

AN OVERVIEW OF THE TESTING PERFORMED BY  
THE SHROUD OF TURIN RESEARCH PROJECT WITH A SUMMARY OF RESULTS

Eric J. Jumper  
Department of Aeronautics and Astronautics  
Air Force Institute of Technology  
Wright-Patterson AFB, OH 45406

ABSTRACT

This paper reviews the tests performed by the Shroud of Turin Research Project on the Turin Shroud in October of 1978. The major findings of the project as they pertain to our understanding of the chemical make-up of the various stains and images on the Shroud are briefly described. Also presented are some of the results of laboratory studies that attempted to simulate these stains and images on the Shroud. The paper is meant to provide the reader with the background necessary to place the remaining papers of this session in proper context.

INTRODUCTION

Before I start the main task of this paper, I would like to make a few prefatory comments. No one who has been driven by curiosity to investigate the Shroud of Turin and has chosen to congregate into, and remain with, a group of researchers calling themselves the Shroud of Turin Research Project (STURP) has remained unscathed. Because of the unprecedented flood of interest by the public, our work and the object which we study have become a media mania and the testing which took place in October of 1978 has become an after-the-fact media event. The group was unprepared for this kind of attention and we soon found ourselves pawns in the hands of the press. We have been quoted on intermediate stages of thought with our careful disclaimers conveniently left off, and, even more annoying and more often the case, we have been misquoted. We have also had two members of STURP leave the group and begin reporting things which are not supported by the data and which the group as a whole does not believe. To these we may attribute the stories that the Shroud exhibits proof of the resurrection of Jesus; this is absolutely untrue. To another we may attribute the report that the Shroud is simply and obviously a painting; while many of us would have well preferred it to be so, the data does not allow this simple explanation. The truth of what we found lies at neither of these extremes. Despite these annoyances, our record is one in which we can take pride, because the group as a whole has adhered to the accepted method of reporting scientific findings; we have a long record of publications in the scientific press. Today we continue this method of responsible reporting by choosing this forum as appropriate for presenting our interpretations of the photographic imagery of the Shroud.

This paper is not intended as a definitive work, but rather a means of giving some background information to enable the reader to better appreciate

the papers which follow in this session.

THE SHROUD

If I were delivering this paper five years ago it would be necessary for me to give a long introductory expose on the Shroud of Turin; today, however, there are few who are not at least somewhat familiar with the subject. Unfortunately, most have become familiar with it through the popular media, and this avenue is inundated with misinformation.

The Shroud of Turin is a piece of old herring-bone-weave linen measuring approximately 4.4 x 1.1 m. On one side of the linen is an image of the front and back of a man layed out head to head at approximately the center of the cloth with each body image extending out for approximately 1.8 m in opposite directions. Because you will be seeing numerous photographs of the Shroud, I need not picture it here. Markings overlaying these body images portray wounds that correlate with those attributed to the scourging and crucifixion of Jesus of Nazareth. The overall appearance of the cloth has led to the traditional interpretation that it is the burial cloth of Jesus.

Our study of this cloth was far from the first (1) and one finds in the early literature results of studies which speak to the complexities of this object. Let me summarize these complexities with a series of questions. Why does the image look more convincing as a photographic negative? Why is the anatomical detail free of error? Why is the image unaffected by exposure to water and elevated temperatures? What is the chemical nature of the image/images on the cloth? What is the physical nature of the image/images on the cloth? What formed the image/images? How old is the cloth? In fact, many of these questions are inter-related. But notice that there is one question conspicuous by its absence: is the Shroud of Turin the burial cloth of Jesus? I did not list this question with the others because this is one question that science cannot answer except in a negative way. If the Shroud were a painting, as an example of many statements which could be made, it could not be the burial cloth of Jesus, but I know of no scientific test which would prove that the image is of Jesus. Nevertheless, it is this question that is responsible for the interest in the Shroud.

Of all the questions I listed above the question of age comes closest to being the definitive one. Unfortunately this is a question we have not been able to address for a number of reasons which are not worth mentioning here. This question, however, is an imperative one, and a carbon-14 date must be performed before we would recommend further serious study of the

Shroud. As to the rest of the questions, we have covered these in some detail to varying degrees of success. Some of this work will be reported here today.

#### TESTING AND CHEMICAL RESULTS

An overview of the direct tests performed by STURP on the Shroud in October of 1978 can be found in more detail elsewhere (2). These tests included Photography, optical and UV reflectance and fluorescent spectroscopy, IR spectroscopy and thermography, X-radiography, X-ray fluorescence, and chemical analysis. The photography experiment will be detailed in a paper in this session (3). The optical-spectrographic studies are detailed in references (4) and (5). The IR studies are detailed in reference (6). Details of the X-radiographic study can be found in reference (7). The X-ray fluorescence study is detailed in reference (8). Finally, details of the chemical study can be found in references (9) and (10).

In addition to these technique-and-result type papers, a number of laboratory simulations have been carried out to simulate what we found on the Shroud. Details of some of these can be found in reference (11) and in a paper to be presented in this session (12). Still other papers have attempted to synthesize the various findings to, in one case, address possible causes of the image (13), and, in another, formulate our best explanation of the chemical make up of the various stains and images on the Shroud (14).

We find the following explanation of the chemical make up of the stains/images to be the most consistent with all the findings. First there are two distinctly different kinds of images forming the body/wound image complex. These may be grouped into body-only images and blood images. We find the blood to be blood (9),(10). The body-only image at first seemed quite mysterious; we found it to be not due to added material (i.e., no trace of material sufficient to explain the presence of the image is now present on the cloth), but rather to a discoloration of the surface fibrils of the linen thread itself--discoloration by an oxidation process chemically similar to natural low-temperature aging (decomposition). Our laboratory simulations have removed some of this mystery, for we find that almost anything from simple stretching to perspiration will cause linen to decompose and discolor more rapidly than the undisturbed linen (11). We have even been able to duplicate the chemistry and microscopic appearance of the image by simple contact (see Figure 1). These laboratory simulations have led some in STURP to believe that the mechanism for the placement of the image on the cloth was some sort of contact transfer. These results, however, have not been wholly satisfying because of one of the characteristics of the image. This characteristic is the subject of one of the papers which will be presented in this session (12). That paper will establish that information encoded into the various shading densities of the image correlate with the distance one would expect to find between a cloth and a body if the cloth were draped over that body.

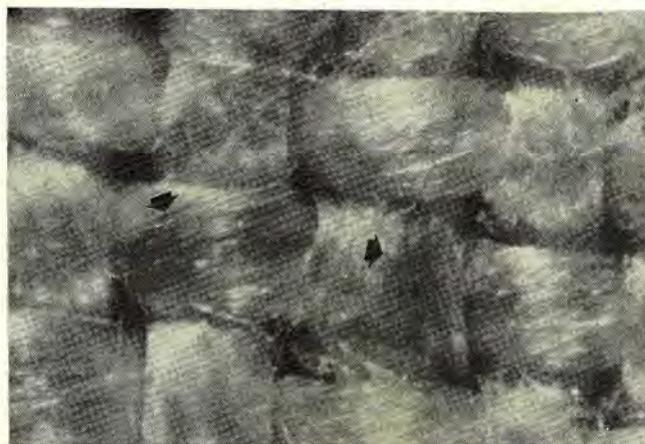


Figure 1. Photomicrograph of laboratory simulation by Pellicori (~40X). Arrows point out placement of image on thread which matches Shroud body-only image.

Before leaving the subject of image chemistry let me address the widely publicized theory that the images on the Shroud are simply painted. This theory is reported in some detail in references (15), (16) and (17). These papers propose that the blood images and the body images are made up of essentially the same substance, a gelatin-based paint whose pigment consists of iron oxides and mercuric sulfide (iron earths and vermilion). On the face of it this report is in direct contradiction with our findings. While this is not quite true, it is true that the painting hypothesis finds contradiction with even the earliest of the technique-and-result papers and is not supported by our chemical studies. Fortunately, it does not require an in depth study of the STURP papers to find fault with this painting hypothesis. Figures 2, 3 and 4 show the same area of the Shroud from three different perspectives. The first, Figure 2, shows a normal reflectance photograph of the side-wound area of the Shroud. Shown in the figure are patches, burn marks and fire damage, and, most importantly, a heavy blood flow area and two water stains. Figure 3 shows the same area in a transmission photograph, that is to say, a normal photograph taken of the Shroud lit from the back. These water stains are typical of many on the Shroud. We have chemically tested these areas and find them rich in calcium and iron and, in particular, rich in very pure  $Fe_2O_3$ ; in other words, these water stains are not untypical of common iron- and calcium-rich hard water stains. In addition, the visible appearance of the water stains is enhanced by organic debris from the fire damaged area of the cloth (14), (18). The X-ray image of Figure 4 is an absorption image. This image is a direct consequence of areal density. The heavier the atomic weight, the more absorption and the lighter the X-ray. From the first two figures it is clear that the blood stain is both darker and denser than the water stains. If the blood image were the result of iron oxide and mercuric sulfide it would show up far more distinctly on the X-ray than the water stains, but quite the opposite is true. As reported in reference (7), we were unable to see any of the blood marks in any of the X-rays, further, all the water stains showed up in the X-rays. Thus, Figure 4 represents only one of many examples why the theory of references (15), (16) and (17) cannot be viable.

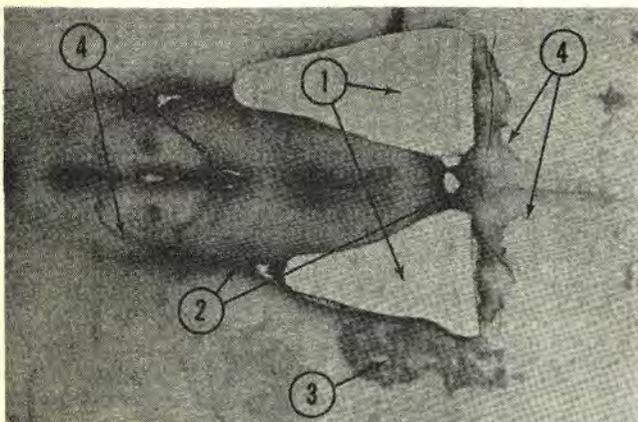


Figure 2. Reflectance photograph of side-wound area: (1)Patches;(2)Burns and Fire Damage;(3)Blood Flow;(4)Water Stains.

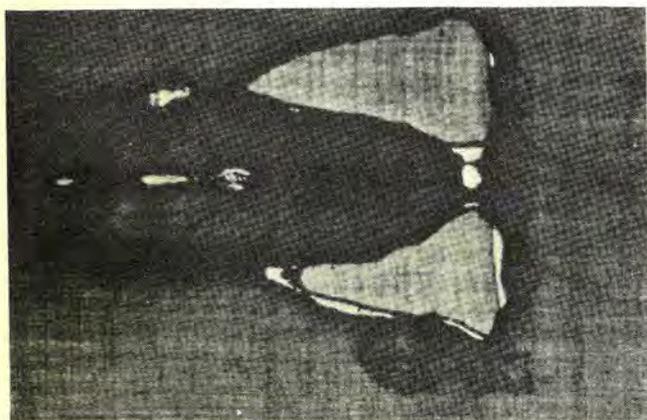


Figure 3. Transmission Photograph of Side-Wound Area.

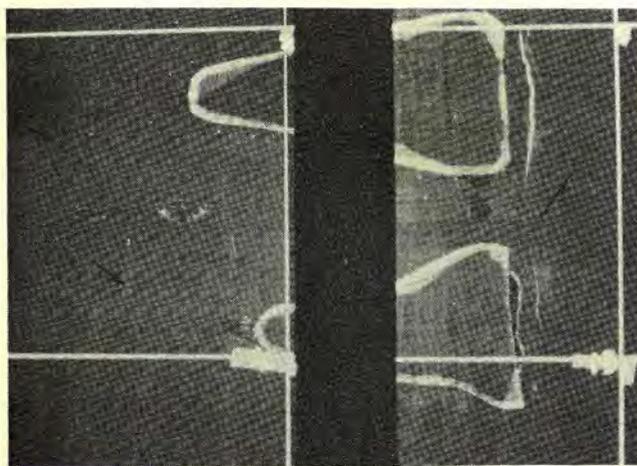


Figure 4. X-ray of Side-Wound Area, Arrows point out Water Stain.

#### CONCLUSIONS

What conclusions can be drawn from all this as they pertain to the question of authenticity? For one, the notion that the Shroud is a simple portrait must be dismissed. More than this cannot be said with any certainty; however, there are some things which seem to logically follow from our

findings. The placement of the image on the Shroud, as will be addressed in a paper of this session (19), and the apparent cloth-distance information encoded in the density patterns of the image suggest that the cloth enveloped a human-body shape at the time the image transfer took place. The presence of blood on the image and the accuracy of both the anatomical detail and the medical forensic studies (20) suggest that this human-body shape was an actual human body. Our laboratory simulations have shown that natural body exudations can produce the chemistry we find on the cloth, but the cloth-body distance information present in the image has yet to be explained.

Does this mean the Shroud is authentic in the sense that it is the burial cloth of Jesus? The truth is that this does not mean that the Shroud is authentic, but neither does it mean that it is not authentic. The question of the Shroud's age seems more imperative now than ever before. All on the project have desperately wanted to know this date so that we might feel more secure in our findings. This luxury we have not been fortunate enough to have been given. I feel certain, however, that this date will not long remain unavailable. Recent advances in Carbon-14 dating techniques now make it possible to date a very small sample. The question is no longer if the Shroud will be dated, but rather, when the Shroud will be dated. The certainty that this date will be forthcoming forced us to be much more thorough than we might have been had a date been available to us. We are well aware of the fact that the date may well not be of first century origin. Keep in mind that even a first century date, on the other hand, will not reverse the suggestion that the cloth enfolded a dead body, but it will swiftly and decisively disprove its claim to be the burial cloth of Jesus.

#### SESSION OVERVIEW

In addition to those mentioned in the body of this paper, this session contains two additional papers. The first of these describes the test documentation method used at the time of the 1978 testing and presents details of test locations of a number of experiments for which this detail has hitherto been absent (21). The second presents a brief overview of the image analysis work done at the Jet Propulsion Laboratory (22).

#### REFERENCES

- (1) Vignon, P., *The Shroud of Christ*, University Books, NY, 1970 (one of many).
- (2) Jumper, E.J., and R.W. Mottern, *Appl. Opt.* Vol. 19, pp 1902-1912: 1980.
- (3) Miller, V.D., and D.I. Devan, "Photography in the Analysis of the Shroud of Turin," *Proc. of IEEE Inter. Conf. on Cybernetics and Society*, Seattle, WA:8-30 Oct 1982.
- (4) Gilbert, R., Jr. and M.M. Gilbert, *Appl. Opt.* Vol. 19, pp. 1930-1936:1980.
- (5) Pellicori, S.F., *Appl. Opt.* Vol. 19, pp. 1913-1920:1980.
- (6) Accetta, J.S. and J.S. Bungart, *Appl. Opt.* Vol. 19, pp. 1921-1929:1980.
- (7) Mottern, R.W., et. al., *Materials Eval.* Vol. 38, pp. 39-44:1979.
- (8) Morris, R.A., et. al., *X-Ray Spectrom.* Vol. 9, pp.40-47:1980.
- (9) Heller, J.H. and A.D. Adler, *Appl. Opt.* Vol. 19, pp. 2742-2744:1980.
- (10) Heller, J.H. and A.D. Adler, *Can. Soc. Forens. Sci. J.* Vol. 14, pp.81-103:1981.
- (11) Pellicori, S. and M.S. Evans, *Archaeology*, pp. 32-43: Jan-Feb 1981.
- (12) Jackson, J.P., et. al., "The Three-Dimensional Characteristic of the Shroud," same as (3).
- (13) Schwalbe, L.A. and R.N. Rogers, *Analytica Chimica Acta* Vol. 135, pp. 3-49:1982.
- (14) Jumper, E.J., et. al., "A Comprehensive Examination of the Various Stains and Images on the Shroud of Turin," *Proc of 7th Sym on Arch Chem*, Kansas City:1982.
- (15) McCrone, W.C. and C. Skirius, *The Microscope* Vol. 28, pp. 1-6:1980.
- (16) McCrone, W.C., *The Microscope* Vol. 28, pp. 6-13:1980.
- (17) McCrone, W.C., *The Microscope* Vol. 29, pp. 19-38:1981.
- (18) Miller, V.D. and S.F. Pellicori, *J. Biol. Photo.* Vol. 49, pp. 71-85:1981.
- (19) Ercoline, W.R., et. al., "Examination of the Turin Shroud for Image Characteristics Associated with Possible Cloth Drape," same as (3).
- (20) Bucklin, R., "The Shroud of Turin: A Pathologist's Viewpoint," *Legal Medicine Annual*: 1981.
- (21) Schwartz, B.M., "Mapping of Research Test-Point Areas on the Shroud of Turin," same as (3).
- (22) Avis, C., et. al., "Image Processing of the Shroud of Turin," same as (3).