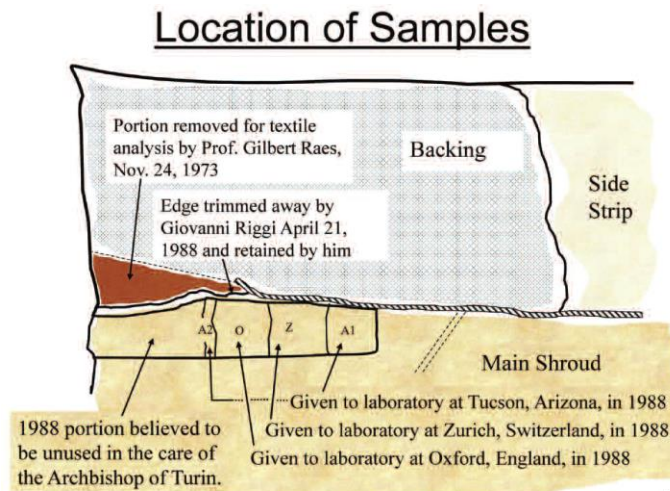


Was the Shroud of Turin Invisibly Rewoven with Foreign Material at the Radiocarbon Site to Match the Rest of the Cloth?

by Mark Antonacci

The intriguing Invisible Repair or Reweave Hypothesis was first announced by Joseph Marino and M. Sue Benford at the International Shroud Conference held in Orvieto, Italy in 2000.¹ This hypothesis states that unlike numerous repairs that are easily visible on the Shroud, a 16th century repair or reweave was made at the radiocarbon site that is “invisible” or undiscerning to the naked eye. While this hypothesis caused an interesting stir, it was given a significant boost by Raymond Rogers who published his research and conclusions from 2001-2005 following his examination of 14 thread segments from the Raes sample and radiocarbon material. Fig. 1 below shows the locations where these and other radiocarbon samples were all taken from this same general vicinity.



Rogers stated in 2005 that his examination and procedures “prove that the radiocarbon sample was not part of the original cloth of the Shroud of Turin,”² He states “all threads from the Raes sample and yarn segments from the radiocarbon sample show colored encrustations (or coatings) on their surfaces. . . . suggesting the color and its vehicle were added by wiping a viscous liquid on the outside of the yarn.”³ He asserts that the “coating is easy to observe on Raes and radiocarbon yarns.”⁴ He further observes “. . . the Raes and radiocarbon samples indicate that the color has been manipulated. Specifically, the color and distribution of the coatings implies that repairs were made at an unknown time with foreign linen dyed to match the older original material. Such repairs were suggested by Benford and Marino.”⁵

Rogers concludes, “The radiocarbon sample had been dyed. Dyeing was probably done intentionally on pristine replacement material to match the color of the older, sepia-colored cloth.”⁶ He adds the dye “is probably the same age as the Raes and radiocarbon [replacement]

yarn.”⁷ He further specifies: “The dye found on the radiocarbon sample was not used in Europe before about A.D. 1291 and was not common until more than 100 years later.”⁸

In 2002, Raymond Rogers also claimed to have clearly identified a Raes thread that “is obviously an end-to-end splice of two different batches of yarn.”⁹ In 2004, Rogers even claimed from his examination of Shroud samples that he “found a medieval splice in the sampling area.”¹⁰ If Rogers’ claims are true, they would provide evidence to bolster the invisible reweave hypothesis of Benford and Marino. Yet, Rogers’ examinations and research do not prove any of his above claims, nor is there any evidence on the Shroud to justify these claims or the invisible repair or reweave hypothesis.

Testing of Hypothesis

Many people do not realize that the comments of Rogers, Benford and Marino contributed to the Shroud itself being re-examined in 2002, along with the testing of one of its radiocarbon samples. These comments also caused STURP scientists to re-examine several of their earlier scientific test results and findings. The repair or reweave hypothesis has actually been tested far more than people realize, but it has consistently failed countless tests and examinations.

The Shroud was examined by scores of scientists and various experts in 1969, 1973, 1978, 1988 and 1997, both before and after the Raes and radiocarbon samples were removed and before the repair/reweave hypothesis was first presented in 2000 —but no repairs were ever discovered at this site. How could a repair or reweave be made that could fool so many experts and scientists on six occasions in the last half of the 20th century? How could a medieval (1260-1532?) repairer fool photo microscopy that was performed on the Shroud? In 1978 between 5,000 - 7,000 photographs of the Shroud were taken in various wavelengths and magnifications, but no photographs or microphotographs have indicated such a repair.



2.



3.

When the backing cloth was removed from the Shroud during its restoration work in 2002, this area of the cloth was again specifically inspected on the image side, as well as on the reverse or outer side of the entire garment. All of the inspectors and observers confirmed what the many previous examinations, photographs, and photomicrographs of the front of the Shroud revealed — that the Shroud had not been patched or rewoven at the radiocarbon or any nearby site. In

addition, there were no threads or stitches found on either side of the Shroud at the radiocarbon site. After weeks of painstakingly examining and restoring the Shroud, Dr. Mechthild Flury-Lemberg stated:

I would like to add here a note on the hypothetical “reweaving done in the 16th century.” There is no doubt that the Shroud does not contain any reweaving . . . Reweaving in the literal sense does not exist. Once the piece of fabric is taken off the loom the weaving process is finished. Afterwards one can only alter a fabric by using needle and thread. An example would be a hole which has been mended by imitating its weave structure. This process will always be recognizable as mending and in any case visible on the reverse of fabric.”¹¹

Flury-Lemberg succinctly states, “In any case, neither on the front nor the back of the whole cloth is the slightest hint of a mending operation, a patch or some kind of reinforcing darning to be found.”¹² She also provided pictures of both sides of the Shroud at the radiocarbon site (Figs. 4 and 5) for us to observe ourselves.



4.



5.

The various scientific imaging and examinations of the Shroud not only fail to reveal a reweave or repair, but they indicate that the cloth was not repaired with replacement material. X-ray fluorescence analysis on thirteen threads from the Raes sample indicated they had roughly the same relative concentrations of calcium, strontium and iron that was found on the rest of the Shroud.¹³ Neither the existence of, let alone the concentrations of calcium, strontium and iron in the Shroud linen could possibly have been known to a medieval or a 16th century repairer. STURP founder John Jackson noted, “the density ratios of the calcium, iron and strontium in both the Shroud and the Raes samples . . . is a compelling argument that the fabric of the radiocarbon site is very likely not due to a fabric that is alien to the Shroud.”¹⁴

Dr. Jackson prefaced his above comment with the statement, “The thesis that the radiocarbon sample site was a medieval reweave would be an excellent solution as to why the radiocarbon date yielded a medieval date. However, this thesis is, in my opinion, profoundly

incorrect and this can be demonstrated to be so using additional data that was collected by STURP in 1978.”¹⁵ Jackson noted a radiograph also taken in 1978 of a fairly large area of the Shroud, which clearly included what ten years later would become the site of the radiocarbon sampling in 1988. The authors of the publication in which this particular radiograph appears suggested that the side strip consists of the same material as the main portion of the Shroud. This is because alternating high- and low-density bands attributed to the Shroud’s horizontal weave (weft) are continuous through this area and the side seam.¹⁶ If the Shroud had been rewoven in this area, the continuity bands would have been disrupted at the reweave intersections; however, they were not. For this and other reasons, Jackson states “. . . we must conclude unambiguously that there has been no reweave whatsoever surrounding the radiocarbon site.”¹⁷

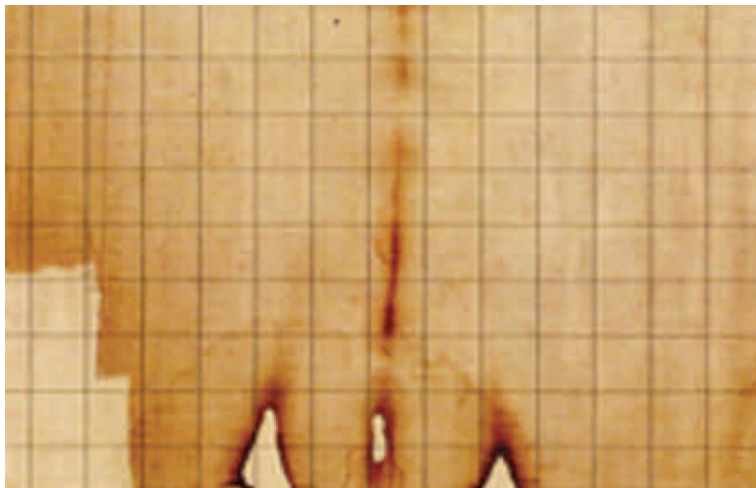
Ironically, the X-ray fluorescence information and the above radiograph were both contained and discussed in a 1982 article by STURP scientists Larry Schwalbe and Raymond Rogers titled “Physics and Chemistry of the Shroud of Turin,” which was a summary of STURP’s findings from its investigation. (The X-ray fluorescence information was in an endnote.) Rogers seems to have forgotten about or misunderstood the elemental analysis of these samples and the cloth itself, or the other numerous photographs and photomicrographs taken of the Shroud.

Incorrect Assumptions

A fundamental mistake that Ray Rogers made in his analyses was that he almost always failed to perform elemental analysis of his samples and ignored or misunderstood the elemental analysis that had been performed on the Shroud’s samples and on the entire cloth. Rogers had most of his samples for twenty years and was a chemist at Los Alamos National Laboratory where extensive elemental analysis could have been conducted on them. Unfortunately, he was away from Shroud studies for 15-20 years, and in the last few years of his life he essentially looked at the samples through a microscope and made subjective interpretations of what he saw. From these subjective interpretations he then made enormous leaps in logic to arrive at his unsupported and erroneous conclusions.

Rogers’ unconcern with or misunderstanding of STURP’s photographic evidence can also be found with the UV fluorescent photographs and reflected light imagery, which allowed details to be seen that were not visible with the naked eye. They revealed that Rogers’ samples from the radiocarbon site were in the midst of a scorch mark. This observation was made in 1989 by Vernon Miller, chief photographer of the 1978 Shroud investigation, after examining the above imaging.¹⁸ It was also confirmed in the mid to late 1990’s by STURP chemist, Dr. Alan Adler, who compared 15 threads from the radiocarbon area with 19 fibers from non-image, image, water stain, scorch, backing cloth and serum-coated locations on the Shroud by Fourier Transform Infrared (FTIR) micro spectrophotometry and by scanning electron microprobe.¹⁹

Rogers failed to understand that his radiocarbon sample was also on the edge of a water stain. This, too, was not only stated by Vernon Miller in 1989, and supported by STURP chemist, Alan Adler, but the normal photograph of this region taken in 2002 during the Shroud's restoration clearly shows that a water stain ran into the radiocarbon site seen at the lower left of Fig. 6.



6.

The edge of a water stain is where much of the debris acquired by or contained in the flow of water is going to be deposited. Adler's FTIR and scanning electron microprobe data show gross enrichment of the inorganic mineral elements in the radiocarbon samples. Adler stated, "In fact, the radiocarbon fibers appear to be an exaggerated composite of the water stain and scorch fibers."²⁰

Rogers' failure to appreciate or understand any of the four discussed sets of photographs taken of the radiocarbon site, or Adler's analysis, or that the radiocarbon site is at the edge of a light scorch and water stain, clearly contributes to his erroneous conclusion that the radiocarbon sample was not part of the original cloth and that it had been dyed.

For the edge of a water stain to run into the radiocarbon site also means that the water stain had to have gotten on the radiocarbon site after the reweave. Most reweave advocates do not contend the original Shroud material had a water stain that was replaced with new material also containing a perfectly matching water stain.

Everyone had previously assumed that all the water stains on the Shroud were from 1532. While many water stains on the Shroud are from 1532, European photographer Aldo Guerreschi and Michael Salcito began asserting in 2002 that the water stain shown in the previous photo and others that are in a row at the bottom of the Shroud do not line up with the fold configuration of the scorch marks and water stains from 1532.²¹ They have concluded these stains came no earlier than the Shroud's 14th century origin in Europe and may be as early as the 1st century. Any time before 1532 takes it out of the 16th century reweaving hypothesis.

Rogers' failure to realize or acknowledge that the radiocarbon samples that he studied were in the midst of or near a scorch also contributes to another faulty argument that he makes. He claims that the presence or absence of vanillin in the lignin of the Shroud indicates its age is between 1000 B.C. and 700 A.D., a 1700 year age range. (Such an age range is hardly a precise scientific calculation.) He also implies that the vanillin content on the cloth supports his medieval repair argument.²² Yet, his reasoning appears to be very inconsistent. According to Rogers, "No samples from any location on the Shroud gave the vanillin test" and that "The lignin on Shroud samples . . . does not give the test." He further states, "The lignin at growth nodes on the Shroud's flax fibers did not give the usual chemical spot test for lignin (i.e. . . . for vanillin)."²³ If vanillin is not present in the Shroud's samples *and* the larger cloth, then it indicates that *all* the material is ancient and homogenous. It does not indicate that medieval or 16th century material is found with material ranging from 1000 B.C. to 700 A.D.

The vanillin argument cannot even be applied to the Shroud. The presence of vanillin in lignin is greatly affected by heat. The effect is so great that it operates *exponentially*. Rogers uses a constant temperature gradient of between 20-25° C (68-77° F) for the Shroud to state that its ". . . vanillin loss suggests that the Shroud is between 1300- and 3000- years old."²⁴ (1000 B.C. to 700 A.D.)

The effect of heat is so great that STURP physicist John Jackson and chemist Keith Propp state if the temperature incurred by the Shroud or its samples during the fire of 1532 was just 200° C that it would lose 95% of its vanillin in a mere 6.4 seconds.²⁵ The Shroud could have lost much or all of its vanillin while folded in a reliquary during the Chambery fire of 1532. The samples that Rogers examined were in the midst of or next to a scorch. Furthermore, the Shroud has a likely 1200 year history in the Middle East (Jerusalem, Edessa and Constantinople) and a known 650 year history in France and Italy, where the temperatures are known to *frequently* exceed 20-25° C or 68-77° F. The vanillin test expounded by Rogers simply cannot be used to estimate the age of the Shroud.

More Testing of Assumptions and Hypothesis

Rogers' assertions that the Raes and radiocarbon samples were dyed and were part of the replacement material that was radiocarbon dated in 1988 fails on several other important grounds. In 2010, a photomicrographic investigation was conducted on a Shroud sample that was removed from one that was used in the radiocarbon dating study at the University of Arizona in 1988. This article appears in the journal *Radiocarbon* and one of its two authors is Timothy Jull, who participated in the Shroud's 1988 radiocarbon dating. The authors state, "Under UV fluorescence, the fibers fluoresce uniformly and do not show any indication of an overall coating."²⁶ They continue, "In addition, we find no evidence for any coatings or dyeing of the linen Linen does not readily accept dye, and any surface 'coating' would be loosely adhered. We viewed a textile fragment dyed using traditional methods under UV light, and observed absolutely no similarity in UV fluorescence consistent with such a dye."²⁷

Furthermore, if a “reweave” of foreign linen had been dyed centuries ago to resemble the undyed older Shroud, then natural aging over the succeeding centuries would have caused a difference in color between the two areas. The reweave would have become lighter as the color of the dye slowly disappeared, but the Shroud linen would have yellowed and gotten darker as it oxidized and dehydrated over the centuries. Similar to the above UV fluorescence testing, textile expert Mechthild Flury-Lemberg has examined a UV-fluorescent picture of woven material comparable to the Shroud that has been darned, yet whose foreign threads were easily visible.²⁸

Perhaps the most subjective observation with the greatest leap of logic is Rogers’ claim that a Raes thread “is obviously an end-to-end splice of two different batches of yarn.”²⁹ I assume this is the same thread that he refers to when he states in the *Skeptical Inquirer*, “I found a medieval splice in the sampling area.”³⁰

He devotes only five lines of text in the first publication and two in the second to build his case. Rogers’ photomicrograph of the Raes thread (below), however, shows no sign of a splice.



7.

The right third of the thread is white because the fibers on the inside of the thread have been clearly exposed or popped out of the yellowed thread. The left two-thirds of the regular thread are straw yellow in color. The fibers toward the end of the exposed white inner region are more loose or frayed. They simply point toward the end of the thread in the direction they ran. They show no signs of any foreign threads or fibers or of any splicing or reweaving. Since the fibers at both ends point to their respective opposite ends in which they ran, it is puzzling why Rogers concludes the entire thread is obviously an end-to-end splice.

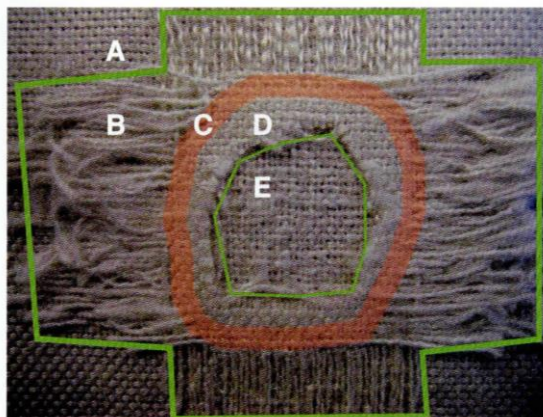
Moreover, when both ends of this thread were examined with X-ray photoelectron spectroscopy (XPS) producing high resolution spectra, chemist Robert Villareal of the Los Alamos National Laboratory reported in 2008 that, “The two ends are chemically similar.”³¹ This clearly indicates that the thread is *not* an end-to-end splice. In addition, the spectra of both ends were comparable to the spectrum of cotton, which was also indicated by FTIR.³² An obvious objection to Rogers’ curious interpretation is raised by A.A.M. van der Hoeven when she asks, “Why splice a cotton thread to a cotton thread in order to repair a linen Shroud?”³³ Furthermore, if threads were spliced onto the cloth, the threads would also appear thicker or fuller at the splices. Yet, that is not the case with Shroud threads at or near the radiocarbon site.

Rogers' end-to-end splice of two different batches of yarn suggest the ends of the Shroud were separated and then rewoven by hand with the end of the threads from another medieval piece of linen at all surrounding edges where the imitation piece was spliced into the Shroud. Even if someone could have done this and the unattached threads held together for 500 - 600 years, the cloth would be thicker at all the doubly woven threads at all the surrounding edges.

A somewhat better reweaving method than trying to splice fine linen threads can be found with the reweaving performed with needle and thread on heavier coarser material like tapestries that Benford and Marino discuss. Joe Marino led me to a video in which a hole in coarse material that looks very loosely woven is repaired with threads that probably came from a hem or other location on the same material, for it is very similar. By overlapping the hole extensively with the weft and warp threads, the hole is covered without attaching the new threads. The needle can be pushed and pulled through the material surrounding the small hole, as well as through the hole and the replacement material that has been woven over the hole to match the surrounding weave. The ends that stick out from the new threads can be settled in or cut with scissors. However, the material surrounding the hole would now be fuller or denser, having more threads than the material over the hole and elsewhere on the cloth.

While the latter method gets respectable results on the front side, it would not fool photomicroscopy or other forms of imaging that was applied to the front of the Shroud.

The December 2015, *British Society for the Turin Shroud Newsletter* carried an article by Hugh Farey on invisible weaving showing the visible results when this method was recently applied over a hole that was smaller than a dime (approximately one centimeter across) on a plain woven cloth, as opposed to the complicated 3:1 herringbone twill of the Shroud. While the mend on the front was still visible when you looked closely with the naked eye, the mend and its fringes were very visible on the back side as seen below in Fig. 8.



High contrast photo showing:
A: Original cloth.
B: Mend overlying original cloth.
C: Merged border.
D: Original cloth overlying mend.
E: Mend alone.

8.

As Mr. Farey stated, “Needless to say, there is no evidence of any such fringes on the reverse side of the Shroud, or the reverse side of any of the extracted samples.” He concludes that the ancient French system of invisible mending is clearly identifiable on the reverse side of the cloth.

He further states, “It is inconceivable that it would not have been noticed by the scientists carrying out the radiocarbon dating.”³⁴ We really don’t need to debate the quality of the reweave method, for it could not have been used on the Shroud.

Benford and Marino refer to French weavers or reweavers of the 16th century. Today those that employ this technique use state-of-the-art microscopes that allow reweavers to view the threads of finely woven fabrics up close, which a reweaver would not have had access to in 1532 or earlier. Yet, even these modern companies state that this type of reweaving of finely woven fabrics with state-of-the-art microscopes will only work on holes as small or smaller than a dime.³⁵ If the repair or reweave on the Shroud only covered the relatively small area first claimed by Marino and Bedford in 2000, it would be much larger than the size of a dime, which even modern repairers with state-of-the-art microscopes could not reweave undiscernibly. In that case they would have to use a patch and attempt to blend the patch in with the surrounding material. A hypothetical 16th century reweaver could not have used surrounding material from the Shroud for it, too, would have dated the same age as the Shroud. If he used a patch from foreign material, he would have as many or more problems to overcome than were discussed earlier.

Monsignor Giuseppe Ghiberti, a participant at the 2002 examination and restoration, succinctly stated in regard to their and Dr. Flury-Lemberg’s detailed inspections: “The truth is that there is no patch and no darn . . . there are no added threads.” He also added the common sense observation that “you apply a patch or a darn where there is a hole,”³⁶ but that no such hole, tear, worn area or patch could be seen at or near the radiocarbon site on either the inner or the outer side of the Shroud of Turin.

In addition, unlike almost all other textiles, the Shroud was kept rolled on a large spool from 1578 to 2002 — a period of 424 years. This would necessarily have caused stretching and pulling that would have revealed any material that was unattached by any reweaving method. Think of the countless times the Shroud has been rolled up and unrolled, as well as hung and displayed at private and public exhibitions. Some of the public exhibitions lasted for weeks at a time when the Shroud would be exhibited outside, so it would have been taken in and probably folded or rolled at night (and during the day if rain or inclement weather was present) and rehung again that day or the next day. The hypothetical reweave would also have been near the weight-bearing, upper left-hand corner of the Shroud where it was invariably displayed horizontally as seen in numerous paintings, drawings and photographs of the famous cloth on display during exhibitions after 1532. Many of these paintings were shown in Russ Breault’s opening presentations at the 2014 and 2017 international Shroud conferences in St. Louis, Missouri and Pasco, Washington.

If Rogers’ undocumented findings and conclusions are accepted, a medieval restorer would had to have separated, spliced and/or rewoven by hand or with needle and thread, foreign material (many centuries younger than the Shroud) into both the Raes/radiocarbon areas; added

coloring that continued to match the rest of the Shroud even though the dye would have lightened and the Shroud would have yellowed or darkened with age over succeeding centuries; repaired the cloth before it was ever stained with water at this location; used material with approximately the same relative concentrations of calcium, strontium and iron as the rest of the Shroud; repaired or rewoven the radiocarbon site so invisibly that it could not be detected by X-radiographs at this location or the surrounding area; permanently attached the new material without any stitching or mending on either side of the cloth; not allowed the rewoven splices or threads to appear any fuller or more numerous, or to appear on the reverse side; yet withstood all the stress or pull they would have incurred from having been repeatedly rolled, unrolled and hung during public and private displays over many centuries, and kept rolled on a spool for 424 years.

Furthermore, neither photomicrographs, nor any other photographs taken of the cloth in any other wavelengths, any UV fluorescence testing of samples from the radiocarbon site, any direct examinations by anyone including countless textile experts, scientists, or other professionals, would be able to detect the repair.

Lastly, the reweaver had to have remained anonymous throughout history, and, unlike other repairs and events with the Shroud, there could be no contemporary historical record by the owners, custodians, priests, nuns, or textile specialists or restorers — all without any reasons for such secrecy. The alleged medieval repair would be reminiscent of the alleged medieval painting of the Shroud: its truly masterful artist is unknown; its brilliant technique remains undetected even today; there is no contemporary historical record; without any reason for such secrecy, and without actual evidence on the cloth for such claims.

No one point or item of evidence absolutely precludes such a repair or reweave, but when these items are taken collectively, such a hypothesis is obviously extremely unlikely. As I have stated many times, I do not object to future testing of the Shroud related to this hypothesis, as long as it is only a part of the overall testing that also includes hypotheses that have evidence on the Shroud to support them.

Endnotes

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2. R. N. Rogers, "Studies on the radiocarbon sample from the Shroud of Turin," *Thermochimica Acta*, 425 (2005) pps. 189-194, 189.
3. Ibid., p. 191.
4. Ibid., p. 192.
5. Ibid.
6. Ibid., p. 193.
7. Ibid.
8. Ibid.
9. R. N. Rogers and A. Arnoldi, "Scientific Method Applied to the Shroud of Turin," (2002), <http://www.shroud.com/pdfs/rogers2.pdf>, p. 21; R. Rogers, "Supportive comments on the Benford-Marino 16th century repairs hypothesis," *British Society for the Turin Shroud Newsletter*, No. 54, November 2001, pp. 28-33.
10. R. N. Rogers, "Shroud No Hoax, Not Miracle," Letter to the Editor, *Skeptical Inquirer*, July/August 2004.
11. M. Flury-Lemberg, *Sindone 2002* (Torino: Editrice ODPF, 2003), p. 60. English translation: Rosamund Bandi and Susie Clavarino Phillips.
12. M. Flury-Lemberg, "The Invisible Mending of the Shroud in Theory and Reality." *British Society for the Turin Shroud Newsletter*, No. 65, June 2007, pp. 10-27, 26.
13. L. A. Schwalbe and R. N. Rogers, "Physics and Chemistry of the Shroud of Turin," *Analytica Chimica Acta* 135 (1982); 3-49, note 6, p. 47.
14. John Jackson's comments on Antonacci's response to Rogers. E-mail to Shroud Science Group on May 31, 2005.
15. Ibid.
16. The radiographs were reported in R. A. Morris, L. A. Schwalbe and J. E. London, *X-ray Spectrom*, 9 (1980) 40, according to Schwalbe and Rogers, "Physics and Chemistry of the Shroud of Turin." The radiograph of the entire lower left portion of the Shroud of Turin can be found in the latter publication by Schwalbe and Rogers.

17. John Jackson's comments on Antonacci's response to Rogers. E-mail to Shroud Science Group on May 31, 2005.
18. M. Antonacci, *The Resurrection of the Shroud* (New York: M. Evans and Company, Inc., 2000) pps. 168 & 304; See also J. Marino, *The Shroud of Turin and the Carbon 14 Controversy*, *Fidelity*, (February 1989): 35-47.
19. A. Adler, "Updating Recent Studies on the Shroud of Turin," *Archaeological Chemistry: Organic, Inorganic, and Biochemical Analyses*, Mary Virginia Orna, ed. American Chemical Society (1996): 223-228; A. D. Adler, A. Whanger, and M. Whanger, "Concerning the Side Strip on the Shroud of Turin," <http://www.shroud.com/adler2.htm>, (October 27, 1997); Dr. Alan Adler, personal communications, June 1998 and February 1999.
20. Adler, "Updating Recent Studies," p. 225.
21. A. Geureschi and M. Salcito, "Photographic and Computer Studies Concerning the Burn and Water Stains Visible on the Shroud and Their Historical Consequences." *IV Symposium Scientifique International, Paris*, April 25-26, 2002; A. Guerreschi and M. Salcito, "Further Studies on the scorches and the Water stains," *Third International Dallas Conference*, September 5-6, 2005.
22. "If the Shroud had been stored at a constant 25° C, it would have taken about 1319 years to lose a conservative 95% of its vanillin. At 23° C, it would have taken about 1845 years. At 20° C, it would take about 3095 years. If the Shroud had been produced between A.D. 1260 and 1390, as indicated by the radiocarbon analysis, lignin should be easy to detect. A linen produced in A.D. 1260 would have retained about 37% of its vanillin in 1978. The Raes threads, the Holland cloth, and all other medieval linens gave the test for vanillin wherever lignin could be observed on growth nodes. The disappearance of all traces of vanillin from the lignin in the Shroud indicates a much older age than the radiocarbon laboratories reported." Rogers, "Studies on the radiocarbon sample," p. 191.
23. Rogers, "Studies on the radiocarbon sample," pps. 190 and 191.
24. Rogers, "Studies on the radiocarbon sample," p. 192.
25. E-mail from John Jackson and Keith Propp to Shroud Science group on February 9, 2005.
26. R. A. Freer-Waters and A. J. T. Jull, "Investigating a Dated Piece of the Shroud of Turin," *Radiocarbon*, Vol. 52, Nr 4, 2010, 1521-1527, 1524.
27. *Ibid.*, p. 1526.
28. Flury-Lemberg, "The Invisible Mending of the Shroud in Theory and Reality."
29. Rogers and Arnoldi, "Scientific Method," p. 21.
30. Rogers, "Shroud Not Hoax, Not Miracle," Letter to the Editor.

31. R. Villarreal, B. Schwartz and M. S. Benford, "Analytical Results on Threads Taken from the Raes Sampling Area (Corner) of the Shroud," (2008), *Proceedings of the 2008 Columbus International Conference*, Shroud Science Internet Group, edited by G. Fanti, 319-336, 322.
32. Ibid.; Villarreal, video of presentation, at 19:23 "looks very much like cotton," 12:30 "both regions, region 1 and region 2, are cotton", and 14:24 slide "unexpected silicon", and 33:53 "Silicon all through the tread", according to A. A. M. van der Hoeven, "Internal selvedge in starched and dyed temple mantle – No invisible repair in Turin Shroud – No Maillard reaction," <http://www.jesusking.info>, May 9, 2012.
33. van der Hoeven, "Internal Selvedge", p. 26.
34. H. Farey, "Invisible Reweaving," *British Society for the Turin Shroud Newsletter*, No. 82, December 2015, pp. 13-17, 17.
35. "Home" page of "The French Re-Weavers," <http://www.thefrenchreweavers.com>; "Alterations-Repairs-Reweaving" page of "Arrow Fabricare Services," <http://www.arrowcare.com/alterations-repairs--reweaving.html>; See also video, <http://www.withoutatrace.com/reweaving.html>. This is the video that I was referred to by Joe Marino.

Exercise no. 19 of the Fenway System talks about reweaving linen cloth that has been woven in a basket weave. This weave is approximately six under and two over for both the weft (horizontal) and the warp (vertical). However, a 3:1 herringbone twill means that the weft thread passes under three warp threads and then over one, with each successive weft thread beginning at an ascending point one warp thread earlier, *and then*, in series, at a descending point to form a diagonal herringbone pattern. As you can appreciate, a herringbone twill is much more complicated and could not have been rewoven or blended invisibly into surrounding linen in the 1500s or earlier. I doubt if it could be invisibly blended or rewoven to match all of the surrounding area with state of the art microscopes today.

Even if you could somehow blend herringbone twill 360° around the damaged area, the overlapping threads would be denser and more numerous. The exercise even states, "The fact that you periodically must pass over and under several threads requires you to begin weaving over intact portions of the damaged threads at a greater distance from the damage than you have to do for simple weaves in order to get sufficient anchorage." This would only make the additional, blended threads more detectable, not only to the naked eye, but also to all the technology that was applied to the Shroud.
<http://shrouduniversity.com/frenchreweavinginstructionbook.pdf>.

36. According to a translation and e-mail provided by Antonio Lombatti to Shroud-Science@yahoo.com on February 8, 2005.

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