

# Evaluation of “A BPA Approach to the Shroud of Turin”

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## Table of Contents

<u>SECTION</u>	<u>PAGE</u>
Abstract	2
1. Introduction	2
2. Problems with Experimental Procedures	3
3. Main Conclusions of the BPA	4
4. Summary of the Six Experiments	8
5. Importance of Presuppositions	10
6. Previous Research on the Shroud	11
6.1 History of the Shroud	11
6.2 The d’Archis Memorandum	12
6.3 Research on the Blood	15
6.4 Formation of the Image on the Shroud	16
6.5 Radiocarbon Dating of the Shroud	17
6.6 Painting Hypothesis of Walter McCrone	19
7. Conclusion	20
8. References	21
Figure 1. Front and Back Images on the Shroud of Turin	24

## **Abstract**

This is an evaluation of a paper published July 10, 2018, in the Journal of Forensic Sciences. The paper is titled “A BPA Approach to the Shroud of Turin” by Matteo Borrini, Ph.D., and Luigi Garlaschelli, M. Sc. (Ref. 1). A “BPA” is a bloodstain pattern analysis. This paper on BPA of the Shroud is evaluated to determine the soundness of its methods and conclusions. Several elements are included in this evaluation. The general problems with this type of analysis and the specific problems with the experimental procedures in Ref. 1 are considered first. The main conclusions are then considered, including possible explanations of the alleged inconsistencies. This is followed by a description and evaluation of the six experiments involved in the BPA. The paper identifies two alleged inconsistencies between the results of the experiments and the blood on the Shroud: 1) the blood on the back of the left hand compared to the forearm, and 2) the blood on the lower back compared to the location of the side wound. As concluded in the last paragraph of Ref. 1, the alleged contradictions point “against the authenticity of the Shroud itself, suggesting the Turin linen was an artistic or ‘didactic’ representation from the XIV century.” There is nothing in their BPA analysis to indicate the century that the Shroud originated, so the authors evidently based this 14<sup>th</sup>-century date on their view of previous research on “the historical records, the radiocarbon dating, and the chemical analysis” of the Shroud. As a result, this evaluation next considers the impact of presuppositions on the results of research, and a summary of previous research on the Shroud of Turin. This research has led most Shroud researchers to reject the view that the Shroud originated in the 13<sup>th</sup> or 14<sup>th</sup> centuries, contrary to the conclusion in Ref. 1. The conclusion also does not necessarily follow from the experimental results because the alleged inconsistencies are more likely to indicate our lack of understanding of the process before, during, and after crucifixion or result from inadequacies in the experimental procedures. The conclusion of this evaluation is that the experimental results discussed in Ref. 1 do not constitute valid evidence that the Shroud originated in the 14<sup>th</sup> century or constitute valid evidence that the Shroud of Turin is not the authentic burial cloth of Jesus.

## **1. Introduction**

The Shroud of Turin is a burial cloth that has been in Turin, Italy, since 1578. It has a well-documented history back to about 1355 with many evidences that it existed long before this date. The unique thing about this burial shroud is that it contains good resolution images of the front and back of a naked man who was crucified exactly as the New Testament describes that Jesus was crucified (Figure 1). Tradition has also long held that it is the burial cloth of Jesus of Nazareth. To determine whether this could be true, more historical and scientific research has been done on the Shroud of Turin than on any other ancient artifact. The experimental procedure and reasoning in “A BPA Approach to the Shroud of Turin” should be carefully considered to determine whether it contains valid evidence regarding this question of the authenticity of the Shroud. This evaluation assumes that readers have already read “A BPA Approach to the Shroud of Turin” by Matteo Borrini and Luigi Garlaschelli (Ref. 1).

## **2. Problems with Experimental Procedures**

The details of crucifixion are poorly understood. This is acknowledged in the third paragraph of Ref. 1 where part of the reason for doing the experiments was to “help to understand how this ancient death penalty practice – of which almost nothing is known – was performed.” Even if all details of a person’s crucifixion, transport, and burial were known, a human body and its blood flow during and after crucifixion would still be extremely difficult to simulate correctly. It would probably require real blood, without an anticoagulant, flowing over real human skin, both in the condition that they would be in during and after crucifixion. The flow rate of the blood must be correctly simulated. The effects of dehydration, sweat, dirt, and swelling would also have to be properly simulated. Crucifixion would probably cause severe dehydration, which would significantly affect blood viscosity and coagulation rates. All these things would have to be known to properly model the situation. And the orientation of all parts of the body during crucifixion, transport, and burial would have to be known and simulated. Due to these extreme difficulties, any attempt to simulate the conditions of a body and its blood flow during and after crucifixion must be very approximate. The experimental procedures in Ref. 1 are a good example of this. The main problems with the procedures in Ref. 1 appear to be the following:

- Synthetic blood or human blood containing an anticoagulant and a preservative would not have the same viscosity or flow behavior as human blood without an anticoagulant or dilution by a preservative. The blood used in the experiments appears to be much too runny. The evidence on the Shroud (Figure 1) indicates that the real blood, due to crucifixion and without an anticoagulant, is much more viscous (Ref. 2) than the blood used in the experiments (Figure 7 of Ref. 1).
- Blood flow on human skin containing pores, hair, wrinkles, and swelling as well as the products of crucifixion such as sweat, dirt, and dried blood products would probably not flow the same as on the clean smooth plastic of the mannequin. This should especially apply to the point at which blood would flow or drip off skin compared to plastic.
- The blood flow rates were not the same. Compressing a sponge onto the side of a plastic mannequin, with the blood containing an anticoagulant and a preservative, would not produce the same flow rate as a spear thrust into the side of a dead man, with the blood not containing an anticoagulant or preservative.
- The angles were not correct. A hand flat on a table does not simulate a hand in a vertical position, and a person standing up probably does not simulate the shape of a person’s body during crucifixion.
- Regarding the nail through the wrist, only blood flow from the back or exit wound was considered. Blood flow from the front or entrance wound was not considered.
- The plastic mannequin torso had no arms, whereas the body as it was wrapped in the Shroud in the horizontal position had bare arms next to the side wound. The arms could have affected the blood flow from the side wound.
- Experiments were only performed on the blood flow from the back of the left hand and from the side wound. Experiments were not performed on blood flow from the front of the left hand, the head, the feet, or the scourge marks.

- The alleged discrepancies assume that the blood stains that show on the forearm were due to bleeding from the back (exit) wounds at the wrists, and that the blood stains on the lower back were due to bleeding from the side wound. No evidence is given in Ref. 1 that these assumptions are valid. If these assumptions are not valid, then there is no basis for claiming any discrepancies. There are other possible options for the source of the blood that now shows on the forearm and the lower back.

### **3. Main Conclusions of the BPA**

The main conclusions from the Bloodstain Pattern Analysis (BPA) in Ref. 1 as listed in the paper's abstract and conclusions are the following:

1. The two short rivulets on the back of the left hand require about a 45° angle during crucifixion but the angle needed to create the bloodstains on the forearms (that part of the arm between the elbow and the wrist) is greater than 80°, so that these two bloodstains “would have to occur at different times” (page 6 of Ref. 1).

This “different times” conclusion appears to assume that the two short rivulets on the back of the left hand and the bloodstains on the outside of the forearms came from the same source – from the exit wound on the back of the hand. This assumption is not discussed or proven. The “outside” of the forearm as it is used here refers to that part of the forearm that is facing outward from the body as the arms are hanging down on a standing person. The “inside” of the forearm would then be facing toward the body. Options that may explain the alleged inconsistency between the two short rivulets and the blood on the outside of the forearm are the following:

- The blood at about 45° may result from the nail when it was initially pounded through the wrist into the wood crossbeam, called the patibulum, as the body lay on the ground, before the crossbeam was lifted onto the vertical column to form the cross. The blood at greater than 80° may result from blood from the wrists as the body was hanging vertically on the cross. It should be noted that the bloodstain evidence has generally been interpreted to indicate arm angles of about 55° and 65° (pages 17 to 19 of Ref. 14).
- It is generally believed that during crucifixion, the victim will be moving up and down on the cross to breathe. Pushing up on his nailed feet and pulling up on his nailed wrists will allow him to breathe until the muscles in his legs and arms become exhausted. He will then collapse into the down-position where he hangs from his arms. In this position, his muscles can rest but hanging from his arms will expand his rib cage so that he cannot exhale, which prevents him from breathing. After resting in the down position, if he can do so, he will then push up again to breathe. In the down position, the forearm can easily be at a 45° angle. In the up position, the angle on the forearm becomes much greater as he pulls his body up. Thus, the required angles (45° and greater than 80°) may be explainable by the up and down motion of his body that is required to breathe. This explanation becomes more feasible if the arm angles are about 55° and 65°, as indicated above.

- The bleeding from the front side of the nail wounds in the wrists was not considered. In crucifixion, the position of the body may have been somewhat bowed out from the cross due to the nailing of the feet to the vertical wood column, and due to the possibility that the crossbeam (patibulum) was not put into a notch in the wood column but was attached to the front surface of the vertical wood column, so that the front of the crossbeam was further forward than the front of the vertical column. This may be indicated by the lack of vertical abrasions on his back in the dorsal image. If his back was in contact with the vertical column when he was pushing up and down to breath, then vertical abrasions on his back should show on the dorsal image. Other abrasions are recognizable on the Shroud, such as the abrasions on his shoulders evidently from carrying a rough heavy object such as the crossbeam, and abrasions on one knee and his nose probably indicating that he fell while not being able to break his fall. But there does not appear to be vertical abrasions on his back. If his body was in a bowed position on the cross, it could have caused the arms to be angled out from the cross. This might cause the blood from the nail entrance wounds at the front of the wrists to drain around the wrists and then down the outside of the forearms as shown on the Shroud. Thus, the two short rivulets on the back of the left hand and the bloodstains on the forearms would not “have to occur at different times” but could simply result from two different bleeding locations – from the entrance and exit locations of the nail wounds in the wrists.
  - The two short rivulets of blood at the wrist might result from the process of removing the nails from his wrists or taking his body down from the cross. The blood on the forearms might result from the process of removing the nails from his wrists, or taking his body down from the cross, or massaging the shoulders and arms to release the rigor mortis to allow his arms to be brought down over his groin. Under normal conditions, full rigor mortis is reached about 12 hours after death and can be significant for about another 18 hours. The shape of the feet on the dorsal image of the Shroud indicates that the body was probably in rigor mortis when the image was encoded onto the Shroud. This may also be indicated by the possible forward head position and at least one knee being bent.
2. The supposed post-mortem bleeding from the side wound onto the lower back for a supine (horizontal, facing upward) corpse is “totally unrealistic.”

Options that may explain this alleged inconsistency are the following:

- The front image on the Shroud shows that while the body was on the cross the blood flowed vertically down from the side wound. Then when the body was placed into the tomb in a horizontal orientation, the blood ran down the side of the lower chest. But the area just below the patches next to the side wound appears to show that the blood flowed down the chest several cm below the spear entrance location. This may have been caused by the blood that initially exited the wound, having dried while the body was on the cross, then redirected the subsequent blood, probably including other body liquids, to flow around the lower chest well below the location of the side wound. Due to the normal curvature of the lumbar region of the back, the skin would probably not have been in contact with the cloth below the body, so that the blood could then flow

across the lower back. The bloodstain on the dorsal image is then in good agreement with this scenario, so that there is no inconsistency.

- The experiment for the body in a horizontal position (experiment #6) was done using a plastic mannequin torso without arms. The Shroud clearly shows that the arms were on the front side of the body with the hands joined over the groin. In this configuration, the arms might have redirected blood and watery fluid toward the lower back. Due to the natural curvature in the lower back, it may not have been in contact with the cloth below the body, so that the blood could run across the lower back.
  - Examination of the blood stains on both sides of the lower back may indicate that the source of the blood was coming from both sides of the body, and not just from the side wound. What could cause this? Perhaps this blood was coming from the front (entrance) wounds in the wrists and running down the inside of the forearms, i.e. the sides that are not visible on the Shroud, and then dripping off the elbows. This may have happened during the massaging of the shoulders and the arms to release the rigor mortis, in the process of bringing the arms down so that the hands would cover the groin area. It also may have happened while the body lay in the tomb. Residual rigor mortis may have kept the forearms sufficiently above the body to allow the blood to run down the inside of the forearms until it dripped from the elbows.
  - The blood flow on the lower back could have been caused by symmetrical injuries on both sides of the body in the kidney areas due to the severe scourging that he underwent (page 38 of Ref. 3).
  - A backward bowed posture of the body while on the cross may have allowed blood to flow from the side wound to the lower back (Ref. 2).
  - Some have suggested that there is evidence that a loincloth was possibly held in place by a belt wrapped around the waist. During crucifixion, this might have caused blood to flow along the belt to the lower back. This blood could have come from blood dripping down the outside of the forearms, dripping off the elbows, and onto the lower back (pages 37-38 of Ref. 3) due to the curvature of the body during crucifixion.
  - Blood flow onto the lower back may have occurred during the process of removing the body from the cross, or transporting the body to the tomb, or burying the body in the tomb because we do not fully understand any of these processes. It is a scientific fact that corpses can bleed spontaneously from their wounds, but corpses will bleed much more if they are mobilized or moved. Some researchers believe that the blood stain in the lower region of the back probably occurred when the body was placed onto the Shroud. One reason for this is that the blood stains seem to show "directionality", that is, there was a relative displacement between the body and the Shroud.
3. The abstract of Ref. 1 says "The BPA of blood visible on the frontal side of the chest (lance wound) shows that the Shroud represents the bleeding in a realistic manner for a standing position ..."

Figure 7 in Ref. 1 indicates a dramatic difference between the results of experiment #5 (spear wound in the chest area of an upright Mannequin torso) and the blood from the side wound that shows on the Shroud. Their experiment in Figure 7 shows that the blood runs

down in several streams – down to the groin and down the leg past the bottom of the plastic mannequin torso. The blood on the Shroud indicates that the blood only traveled inches from the side wound. For it to be concluded in Ref. 1 that the experiments indicate “that the Shroud represents the bleeding in a realistic manner” requires the authors to disregard the results of their own experiment. They evidently recognized that their experimental procedures were so inadequate that the experimental results could be ignored for the side wound. This should have been recognized for the other experiments as well.

4. The last paragraph says, “The inconsistencies identified by the authors seem not only to point against their own reality, but against the authenticity of the Shroud itself, suggesting that the Turin linen was an artistic or ‘didactic’ representation from the XIV century. This new Bloodstain Pattern Analysis supports the historical records (Ref. 4), the radiocarbon dating (Ref. 5), and the chemical analysis (Ref. 6 to 11)” where the original reference numbers have been changed to correspond to the reference numbers in this evaluation.

Is it true that the above inconsistencies necessarily argue against the authenticity of the Shroud? If the Shroud is from the 14<sup>th</sup> century and thus not the authentic burial cloth of Jesus, then it must be a forgery or an artistic work. But a forger or an artist in the 14<sup>th</sup> century probably would have considered how blood should flow during and after crucifixion so that his production would not include any obvious inconsistencies. It seems more reasonable to argue that the presence of alleged inconsistencies means that the Shroud is the product of a real crucifixion in which things were happening that we don’t understand. Or it could be argued that the alleged inconsistencies result from inadequacies in the experimental procedures. Also, the alleged inconsistencies do not indicate the century in which the blood stains occurred.

The alleged inconsistencies in #1 and #2 above have reasonable possible solutions, as discussed above, but the authors were not motivated to further research and improve their techniques to solve these alleged inconsistencies. This is stated in the third to the last paragraph, which says, “The authors performed the BPA to understand the different behavior of blood flowing from the crucified individual” (according to their assumptions and inadequate simulation techniques) “rather than to find an explanation for the patterns on the Shroud”. Why were they not motivated to solve the alleged inconsistencies? They were evidently satisfied that they had arrived at the correct conclusion, i.e. that the Shroud was from the 14<sup>th</sup> century and thus not the authentic burial cloth of Jesus, because this conclusion was supported by their view of “the historical records, the radiocarbon dating, and the chemical analysis”. But research on these issues over the last 40 years has led most Shroud researchers to reject the concept that the Shroud was produced in the 13<sup>th</sup> or 14<sup>th</sup> centuries, as will be discussed in Section 6:

- The study of documents, traditions, coins, artistic works, pollen, and DNA indicates that the Shroud of Turin has a long history before the 13<sup>th</sup> and 14<sup>th</sup> centuries.
- The conclusion of the 1988 C<sup>14</sup> dating of the Shroud to 1260 to 1390 AD was badly flawed due to the inadequate statistical analysis in Damon, et al. (Ref. 5). This analysis failed to recognize that a systematic bias had very likely (98% probability)

altered the measurement values (Ref. 12 and 13). This means that the date range of 1260 to 1390 AD should be rejected.

- The evidence claimed by Walter McCrone that the image on the Shroud is a painting has been thoroughly disproven by investigations done by the Shroud of Turin Research Project (STuRP, Chapter 4 of Ref. 14).

#### **4. Summary of the Six Experiments**

Six Bloodstain Pattern Analysis (BPA) experiments were performed. Experiments 2, 3, and 4 used human blood to which was added citrate phosphate dextrose (CPD) as an anticoagulant and saline-adenine-glucose-mannitol (SAGM) as a preservative. The anticoagulant would prevent the blood from coagulating as it naturally would as it leaves the body. Experiments 1, 5, and 6 used synthetic blood for convenience. In experiments 2 through 6, blood flow was brought about at the desired location by a transfusion cannula, with the volume of blood flow controlled by a rolling clip on the tubing. According to Ref. 1, there was effectively no difference between the human blood and the synthetic blood for these tests: “Preliminary tests confirmed that the behavior of whole human blood and synthetic blood were identical, and that the results of the experiments were super imposable.” (Page 2 of Ref. 1) Comparison of the synthetic blood used in experiment #5 (Figure 7 in Ref. 1) with the real human blood from the side wound on the Shroud (Figure 1) indicates that the synthetic blood in experiment #5 is much too runny, i.e. its viscosity is much too low. Since Ref. 1 states that the experimental results using the synthetic blood were “super imposable” with the experimental results using the human blood with an anticoagulant and a preservative, this human blood was also much too runny.

In experiment #1, 0.3 mL (0.3 cm<sup>3</sup>) of blood was placed on the back of a hand and then a piece of wood was pressed onto it for 10 seconds. The wood was then removed, and the pattern of the blood was observed. This was repeated four times with wood ranging from smooth to very rough. The result of this experiment “underlines how difficult it is to speculate on the real location of the nail’s exit-wound based on the imprint on the Turin Shroud.” This experiment was evidently done with the hand in a horizontal position on a table (Figure 2 in Ref. 1). But squashing a 0.3 cm<sup>3</sup> hemisphere of noncoagulating blood sitting on the back of a horizontal hand with a piece of wood is vastly different than a vertical hand nailed to a piece of wood with the blood coagulating as it slowly exits from the wound. In the experiment the blood went in all directions, which according to the authors, led them to be unable to determine where the nail wound would have been located. But in a real crucifixion the blood runs down the back of the hand due to gravity. The location of the nail wound is therefore clearly indicated on the Shroud by the top of the bloodstain. This indicates that the nail went through the wrist.

This is important because paintings in the Middle Ages have the nail going through the palm of the hand rather than the wrist. The painters in the Middle Ages did this because the New Testament implies that the nails were put into the “hands” (Luke 24:39, 24:40, John 20:20, 20:25). Painters in the Middle Ages interpreted this to mean that the nails went into the palms, not knowing that in Jewish culture the “hand” included the wrist and the forearm perhaps about half-way down to the elbow. A forger or artist in the 13<sup>th</sup> or 14<sup>th</sup> centuries would have placed the bloodstain at the palms to be believable in their culture. Therefore, the nail wound in the wrist



indicates that the Shroud was not made in the Middle Ages, contrary to the conclusion in Ref. 1. This is also indicated by the thumbs. Paintings from the Middle Ages prominently show the thumbs, because the painters did not know that when the nail goes through the wrist, it crushes the main nerve for the hand. This forces the thumbs to fold under the palms. The Shroud gets it right, with the nails in the wrists and the thumbs folded under. This indicates that the Shroud originated when there was current knowledge about crucifixion. Crucifixion was abolished in the Roman Empire by Constantine the Great in 337 AD so that the Shroud probably originated before this date.

In experiment #2, the volunteer was standing on the floor with: 1) an arm, which is straight at the elbow, at various angles to the body to simulate crucifixion on a horizontal cross beam, 2) an arm, which is bent at the elbow at various angles but with a horizontal upper arm, to simulate crucifixion on a horizontal cross beam, 3) both arms folded in front of him with the hands crossed over the groin as on the Shroud, and 4) various arm configurations with the hands directly above the head to simulate crucifixion on a single vertical pole without a horizontal cross beam. The blood stains on the hands and the forearms in the experiments showed no difference between configurations 1 and 2. These tests indicate that the arms were not tied horizontally to the cross beam or extended vertically up above his head, but that the arms were nailed to the cross at an intermediate angle consistent with the traditional concept. It should be noted that the volunteer standing on the floor probably does not properly simulate the configuration of a man being crucified. When a crucifixion victim's feet are nailed to the vertical wood column, his knees would be positioned well forward of the column thus also, in the up-position to breath, probably bringing the middle and upper part of his body forward. His back and arms would then have to be arched backward to nail his hands to the cross beam. In this position, blood from the entrance wound on the front side of the wrists might run down on the outside of the forearms as shown on the Shroud.

In experiment #3, the volunteer was lying in a supine (horizontal, looking upward) position with his arms down so that his hands joined over the groin, with the left hand on top. This simulates the configuration on the Shroud. The table on which the volunteer was lying was placed at three angles: horizontal, 5° clockwise (presumably meaning 5° downward at the head), and 5° counterclockwise (presumably meaning 5° upward at the head). For each inclination, two postures were used: 1) the volunteer lying flat on the table, and 2) with the feet flat on the table, knees up, and head forward (Figure 5 of Ref. 1) to simulate the body in rigor mortis in the position of crucifixion. A small amount of blood was allowed to drip from the cannula attached to the back of the left hand. The conclusion was that the pattern of blood running off the top of the left hand did not match the pattern of rivulets as they appear on the left hand or forearm on the Shroud. This should not be surprising since it is usually believed that the left hand and forearm rivulets were formed while the body was in the vertical crucifixion position on the cross rather than the supine position in the tomb.

In experiment #4, the volunteer was standing on the floor with arm positions as in experiment #2. The conclusion was that the angle of the hand on the cross beam had to be between 45° and 50°, whereas the angle of the forearm had to be greater than 80° [Note: the “see experiment 3” on page 5 of Ref. 1 may be in error], so that the bloodstains on the hand and the forearm “would

represent the results of two different unknown events”. Several options to explain this alleged inconsistency are given in Section 3.

In experiment #5, synthetic blood was absorbed into a sponge which was then pressed against the side of a plastic vertical mannequin torso (Figure 7 in Ref. 1) using a stick to simulate the spear wound on the Shroud. The blood running down the mannequin is very different than the blood below the side wound on the Shroud (Figure 1), demonstrating that the synthetic blood is much too runny, i.e. its viscosity is much too low, compared to the Shroud’s real human blood without anticoagulant or preservative.

In experiment #6, the plastic mannequin was placed horizontally on a cloth covering a table (Figure 8 in Ref. 1) to simulate a human body in a tomb. The bloody sponge was then pressed against the side of the mannequin as in the previous experiment. As would be expected, the blood simply ran down the side of the mannequin and was absorbed into the cloth below the body. As pointed out in Section 2, there are many simulation inaccuracies in this process: wrong viscosity of the blood, wrong blood flow rate, use of plastic instead of skin, and no arms in contact with the body torso to redirect the blood flow. Several options to explain this alleged inconsistency are given in Section 3.

## **5. Importance of Presuppositions**

Modern science has been very beneficial to our living standard. It is also usually reliable in determining truth. But when science is poorly done, it can be deceptive. One potential issue is that the conclusions drawn from a series of experiments can be predetermined by the underlying presuppositions that are held by the experimenters, though the experimenters may be unaware of their presuppositions. These presuppositions can influence the types of experiments that the experimenters decide to perform, the thoroughness of their experiments, and the nature of the conclusions that are permitted:

- Only certain types of experiments might be performed because they may be the only ones that the experimenters believe will support the conclusion that they “know” is true. In Ref. 1, experiments were only performed relative to the blood stains from the back of the hand and from the side wound. It was assumed that the blood stains that show on the forearm were due to bleeding from the back (exit) wounds at the wrists, and that the blood stains at the lower back were due to bleeding from the side wound. Experiments were not performed for blood flow from the front of the hand, the head, the feet, or for the blood of the scourge marks.
- One of the most difficult issues for scientists to determine is the question of when they have done enough. What are the criteria for scientists to determine when they are finished? Criteria that are commonly used are remaining funding, whether preassigned deadlines have been reached, and reasonableness of the results. Whether their results appear to be reasonable depends, in general, on their understanding of the underlying assumptions of science and specifically, on their understanding of previous research on the subject. In Ref. 1, the experimenters evidently believed that previous research (“historical records, the radiocarbon dating, and the chemical analysis”) indicated that the

Shroud was made in the 14<sup>th</sup> century so that the Shroud could not be the authentic burial cloth of Jesus.

- Presuppositions can also determine what conclusions are permitted. Unfortunately, for research on the Shroud of Turin, this can have a dramatic effect. For example, researchers with an atheistic or rationalistic mindset will assume naturalism, i.e. that only “natural” causes are allowed; that no “god” can have any impact on our physical reality. In practice, this usually leads to an assumption that only causes within our current understanding of science are allowed. For research on the Shroud, this leads to a presupposition that the image on the Shroud and the dating of the Shroud must be consistent with the laws of science as we currently understand them. For example, their worldview would not permit them to conclude that the evidence on the Shroud could result from the resurrection of Jesus. On the other hand, a researcher that believes in Christian theism can accept or reject the authenticity of the Shroud of Turin and accept or reject that it gives evidence for Jesus’ death, burial, and resurrection, because his Christian beliefs are based on historical documentation in the New Testament and not on the Shroud of Turin.

Therefore, in doing research on the Shroud of Turin, it is very important to seek the truth while avoiding bias and presuppositions. Researchers ought to follow the evidence where it leads, apart from their presuppositions, and make judgments based only on the experimental evidence. This is done by the researchers doing the experiments and evaluating the results with a neutral mindset, i.e. believing that the Shroud of Turin may or may not be the authentic burial cloth of Jesus, and that it may or may not be the results of the death, burial, and resurrection of Jesus. This requires researchers to be aware of their own presuppositions and be willing to eliminate them from affecting their thinking or actions.

The conclusion in Ref. 1 appears to have been significantly influenced by their belief that previous research showed that the Shroud was a product of the 14<sup>th</sup> century. This is indicated in the last sentence in Ref. 1: “This new Bloodstain Pattern Analysis supports the historical records, the radiocarbon dating, and the chemical analysis”. But if the history, dating, and chemical analysis do not indicate that the Shroud is a painting or forgery from the 14<sup>th</sup> century, then this support for their conclusion is eliminated. They will then have no reason to claim that the Shroud is from the 14<sup>th</sup> century, because the results of their BPA experiments indicate nothing about which century the image on the Shroud was made. These issues are addressed in the next section which summarizes previous research.

## **6. Previous Research on the Shroud**

### **6.1 History of the Shroud**

According to research on documents, traditions, coins, artistic works, pollen, and DNA (Ref. 15) the following is the most likely history for Jesus’ burial cloth (Ref. 16 to 20). Jesus’ burial shroud was found by Peter and John in the tomb after Jesus’ crucifixion in Jerusalem (John 20:3-9). Many of the early believers, when they fled Jerusalem to avoid persecution, went to Antioch (Acts 11:19) so that it became the center for Christian outreach (Acts 11:26, 13:1). At that time,

Antioch was the third largest city in the Roman Empire next to Rome and Alexandria in Egypt (Page 9 of Ref. 16). A tradition preserved in the writings of Athanasius indicates that prior to the destruction of Jerusalem in 70 AD, the Christian relics were brought from Jerusalem down to Antioch in Syria. If Jesus' burial shroud was in Jerusalem at that time, it is reasonable to assume that it was taken to Antioch along with the other relics. Jesus' shroud may have been employed during the first century in the evangelization of Galatia in Anatolia (Galatians 3:1) and, in the second century, in the conversion of King Abgar the Great of Edessa in Mesopotamia. The image that is now on the Shroud of Turin was frequently copied in Byzantine art, the earliest surviving example being the Christ Pantocrator painting from St. Catherine's Monastery at Sinai, which probably dates to about 550 AD (pages 2 and 17 to 18 of Ref. 16). The Shroud was most likely brought to Constantinople, the capital of the Byzantine Empire, in 574 as the Image of God Incarnate. An alternate theory is that it was brought to Constantinople in 944 as the Mandylion or Image of Edessa (Ref. 21 and 22). Its presence in Constantinople long before the C<sup>14</sup> date (1260 to 1390 AD) is confirmed by Byzantine coins starting in 692, the Hungarian Pray Manuscript (1192-1195 AD), and the report (1203-1204 AD) of French crusader Robert de Clari that it was exhibited weekly at the Church of St. Mary in the Blachernae district of Constantinople. It was probably sold to King Louis IX of France between 1237 and 1261. Others believe it may have been stolen from Constantinople in the sack of the city in 1204 (Ref. 21 and 22). In about 1355 it was exhibited in Lirey, France, as the true burial cloth of Jesus by the French knight Geoffrey de Charny, the grandson of a close associate of King Louis IX. In 1453, it was sold by Geoffrey de Charny's granddaughter to Louis, the Duke of Savoy. It was then gradually transported across France till it came into Turin, Italy, in 1578. The following is thus indicated:

- The Shroud of Turin has a long history before the C<sup>14</sup> date of 1260 to 1390 AD.
- There is no historical evidence that precludes the Shroud of Turin from being the authentic burial cloth of Jesus.
- Though there are still historical uncertainties, there are legitimate options for the history of the Shroud of Turin that connect it to Jesus' burial cloth that was found in Jerusalem.
- The historical evidence, when combined with the results of the scientific investigation of the Shroud, is sufficient to convince most Shroud researchers that the Shroud of Turin is very likely the authentic burial cloth of Jesus.

## **6.2 The d'Archis Memorandum**

Contrary to the above evidence, the last paragraph of Ref. 1 says that the evidence obtained in the BPA is "suggesting that the Turin linen was an artistic or 'didactic' representation from the XIV century" which "supports the historical records". This indicates that the authors of Ref. 1 believe that the historical records indicate that the Shroud was made in the 14<sup>th</sup> century. According to their reference (Ref. 4), they based this belief on the works of the French historian Ulysse Chevalier (1841-1923), who wrote on this subject between 1899 and 1903. Chevalier believed that the Shroud was a painting for three reasons:

- The New Testament never mentions a piece of cloth with an image of Jesus on it. Answer: Based on experiments, the image probably appeared gradually on Jesus' burial shroud due

to aging and exposure to ultraviolet light over a period of years. Due to persecution, they may not have wanted to publicly reveal its existence. And in Galatians 3:1, without revealing exactly what he was talking about, Paul refers to previously showing something to the believers in Galatia, i.e. “before your very eyes”, that “clearly portrayed” Jesus as crucified (Gal. 3:1, NIV). If this was not Jesus’ burial shroud, then it is a mystery what it would have been.

- How could Jesus’ burial shroud appear suddenly in about 1355, with no previous history? Answer: This is an argument from silence, which is a precarious type of argument. With over a hundred years of additional research since the writings of Chevalier, we now have much evidence (documents, coins, artistic works, etc.) that the Shroud existed long before 1355.
- The d’Archis Memorandum says that an artist confessed to painting the Shroud. Answer: There is convincing evidence that this is not true, as discussed below.

The d’Archis Memorandum is an angry letter written by Pierre d’Archis, Bishop of Troyes, France, to Pope Clement VII in Avignon, France. Chevalier dated it to late 1389, but internal evidence requires it to be written after August 4 of 1389 and probably before August 15 of 1389. It was originally written in Latin. The English translation is about six typed pages long (pages 266 to 272 of Ref. 23, though this is a truncated version of a hybrid created by Chevalier). Troyes is 12 miles from Lirey, France, where the Shroud of Turin was exhibited as the true burial cloth of Jesus by its owner, Geoffrey II de Charny, in about 1355 or 1356. In 1389 it was being exhibited again with permission of Pope Clement VII. This angered Pierre d’Archis, because as Bishop of Troyes with authority over Lirey, his permission should have been required. Also, display of the Shroud in Lirey was bringing in significant donations to the small church in Lirey whereas his efforts to complete the cathedral in Troyes had a very significant lack of money. In the memorandum, Pierre d’Archis claimed that the previous Bishop in Troyes, Bishop Henry de Poitiers, investigated the Shroud when it was previously exhibited in Lirey 34 years earlier (1355 or 1356) and that Poitiers had found a painter who admitted to painting it. The reasons for rejecting this allegation in the d’Archis Memorandum are the following (page 37 of Ref. 16, pages 151 to 153 of Ref. 14, pages 100 to 104 of Ref. 24, and Ref. 50):

- The document only exists in two editions consisting of a messy first draft (called Folio 138) and a neater second draft (called Folio 137), both found in the Bibliotheque Nationale in Paris. The document in Chevalier’s book is a mixture of these two draft copies. His book shows the first draft with the explanatory heading from the second draft appended to it. Thus, the document shown by Chevalier does not exist.
- If Bishop d’Archis had sent the memorandum to Pope Clement VII, then it would imply that Bishop d’Archis had great confidence in its accuracy, for he would surely not risk making an accusation that might be exposed as false and slanderous by a papal investigation. But there is no evidence that the memorandum was ever sent to Pope Clement VII. The memorandum has not been found in the Vatican Archives, the Troyes diocesan records, or anywhere else. It is also not referred to anywhere else. If it was ever sent to Pope Clement VII, it should have been in his records. Numerous subsequent documents by Pope Clement VII regarding the Shroud and its exhibition say nothing about a previous investigation or a communication from Bishop d’Archis. Both drafts of the

memorandum were neither signed nor dated, and though the heading of the second draft makes it clear that it was intended to eventually go to Pope Clement VII, it was not addressed to him. Instead it was addressed to a scribe for editing, which was the common practice. But there is no evidence that it was ever sent to the scribe, and there is no evidence that Bishop d'Archis received an edited version back from the scribe. The fact that we only have two draft copies is important, because if a final edited version was received back from the scribe and sent to Pope Clement VII, then these two draft copies very likely would have been discarded. The existence of only these two draft copies indicates that very likely a final copy was never made or sent to Pope Clement VII. And without it being sent to the Pope, its historical importance is greatly diminished, for it may be little more than hearsay.

- Pierre d'Archis does not reveal how he obtained his information. If there had been an investigation by his predecessor in Troyes, Bishop Henry de Poitiers, then the investigation would have been documented and this documentation would have been available to Bishop Pierre d'Archis in Troyes. Pierre d'Archis' lack of making any reference to such documentation in his memorandum indicates that he could not find any documentation in Troyes, where it should have been. And no record of such an investigation has been found anywhere else. The memorandum gives no indication that Bishop Pierre d'Archis had any personal knowledge of this alleged previous investigation. He would have included a statement regarding this if he had any personal knowledge of it. Without documentation or personal knowledge of the investigation, he must have been depending on what other people told him, which may have been little better than rumor.
- The essence of Bishop Pierre d'Archis's evidence regarding the painter is found in only one sentence referring to his predecessor Bishop Henry de Poitiers: "Eventually, after diligent inquiry and examination, he discovered the fraud and how the said cloth had been cunningly painted, the truth being attested by the artist who had painted it, to wit, that it was a work of human skill ..." (page 267 of Ref. 23). Notice that the memorandum does not indicate the painter's name or any of his background, how he was found, under what circumstances he made his admission, how he painted the Shroud when there is nothing like it among all other paintings, or any details about his testimony. It also does not say when the investigation was done or who was involved in the investigation. This is all very odd since the painter's statement is the only evidence for Bishop Pierre d'Archis's claim that the Shroud is a painting.
- In the best scenario, this is at least second level hearsay evidence, i.e. that someone who heard the painter 34 years earlier told Bishop d'Archis about it, who then referred to it in his memorandum. Hearsay evidence is second-hand information and is generally not admissible in trials because it prohibits the other side from cross-examination.
- Even if there was an artist who 34 years earlier (1389 – 1355 = 34) admitted to painting the Shroud, he could have meant that he had painted a copy of the Shroud. This was frequently done in later years for devotional purposes for people at other locations. These copies were often partial size, often signed by the painter, and often dated. Over many centuries, many copies have been made of what we now call the Shroud of Turin. But these many copies, by their contrast with the Shroud, only serve to identify the Shroud of Turin as Jesus' true burial cloth. They show that the artistic techniques used by painters during this period could not have produced the characteristics of the Shroud of Turin. In fact, the

characteristic of the Shroud of Turin could not have been produced by any technique existing in any era, past or present.

- Pope Clement VII, based upon facts known to him *ex certa Scientia* (of certain or sure knowledge), sent a letter to Geoffrey II de Charny on July 28, 1389, permitting the display of the Shroud in Lirey, France, and stating that Bishop d'Archis must remain perpetually silent on the matter. Clement VII reiterated this in a letter to Bishop d'Archis dated January 6, 1390, in which Clement VII threatened to excommunicate d'Archis if he opposed the display of the Shroud.
- D'Archis successor at Troyes, Bishop Louis Raguier, maintained that the Shroud that was shown in Lirey was genuine.
- And most importantly, the Shroud of Turin has been scientifically proven to not be a painting. In 1978, the Shroud of Turin Research Project (STuRP) sent about 26 researchers from the US to Turin, Italy, to perform hands-on non-destructive testing of the Shroud for five days, 24 hours a day. Their main objective was to determine how the image was formed. Their experiments determined that the image on the Shroud contains no pigment, no carrier, no brush strokes, no clumping of anything between the fibers or threads, no capillarity (soaking up of a liquid), and no cracking of the image along the fold lines. All these would be present if the image on the Shroud were a painting, yet none of them are present. Their experiments also proved that the image on the Shroud is not due to a liquid, a scorch, a photographic process, or any other process that the researchers could think of (Ref. 14, 25, and 26). Because of the detailed historical accounts that trace the cloth that was exhibited in Lirey, France, to where it is today in Turin, this proves that the Shroud that was exhibited in Lirey was also not a painting, contrary to the d'Archis Memorandum.

The conclusion of this is that apparently “Pierre D’Archis, sentenced to perpetual silence and fearing that a papal investigation would prove his charges baseless, thought better of having his draft memorandum transcribed and then prudently discarded it.” (page 11 of Ref. 50). Thus, there is no reliable historical documentation to indicate that the Shroud of Turin originated in the 13<sup>th</sup> or 14<sup>th</sup> centuries.

### **6.3 Research on the Blood**

Serious scientific research on the Shroud began in 1898 when the first photograph of the Shroud was taken by Secondo Pia. For decades, the main object of research was the nature and meaning of the blood on the Shroud. Some of the most notable researchers on this topic, with their years of study are:

- Dr. Yves Delage, Professor of Comparative Anatomy, Paris 1900-1902
- Dr. Paul Vignon, Professor of Biology, Paris 1900-1943
- Dr. Pierre Barbet, Chief Surgeon, Professor of Anatomy, Paris 1932-1961
- Dr. Robert Bucklin, M.D, Prof. of Pathology, Forensic Examiner, LA 1941-1993
- Dr. Frederick Zugibe, Chief Medical Examiner, Rockland county, NY 1953-2002
- Dr. Alan D. Adler, Professor of Chemistry, W. Connecticut State Univ. 1978-2000
- Dr. John Heller, Prof. of Internal Medicine & Medical Physics, Yale 1978-1995

- Dr. Baima-Bollone, Chief of Forensic Medicine, U. of Turin, Italy 1978-

A total of 24 such names are listed on pages 15 to 16 of Ref. 14. The point is that many very qualified people have investigated the blood and the bloodstain evidence on the Shroud for many years or even decades, and though they may still have certain questions, they generally conclude that the best evidence supports the belief that the Shroud of Turin wrapped a real human body, and that it was probably the body of Jesus. Some of the evidence that these conclusions are based on is the following:

- The definite appearance of real blood congealed on the skin.
- The blood flows on the head can be distinguished as either from a vein or an artery. These vein or artery blood flows are found on the skin over either veins or arteries under the skin, respectively. The distinction between blood in a vein or an artery was not even discovered until 1593, yet the Shroud gets it right.
- Under microscopic examination, the blood marks from the scourging that are now on the Shroud are realistic with indented centers and raised edges, well defined continuous edges with no evidence of the cloth being separated from the blood mark on the body, scratches that only show up under UV light, and blood serum visible only under UV light that extends beyond the visible blood marks. A forger or a painter would not have known to include these items in his painting before the invention of the microscope in 1590 and the discovery of UV light in 1801.
- The size and shape of the hole in the skin of the chest wound is consistent with a Roman thrusting spear called a lancea. The wound being postmortem is indicated by the wound margins which are enlarged and well outlined, the lack of swelling around the wound, the denser-than-normal blood loss followed by serum runoff with evidence of blood clots separated from serum, and the large blood flow from a dead man after severe blood accumulation in the chest cavity (page 37 of Ref. 3).

#### **6.4 Formation of the Image on the Shroud**

The conclusion of most Shroud researchers is that the image was formed in some way by the body of the crucified man that was wrapped within the Shroud. Most of these Shroud researchers thus conclude that most likely the Shroud is the authentic burial cloth of Jesus. But a natural process (a process that is consistent with our current understanding of the laws of science) also seems to be ruled out by the image characteristics as well as the uniqueness of the Shroud, i.e. if a natural process created the image on the Shroud then there should be other examples of a person's body causing good resolution front and back images of itself on fabric.

Based on following the evidence where it leads apart from biases and presuppositions, there are many reasons that most Shroud researchers now believe that the image was caused by radiation so that the image is a radiation burn (Ref. 27). We do not understand most of the details about the mechanism that discolored the fibers to form the image, but we do know some things about it. To form the image on the Shroud, the mechanism that discolored the fibers had to be controlled by information to cause the correct number and length of fibers to be discolored. This



required information is that which defines the appearance of a naked crucified man. We can see the image of a crucified man on the Shroud because the information that defines the appearance of a crucified man has been encoded into the pattern of discolored fibers that form the image, and our brains have learned to recognize this information as the image of a crucified man. This information could not have come from the limestone walls of the tomb or the air in the tomb. It could only have come from the body that was wrapped within the cloth. Only radiation, by its energy, intensity (number of photons), and direction could communicate this information from the body to the cloth (Ref. 28), just as reflected photons of light, which is radiation, communicate all the information to our eyes that allows us to see the scene in front of us.

The radiation emitted from the body that formed the image was not emitted from only the surface of the body but had to come from within the body to carry the information related to the bones from the body to the cloth, since some of the bones can be recognized on the cloth. This radiation had to be emitted from within the body in an extremely short intense burst to discolor only the top one or two layers of fibers in a thread, since energy deposited on the cloth over a longer period would allow the energy to transfer beyond the top two fiber layers. This hypothesis is attractive because it produces a logically consistent explanation for the many mysteries related to the Shroud (Ref. 29). Also, experiments have shown that radiation (ultraviolet light and/or charged particles such as protons) can cause the type of discoloration on flax fibers in linen cloth that is seen in the image on the Shroud (Ref. 30 to 36).

### **6.5 Radiocarbon Dating of the Shroud**

Based on results from the STuRP analysis, by the mid-1980s a consensus was rising that the Shroud probably was the authentic burial cloth of Jesus (Ref. 37). But in 1988, samples were cut from the lower corner of the Shroud and sent to three laboratories for  $C^{14}$  dating in Tucson in Arizona, Zurich in Switzerland, and Oxford in England. The average date from the three laboratories was  $1260 \pm 31$  AD. This was the raw or uncorrected value. When this value was corrected for the changing  $C^{14}$  in the atmosphere, a 2-sigma date range of 1260 to 1390 AD was obtained (Ref. 5, usually called Damon, et al.). This means that the true date for the Shroud should have a 95% probability of falling within this range. Based on this range, they concluded in their paper that “The results provide conclusive evidence that the linen of the Shroud of Turin is mediaeval.” If true, this would mean that the Shroud of Turin could not be the authentic burial shroud of Jesus, since according to history Jesus died about 30 or 33 AD. But Phillips (Ref. 38), in the same issue of *Nature* that published the paper by Damon, et al., recognized that  $C^{14}$  dating may not be accurate for the Shroud if it is the authentic burial cloth of Jesus, since special circumstances may have applied. Subsequent statistical analysis of the measurement data in Damon, et al., by multiple individuals (Ref. 12, 13, and 39 to 46) found strong evidence that the variation in the measurements was not only due to random measurement errors but also very likely due to a systematic bias that would have affected all the measurements. A bias is something that causes a measurement to be shifted from the true value to an incorrect value. A systematic bias is something that causes the measurement to be in error in a systematic (not random) fashion as a function of some other parameter. This likely systematic bias, since it was not recognized or corrected for in the paper by Damon, et al., means that the conclusion in

Damon should be rejected. The evidence that the Shroud does not date to 1260 to 1390 AD is summarized in Section 6 of Ref. 26:

- Due to the unique characteristics of the image, it would not have been possible to form the image between 1260 and 1390 AD. The technology to make the image has never existed in any previous era or even today.
- There are 15 indicators for the date of the Shroud. 14 of these indicators are consistent with a first century date for the Shroud and inconsistent with a 1260 to 1390 AD date for the Shroud. (Section 6C of Ref. 26)
- The dates obtained from the three laboratories did not agree with each other. For example, the average dates from the laboratories in Tucson ( $1303.5 \pm 17.2$ ) and Oxford ( $1200.8 \pm 30.7$ ) were statistically different (difference =  $102.7 \pm 35.2$ ) from each other at the 2.9 sigma level, which is above the normal 2.0 sigma acceptance level.
- Plotting of the average values from the three laboratories indicates that there is a gradient or slope to their average values of about 36 years per cm of distance from the bottom of the Shroud (Figure 3 in Ref. 13). This indicates the presence of a systematic bias. This means that for some reason, an error in the measurements was caused as a function of the original locations of the samples on the Shroud. Such a systematic bias could result from a patch or reweave of the fabric at the sample location on the Shroud (Ref. 47), or by neutrons if they were included in the burst of radiation emitted from the body that caused the image (Ref. 38 and 48).
- If all the measurement values and measurement uncertainties are assumed to be correct, then a Chi-squared statistical analysis indicates that there is only a 1.4% probability that the measurements could be consistent with the measurement uncertainties (Table 6 in Ref. 13) assuming only random measurement errors without a systematic bias. This is well below the usual 5% criteria for acceptance. This means that there is about a 98% probability that a systematic bias had a significant effect on the C<sup>14</sup> dating measurements discussed in Damon, et al., so that the measured values cannot be trusted.
- The conclusion in the paper by Damon, et al., that the Shroud dated to 1260 to 1390 AD was based on rejecting half of the data, i.e. all the measurement uncertainties. It is not legitimate to simply ignore all the measurement uncertainties because: 1) the measurement uncertainties were obtained using the same equipment and procedures as the measurements, 2) the measurement uncertainties were reasonably consistent for all laboratories, 3) the measurement uncertainties were reasonably consistent with the uncertainties for the three standards that were run at the same time, and 4) it is not credible to increase the measurement uncertainties for the Shroud samples sufficiently to make the measurements and the revised uncertainties consistent (Ref. 13).

Based on the above information, most Shroud researchers believe that the conclusion in the paper by Damon, et al., (Ref. 5) that the Shroud dates to 1260 to 1390 AD is badly flawed. It should not be concluded that the radiocarbon dating of the Shroud in 1988 proved that the Shroud was made between 1260 and 1390 AD. This is because a systematic bias was probably present (98% probability) that shifted the measurements from the true date to the apparent range of 1260 to 1390 AD. Thus, in doing any experiments related to the Shroud, great care should be

taken to not assume that the Shroud is a forgery or an artistic work from the 13<sup>th</sup> or 14<sup>th</sup> centuries and to realize that it could be the authentic burial cloth of Jesus.

## **6.6 Painting Hypothesis of Walter McCrone**

Occasionally papers by microscopist Walter McCrone are appealed to as evidence that the image on the Shroud is a painting. He asserted that the image was painted onto the Shroud using red iron earth pigment (also called jeweler's rouge) suspended in a gelatin-binding medium because in his microscope he saw fine iron oxide particles ( $\text{Fe}_2\text{O}_3$ ) on fibers from the image area. A natural test of whether the Shroud could be a painting resulted from the Shroud being in a fire in 1532. This fire would have set up very significant temperature gradients across the cloth because parts of it was burned, parts of it were scorched to various degrees, and parts of it seemed to be unaffected. These temperature gradients would have significantly altered the appearance of most inorganic pigments, such as iron oxide, and organic stains or dyes available in the 14<sup>th</sup> century, as well as a gelatin-binding material. Analysis by the STuRP scientists confirmed what is obvious to the unaided eye – that the intensity of the image was not altered by the temperature gradients, so the image is not a painting. This is confirmed by the water that was thrown onto the Shroud after the fire. The resulting water stains did not appear to transport any significant amount of pigment or binder.

Further research by STuRP scientists (Ref. 49) found that the fine iron oxide particles were present on image fibers in a concentration that was much too low to form an image. Fine iron oxide particles were also found on fibers from the non-image areas of the Shroud in about the same concentration. They were also found inside the flax fibers rather than just on the outside of the fibers, as they should have been if the image was a painting. The STuRP scientists reasoned that the iron must have passed through the flax fiber's dense outer cell wall in a chemical solution and then formed the iron oxide particles inside the fibers. The STuRP scientists concluded that the iron oxide particles were not painted on but were probably present on the Shroud due to the ancient retting (rotting) process that was used to separate the flax fibers from the stems of the flax plant. As discussed above, STuRP also found that the image contains no pigment, no carrier, no brush strokes, no clumping of anything between the fibers and threads, no cracking of the image at the fold points, and no evidence of capillarity – soaking up of a liquid. All of these would be present if the image was a painting, but none of them are present. Based on this evidence from the STuRP analysis, most Shroud researchers agree that McCrone's hypothesis has been thoroughly disproved (Page 80 of Ref. 16, Chapter 4 of Ref. 14, and page 83, 106, and 192 of Ref. 24).

The last paragraph of Ref. 1 says that the BPA suggests that the Shroud is from the 14<sup>th</sup> century, which supports the chemical analysis. To support the author's view that the chemical analysis of the Shroud indicates that it is not authentic, four references are listed that refer to papers by Walter McCrone (Ref. 6 to 9) and two references are listed that refer to papers by John Heller and Alan Adler (Ref. 10 and 11). But only the papers by Dr. McCrone claim that the Shroud is a painting, whereas the papers by Dr. Heller and Dr. Adler give extensive evidence that disproves the claim of McCrone. And the book by Dr. John Heller (Ref. 49) gives an extensive history of the research done on the Shroud by the STuRP team of about 40 scientists, with chapters 9 to 11

focusing on their research to determine whether Dr. McCrone could be correct in his claim that the image on the Shroud is a painting. They concluded that the image on the Shroud is not a painting – that McCrone was wrong. The STuRP scientists organized a special conference at the Air Force Academy in Colorado Springs on the chemistry of the Shroud to give McCrone an opportunity to defend his conclusions, and even rescheduled the conference to assure that McCrone could attend. But McCrone decided not to attend and thus not to defend his conclusions (pages 153 to 154 of Ref. 49).

It can be concluded that the “historical records, radiocarbon dating, and the chemical analysis” provide no evidence for believing that the Shroud is a forgery or an artistic work from the 13<sup>th</sup> or 14<sup>th</sup> centuries. Thus, they provide no support to the conclusion of the Bloodstain Pattern Analysis (BPA) that “the Turin linen was an artistic or ‘didactic’ representation from the XIV century”.

## **7. Conclusion**

For many reasons, a human body and its blood flow during and after crucifixion is extremely unlikely to be simulated correctly. Many details of crucifixion followed by removal of the nails, lowering the body from the cross, massaging of the body to relax the effects of rigor mortis, transport of the body to the tomb, and burial in the tomb are not known. The Bloodstain Pattern Analysis (BPA) in Ref. 1 found two alleged inconsistencies in the bloodstains on the Shroud: 1) the bloodstains on the back of the left hand appeared to be inconsistent with the bloodstains on the forearms, and 2) the bloodstains on the lower back appeared to be inconsistent with the location of the side wound. From these inconsistencies, the authors of Ref. 1 concluded that the Shroud could not be the cloth in which Jesus was buried. But it is probably more reasonable to conclude that these alleged inconsistencies indicate that the Shroud is the product of a real crucifixion in which some things were happening that we don’t understand, or that the experimental procedures were inadequate. Several possible solutions to these alleged inconsistencies are discussed in Section 3. There was no attempt in Ref. 1 to solve the alleged inconsistencies between the blood stains in the experiments and those on the Shroud. There was also no attempt in Ref. 1 to explain how blood that would have been dried on the body is now found on the Shroud, since dried blood does not soak into cloth.

The authors of Ref. 1 appear to have been very influenced by their belief that historical records, radiocarbon dating, and chemical analysis indicate that the Shroud is a forgery or an artistic work from the 14<sup>th</sup> century. This is contrary to the consensus of historical and scientific research over the last 40 years, as discussed in Section 6. Historical research indicates that the Shroud existed long before the 14<sup>th</sup> century. The conclusion of the 1988 C<sup>14</sup> dating of the Shroud to 1260 to 1390 AD should be rejected because 14 other date indicators give earlier dates than this range, and because the statistical analysis of the 1988 measurement data in the paper by Damon, et al. (Ref. 5) failed to recognize that a systematic bias very likely (98% probability) affected all the measurements (Ref. 13). And the chemical analysis of Walter McCrone has been thoroughly disproven by the results of the STuRP analysis (Chapter 4 of Ref. 14). This means that there is no valid reason to claim that the Shroud is from the 13<sup>th</sup> or 14<sup>th</sup> centuries. The conclusion in Ref. 1 that the Shroud is not authentic but originated in the 14<sup>th</sup> century is not proven by the

experimental results and is contrary to the consensus of research over the last 40 years. It is concluded that the experiments discussed in the paper “A BPA Approach to the Shroud of Turin” (Ref. 1) do not constitute valid evidence against the Shroud of Turin being the authentic burial cloth of Jesus.

The methods and conclusions in Ref. 1 are evaluated by other authors in Ref. 2, 51, and 52.

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## **Biography**

Robert A. Rucker earned an MS degree in nuclear engineering from the University of Michigan and worked in the nuclear industry for 38 years primarily in nuclear reactor design, nuclear criticality safety, and statistical analysis for quality control of nuclear material inventories. He holds two Professional Engineering (PE) certificates in nuclear engineering and mechanical engineering. He organized the International Conference on the Shroud of Turin (ICST-2017) held July 19-22, 2017, in Pasco, Washington. His website is [www.shroudresearch.net](http://www.shroudresearch.net). Send comments, questions, or corrections to [robertarucker@yahoo.com](mailto:robertarucker@yahoo.com).

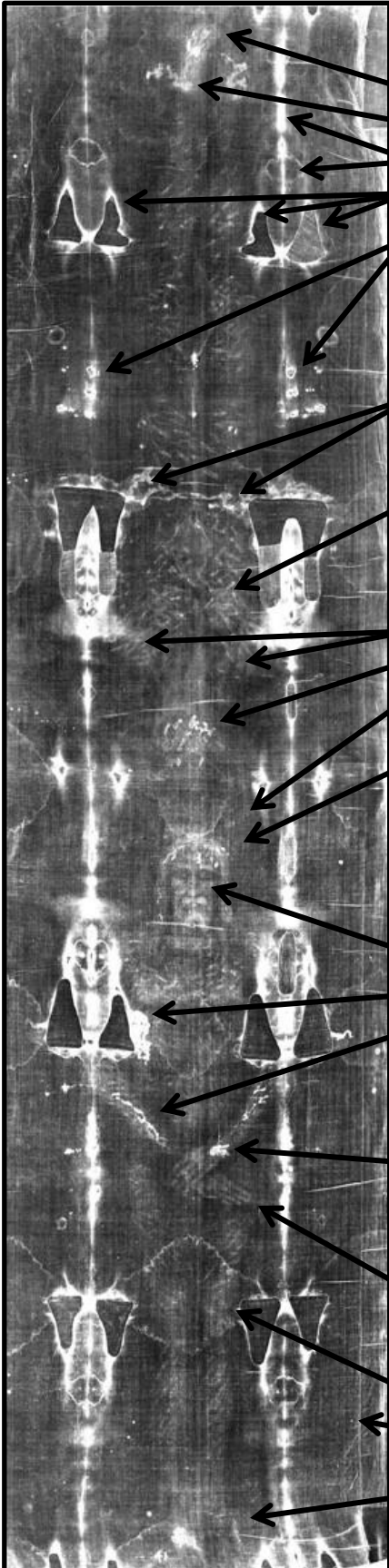


Figure 1. Front and Back Images on the Shroud of Turin

1. Rigor mortis in the feet. This indicates the victim was dead.
2. Two nails through one foot, one of them through both feet.
3. Fire in 1532 resulted in scorch marks and water stains.
4. Areas badly damaged in the fire were patched in 1534.
5. The Hungarian Pray manuscript (1192-1195) has a painting of a famous burial cloth that had long been in Constantinople. It shows the same L-shaped burn holes that are on the Shroud, so the Shroud must have existed significantly ( $> 2$  sigma) before the  $C^{14}$  date of 1260 to 1390 AD.
6. The Shroud appears to show a flow of blood and clear blood serum from a wound in the side. Compare with "blood and water" in John 19:34.
7. The Shroud shows 100 to 120 scourge marks from Roman flagrum. Resulting blood marks show blood serum rings (visible only under UV) around the blood exudate. Compare with Mk. 15:15.
8. Abrasions on both shoulders from carrying a rough object.
9. Puncture wounds from sharp objects that pierced his scalp.
10. Pollen on the Shroud unique to the area around Jerusalem. Pollen from a plant with long thorns found around his head.
11. The images are negative images and contain 3D information that indicates the distance of the cloth from the body. Only the top 1 or 2 layers of fibers in a thread are discolored. The discolored fibers in the image result from the carbon atoms that were already in the cellulose molecules in the flax fibers being changed from single to double electron bonds.
12. Swollen cheeks and damaged nose from a beating or a fall.
13. Side wound shows a hole the size of a Roman thrusting spear.
14. Blood running down arms at the correct angles for crucifixion. Blood is real human blood, male, type AB. The blood with high bilirubin content and nanoparticles of creatinine bound to ferritin prove he was severely tortured.
15. Paintings from the Middle Ages show nails through the palms, but this will not support enough weight since there is no bone structure above this location. The Shroud shows the correct nail locations - through the wrist instead of the palm.
16. Shroud correctly shows thumbs folded under due to contact of the nail with the main nerve that goes through the wrist. This is also contrary to paintings from the Middle Ages.
17. Abrasions on one knee show a microscopic amount of dirt.
18. Three-inch wide side strip sown on with a unique stitch very similar to that found at Masada (destroyed in 73-74 AD).
19. Microscopic chips of travertine aragonite limestone containing impurities that closely match limestone in Jerusalem.