The scientific paper that AMSTAR successfully denied to those who attended the Dallas Conference ...

Could the Shroud's radiocarbon date have been Skewed due to 16th century repairs?

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It is well known and documented that the Shroud has been repaired several times in its history, including in the area from which the C-14 sample was taken. The most recent was in 1973 after Professor Gilbert Raes, a member of the Turin Commission that studied the Shroud in 1969 and 1973, was given some samples. But is it possible that other undocumented repairs were made to the Shroud? Enzo Delorenzi, also a member of the Turin Commission, made the very significant statement:

> ... I should like to mention the impression I received during the course of my examination, namely, that more pairs of hands have carried out the darning than is suggested in the historical records (the four Clarissas of Chambery, the Blessed Valfre and the Princess Clotilde). (Delorenzi 1976, pg. 111)

In light of the compelling evidence that we are about to present, we believe that the theory that the Shroud has literally been patched with medieval material from the 16th century, in the C-14 sample itself, explains the medieval carbon dating results. Furthermore, several other sindonologists have identified various anomalies that also seem to point to undocumented repairs (Gervasio, 1986: 264, 268), which adds credence to the hypothesis that the C-14 sample area may have been similarly enhanced.

Giovanni Riggi, the person who actually cut the C-14 sample, which was from the same area from which the 1973 "Raes piece" was taken, stated:

> I was authorized to cut approximately 8 square centimetres of cloth from the Shroud ...This was then reduced to about 7 cm because fibres of other origins had become mixed up with the original fabric ... (Riggi 1988:182).

Italian author Giorgio Tessiore, discussing the sample taking, noted:

> "...1 cm of the new sample had to be discarded because of the presence of different color threads" (Tessiore, 1988:44).

Upon microscopic examination of the Oxford C-14 sample, Professor Edward Hall, head of the Oxford lab, noticed fibers that looked out of place. A laboratory in Derbyshire determined that the rogue fibers were cotton of "a fine, dark yellow strand." According to Peter South of the lab,

"It may have been used for repairs at some time in the past ..." (Rogue Fibres found in the Shroud, 1988:13).

Professor Raes, who extracted the above cited Shroud sample in 1973, believes that in the 1988 Oxford sample he examined, the cotton he observed was contained inside the threads, which could help to explain the difference in fiber diameter (Raes, 1989). We believe that the heavier, blended material may explain why the C-14 sample apparently weighed about twice as much as expected (Petrosillo and Marinelli, 1996:63).

However, one also needs to find chemical differences to support the theory of a medieval patch. The late Dr. Alan Adler, a chemist and member of the STURP team that studied the Shroud in 1978, noted:

> So you can talk all you want about how reproducible the date is, but you can't talk about how accurate it is. You have no way of knowing if the area you took the C14 sample from represents the whole cloth. That's an area which has obviously been repaired. There's cloth missing there. It's been rewoven on the edge. They even cut part of it off, because it was obviously rewoven on the edge. The simplest explanation why the date may be off is that it's rewoven cloth there. And that's not been tested (Case, 1996:73).

Dr. Adler in a 1996 article showed a graph that illustrates the absorbance patterns of image, non-image, radiocarbon warp, water stain, scorch, and serum single fiber samples and made the following statements (Adler, 1996:225):

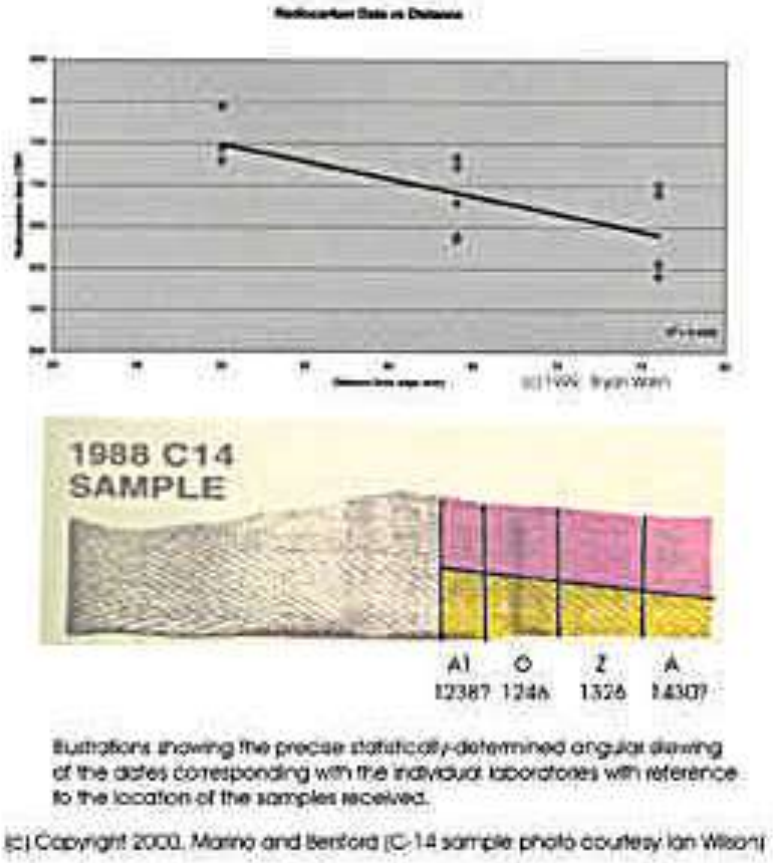
> The patterns ...are all distinguishably different from one another, .clearly indicating differences in their chemical composition. In particular the radiocarbon samples are not representative of the non-image samples that comprise the bulk of the cloth.

Not only is the radiocarbon sample atypical of the main Shroud cloth, but statistician Bryan Walsh shows that the data indicate that there is a 97.7% chance that the C-14 subsamples themselves are from different populations, and in this case, the population would refer to the threads. (Walsh, 1999). Walsh states:

> It was determined that there was a statistically significant ($P>98.8\%$, $r^2=0.49$) inverse linear relationship between the date measured and the distance from the sample to the edge of the cloth. This finding indicated that there was an apparent gradient of radiocarbon measured on the Shroud sample with the higher levels of C14 measured at increasing distance from the edge of the Shroud linen based on the sample measured (Walsh, 1999).

Further, to pass the Chi Square test, which determines comparability of two or more disparate samples, statisticians tell us that the calculated value should be lower than 6. The Chi Square test value for the Shroud is 6.4, meaning that the subsamples cannot be considered identical, or rather, from the same representative sample (Van Haelst, 1991:5).

The labs produced a wide range of dates, with the range between 1238 and 1430 for Arizona and the average dates for Oxford and Zurich falling between the oldest and youngest dates obtained by Arizona.



Illustrations showing the precise statistically-determined angular skewing of the dates corresponding with the individual laboratories with reference to the location of the samples received.

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Fig. 1

Figure 1 illustrates a color-enhanced version of the approximate location of each of the laboratories' subsamples. These are our proposed areas of patched (pink) and original (yellow) weaves. The Oxford and Zurich dates as shown are the average of their range. As can be seen in our proposal, Arizona had a sample with both minimal and maximal medieval material, corresponding to Oxford's older age on one end and Zurich's younger age on the other. Since Arizona had two separate pieces, and we are unable, based on the data revealed by them, to determine which dates match up with which pieces, we have put a question mark after their dates, but feel fairly certain that we have postulated correctly, based on the close correspondence with the Walsh graph.

A striking similarity can be observed between the angle at which the C14 rate changes and the angle at which the disparate weave intersects the Shroud weave. Note the correlation between the

angle of what appears as the patch of medieval material spliced into the original weave, and what Walsh has portrayed statistically.

If one looks at the location from which the Shroud samples were taken for each of the three labs, it can be seen that the C-14 dates correspond closely to the change in weave percentage. This would resolve the question as to why Arizona's results were both the oldest and youngest of the three labs.

It is our premise that the reinforcement with 16th century material occurred following the removal of the 5½ inch x 3½ inch section of cloth adjacent to the C-14 sample (see Figure 2) This may have occurred as a result of the will and testament bequeath, drawn up on February 20th, 1508, by the Duchess of Savoy, Margaret of Austria, who wanted to leave a portion of the Shroud to her church (Wilson, 1998:67, 287). Margaret died around the beginning of 1531 (BSTS Newsletter, no. 51, June 2000, pg. 43), at which time her last will and testament was executed. We propose that it included the excision of the 5½ inch x 3½ inch section. Supporting this timeline of events is empirical testing by Adler, which compelled him to conclude that the "missing panels were already missing at the time of the 1532 fire" (Adler, 1997:104). Since this would have been prior to the addition of the backing cloth in 1534, a more sophisticated patch-type repair would have been necessary to prevent unravelling of the raw edges.

In Figure 2 one can observe several anomalies in the area from which the sample was taken. The first is the distinctive definition in the seam that extends the length of the cloth. It is clearly more defined next to the excised piece, possibly indicative of restorative stitching, as reported by Raes, which we will soon describe. The second is the more pronounced discoloration extending only into the area that we have designated as the medieval patch. According to Louise Harner of the Albany International Research Company, which specializes in textile analysis, inconsistent discoloration in heat-exposed fabrics can be due to different thread types or different preparations, including the addition of various oils and dyes (Albany International Research Company, 2000). This observation is supported by the 1982 discovery of starch on a thread from the 1973 Raes samples. Starch was, in fact, used by medieval restorers for invisible mending (Petrosillo and Marinelli, 1996:149). Harner further noted that cotton's lower scorch threshold, as compared to linen's, supports the notion that fabric containing cotton may disproportionately darken compared to pure linen (Harner, 2000, August 2).

The third and most compelling of the anomalies is the existence of a subtle vertical seam directly below the end point of the excised area and proceeding down to the section we have designated as the 16th century patch. Does this seam indicate the connecting point of the patch to the main Shroud?

A blinded analysis of a photograph of the Zurich C-14 sample, by Thomas Ferguson & Co. Ltd, world-renowned makers of Double Damask Linen, resulted in their perception that the sample was "touched up to prevent unravelling." They further observed, "We have to say that we see the twill pattern clearly on both sides, but still there is something different left versus right." (Ferguson & Co., 2000)

In a second blinded examination of photographs of both the Zurich and uncut C-14 samples, European-trained weaver David Pearson, owner of the French Tailors in Columbus, Ohio, immediately recognized the disparate weave pattern and differences in thread size, stating "there is no question that there is different material on each side ... It is definitely a patch." [(referring to what we have highlighted in Figure 1 as the pink section)] (French Tailors, 2000). He stated that medieval European weavers would typically try to match the original cloth and then hand-stitch approximately ½ inch of new material into the old, such that it was invisible to all but the trained eye. This would ensure the long-term integrity of the material, while maintaining aesthetic consistency throughout the fabric. This type of detail to repairs would be consistent with the wealth and devotion of the Savoy family, who owned the Shroud at the time.

In a third blinded analysis of the Zurich C-14 sample, by Albany International, Louise Harner remarked that "the float is different on either side of the sample" (Albany International Research Company, 2000). It forms a thick/thin, thick/thin pattern on the right side, whereas the left is much more consistent throughout (see Figure 3). This is probably due to the fact that each side of the pattern was woven independently, possibly corroborating Pearson's belief that part of the sample was a patch.

But is an invisible and undetected patch as described by Pearson plausible with reference to the C-14 sample region? Although Riggi had given his assurances that the excised C-14 samples given to the labs were free of foreign threads, both red silk and blue satin fibers were documented by Arizona (Petrosillo and Marinelli, 1996:86), leaving one to ponder if he also failed to detect the much more subtle patch.

Due to its adjacent location next to the excised region and C-14 sample, it is highly likely that the Rates sample also contained the 16th century patch. In Raes' examinations of his 1973 samples (Raes, 1976:86) and the 1988 Oxford C-14 sample (Raes, 1989), he reported the presence of cotton fibers. More importantly, he detected two pieces of material sewn together, noting, "The thread used for sewing the two pieces together is ... twisted in an S-direction, whereas the individual threads are twisted in a Z-direction" (Raes 1976:85). Here Raes is referring to the connection between the fabric and the seam, which raises further suspicions of a patch, since studies have shown that the side strip is, in actuality, a continuation of the main Shroud (Schwalbe and Rogers, 1982:42; Adler, 1997).

A radiograph of the C-14 sample region demonstrated high and low-intensity bands continue uninterrupted between the main Shroud and side strip, indicating a singular fabric (Schwalbe, 1982:42).

However, as depicted in Figure 4, band "C" seemingly terminates as it reaches the area we have designated as the 16th century patch (Schwalbe, 1982:42), suggesting that the band does not extend any further.

Further support for the theory of a 16th century patch can be found in a theoretical C-14 calculation (see fig 5). According to Ronald Hatfield, a scientist at Beta Analytic, the world's largest radiocarbon dating service, a merging of threads from AD 1500 into a 2,000 year old piece of linen would augment the C-14 content, such that a 60/40 ratio of new material to old,

determined by mass, would result in a C-14 age of approximately AD 1210 (Beta Analytic Laboratories, 2000). This correlates very closely with the Oxford mean date of AD 1200 as reported in *Nature* (Damon, 1989:613) and with the observed ratio of original versus medieval material in the C-14 sample.

Conclusion

An acceptable theory of why the Shroud dated between AD 1260-1390 must satisfactorily explain the precise, statistically-determined angular skewing of the dates corresponding with the individual laboratories, with reference to the location of the subsamples received. The traditional theories of generalized ionizing radiation, thermal effects, and bioplastic coating are incapable of meeting this latter requirement, as is the premise that the cloth itself, is, *in toto*, medieval. Our theory that a significant portion of the C-14 sample was, in actuality, a patch of 16th century material, meets all the requirements necessary to explain the results obtained by the laboratories.

Much could be learned by microscopically examining the extra Shroud material saved by Giovanni Riggi when the C-14 sample was taken, investigating the cloth adjacent to where the sample was removed, and conducting another C-14 test using material beneath a patched hole area as previously proposed by Shroud of Turin Research Project scientists (Schwalbe and Rogers, 1982:44). By performing these tests, perhaps we can finally unravel the truth regarding the age and origin of this fascinating cloth.

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