald Lynn and Jean Lorre at Jet Propulsion Laboratory in Pasadena, CA and by Dr. John Janey at Los Alamos National Laboratory in New Mexico.

⁴However, Dr. John Jackson, in a lecture presented at the St. Louis Symposium on Saturday evening, June 22, 1991, compared a scorch on the frontal end of the Shroud with a similarly colored nearby area on the face on light reflectance photographs, observing the remarkable similarity in density and color. But he pointed out that in light transmission photos the scorch turns black whereas the image becomes extremely vague to the eye.

⁵Riggi indicates that the coating is composed of calcium, magnesium, and strontium with calcium being the primary component.

REFERENCES

- Barbet, P. (1963). A doctor at Calvary. New York: Doubleday.
- Bollone, P. B., & Gaglio, A. (1984). Demonstration of blood, aloes and myrrh on the Holy Shroud with immunofluorescence techniques. Shroud Spectrum International. 3(13), 3-8.
- Flaherty, T. (1989). Verification of the Max Frei Collection. The ASSIST Newsletter. 1(1), 3-5.
- Fossati, L. (1984). Copies of the Holy Shroud: Part I. Shroud Spectrum International. 3(12), 7-23.
- _____. (1984). Copies of the Holy Shroud: Parts II & III. Shroud Spectrum International. 3(13), 23-39.
- Jumper, E.J., Adler, A.D., Jackson, J.P., Pellicori, S.F., Heller, J.H., Druzik, J.R. (1984). A comprehensive examination of the various stains and images on the Shroud of Turin. In J.B. Lambert (Ed.), Archaeological chemistry--III, (Advances in chemistry series, no. 205, pp. 446-476). Washington, D.C.: American Chemical Society
- Lavoie, G. R., Lavoie, B., Klutstein, Rev. D., & Regan, J. (1982). Shroud Spectrum International. 1(3), 8-17.
- Maloney, P. C. (1986). Five sticky tapes from Dr. Max Frei's collection: Preliminary report # 1. Unpublished manuscript.
- _____. (1988). An interim progress report on the photo-inventory/survey project: The Max Frei sticky tape collection on loan to ASSIST. Unpublished manuscript.
- _____. (1989). ASSIST announces the acquiring of the Max Frei Collection for Shroud research. The ASSIST Newsletter. 1(1), 1-3.
- _____. (1990). The current status of pollen research and prospects for the future. The ASSIST Newsletter. 2(1).
- McCrone, W. C. (1980). Light microscopical study of the Turin "Shroud" II. The Microscope. 28(3, 4), 115-128.
- _____. (1981). Microscopical study of the Turin "Shroud" III. The Microscope. 29(1), 19-38.

- McCrone, W. C., & Skirius, C. (1980). Light microscopical study of the Turin "Shroud" I. The Microscope. 28(3, 4), 105-113.
- Morris, R.A., Schwalbe, L.A., London, J.R. (April, 1980). X-ray fluorescence investigation of the Shroud of Turin. X-Ray Spectrometry, 9(2), 40-47.
- Mottern, R.W., London, R.J., Morris, R.A. (1980). Radiographic examination of the Shroud of Turin: A preliminary report. Materials Evaluation, 38(12), 39-44.
- Nickell, J. (1983). Inquest on the Shroud of Turin. Buffalo, N.Y.: Prometheus Books.
- Pellicori, S. F., & Evans, M. S. (1981). The Shroud of Turin through the microscope. Archaeology, 34(1), 34-43.
- Rhein, R. W., Jr. (1980). Medical World News. 21(26), 40-50.
- Riggi, G. (1981, Oct. 9). The dusts of the Holy Shroud: Progress report on the work of the Turin section of STURP. Paper presented at the STURP conference on the Turin Shroud in New London, Connecticut.
- Schwartz, B. M. (1982). Mapping of research test-point areas on the Shroud of Turin. Institute of Electric and Electronics Engineers 1982 Proceedings of the international conference on cybernetics and society, October, 1982, 538-547.
- Wilson, I. (1986). The mysterious Shroud. New York: Doubleday.
- Zugibe, F. T. (1988). The cross and the Shroud: A medical inquiry into the crucifixion (2nd ed.). New York: Paragon House.