



### **How Image Enhancement May Explain Past Events**

The following article is reprinted from NASA's Jet Propulsion Laboratory's house magazine, "JPL Universe," dated July 5, 1977.

In the "truth is stranger than fiction category" a phone call to NASA's JPL from a member of the Christ Brotherhood in New Mexico, requesting image analysis of a religious relic, has drawn two men from JPL's image processing lab into a fascinating investigation of the famous "Shroud of Turin."

The controversial shroud is a 4 1/2 meter, 7.62 centimeter long linen cloth that bears a remarkably detailed image of a bearded, long-haired man, with numerous lacerations over his body.

Tradition, dating back to at least 1354 A.D., has it that the fabric, with its brownish, stain-like shadings, is the burial shroud of Jesus Christ.

Enshrined in the northern Italian city of Turin since 1578, the shroud has inspired widespread curiosity, especially since the first photographs of it taken in 1898 showed the markings to be a "negative" rather than a "positive" image. The resulting "picture" resembles rubbings made from base-relief art works.

JPL's Donald Lynn and Jean Lorre were drawn into the quest for further information about the relic when the Christ Brotherhood members and representatives of a New York based Holy Shroud Guild contacted them last year. These people had learned of the NASA/JPL advanced image processing techniques, and hoped that sophisticated computer analyses might be applied to negatives and color slides of the shroud obtained in 1973. They explained that many questions about various types of marks on the shroud remained unanswered:

Was the body image formed from ammonia vapors absorbed into the linen threads, as thought in earlier years? Was it caused by a radiation phenomenon, as one analysis has indicated, or by processes of which scientists are still unaware? Are the dark spots at the wrists and feet direct-contact blood stains? Is the image possibly a "picture" that was painted on? And how could investigators better distinguish between the original image and blemishes such as holes, wrinkles, and burns, scorching and water stains that damaged the cloth during a fire in the Sainte Chapelle in Chamery in 1532?

The challenge for Lynn and Lorre was in the first phase a technical one, yet both men became caught up in the age-old mystery, and agreed to see what they could do. Their task was to remove as many of the extraneous markings or "artifacts" as possible in an attempt to reveal a more distinct picture of the figure on the shroud.

The pictures they produced (using mathematical and contrast enhancement techniques) revealed a noticeably clearer image of the figure.

"We didn't feel we made any major finds," says Lynn, "partly because we had poor quality negatives to work with. However, frequency analysis did tend to rule out the possibility that the figure was hand painted."

Both men were so optimistic about the mysteries they might eventually solve if allowed to obtain better photographs, that they chose to present their work to the Holy Shroud Conference in Albuquerque last March.

The Albuquerque gathering consisted of 40 participants, including forensic specialists, clergy, scientists from the Air Force Academy, Sandia Laboratory, and the nearby Los Alamos Scientific Laboratory, and eminent Protestant and Catholic scholars, including Vatican representatives.

Their common objective was to share current studies on the relic and to prepare for greater scientific examination of the garment at an unprecedented exhibition of the shroud in Turin in 1978.

The Face of Jesus? Enlargement of the face of the figure imprinted on the "Shroud of Turin" by image enhancement techniques used at NASA's JPL shows white spots, thought to be bloodstains, on hair and forehead.

That exhibition could be the "moment of truth" for the shroud's authenticity, according to Anglican scholar John A. T. Robinson of Trinity College, Cambridge, especially if use of the destructive carbon-14 dating process (now successful when applied to fragments as small as a square centimeter) is permitted on the fragile fabric.

A report by Dr. John Jackson and Dr. Eric Jumper of the Air Force Academy showed that the figure discernible on the shroud probably was that of a man 5' 10" tall, weighing about 175 pounds. These scientists ultimately hope to produce a three-dimensional statue of the body imprint.

One unusual examination by Zurich criminologist Max Frie, indicated that pollen particles found on shroud fibers are indigenous to Palestine, Turkey, France, and Turin, at dates appropriate to the alleged history of the shroud.

Despite the many tests made, scientists at the conference emphasized that they still are at a loss to explain how the image got on the shroud.

That is why Lynn and Lorre want to pursue this project. They'd like to apply color classification analysis such as is used routinely on Earth-orbiting satellite pictures. "To separate the various markings and determine their nature," says Lorre, "we would need to take high resolution photographs of the shroud in many colors, with adequate calibration controls to allow intercomparison between the photographs.

"Then very sensitive color variation maps could be produced, which might allow one to separate marks by their chemical composition."

Because of their professional and personal curiosity, Lynn and Lorre are hoping to participate in a more detailed examination and analysis of the shroud before the planned public exposition in Turin in 1978.

"Everyone who has come in contact with our shroud pictures shares our excitement," says Lynn. "I've observed a level of religious consciousness, especially among lab employees, which I did not know existed."

"Like many people around the world, we'd like answers to these compelling questions... Is this cloth really 2000 years old? Is the image truly the imprint of a human corpse? If so, whose image is it? And, especially from the scientific viewpoint, how did that image get there?"

NASA Activities, November 1977

### **Detective Story, Part Two**

(The following article appeared in "NASA Activities," September 1978, p. 7.)

Although the "Shroud of Turin" investigation by JPL scientists is not a NASA enterprise, the image enhancement techniques used stem from space technology. The work, therefore, has a NASA connotation. The following article, from the JPL Universe, covers the latest developments in this fascinating story. (See NASA Activities for November 1977 for earlier coverage.)

The Shroud of Turin, that ancient burial cloth mysteriously imprinted with a figure thought to resemble Jesus Christ, is dramatically affecting the lives of two JPL scientists.

When Don Lynn and Jean Lorre agreed to apply image processing techniques to photographs of the shroud in 1977, they hardly expected to find their results published in newspapers and magazines around the world.

Since then, their initial mild curiosity about the relic has intensified through involvement with other American scientists who propose to determine how the shroud was imprinted through a variety of sophisticated tests. The result is that Lynn and Lorre will go to Turin, Italy, in October when Catholic authorities will allow the American science team to make an unprecedented 24-hour examination of the shroud itself.

The team is sponsored by the New York-based Holy Shroud Guild of America. And the tests coincide with a public exhibition and international conference about the shroud, to be held in Turin September 26 through October 8.

Lynn and Lorre will take infrared and ultraviolet photographs as well as conventional black and white and color pictures. Other team members will make radiographic and X-ray fluorescence examinations.

Primarily, they will explore the mechanical formation of the unique "negative" image of a 5-foot-10 man with lacerations about his head, face and body.

Turin authorities declined to accept the proposed age-dating tests until it is determined exactly how much cloth is needed to get accurate results. If approval is granted by the conclusion of the exhibition, results from those tests will take months to obtain.

Although the shroud has been stitched to a protective cloth backing, the reverse side of the fragile fabric will be examined also, by using a flexible optical instrument.

A special frame from which the fabric will be suspended with magnets has been designed by Tom D'Muhala, president of an international nuclear decontamination firm in Connecticut. D'Muhala's chance reading of a book about the shroud led him to build and donate this equipment and to supervise logistics of the team's trip to Europe.

A formal proposal for the examinations was sent to authorities in Turin, along with a model of the frame and a unique three-dimensional model of the shroud figure, derived from image enhancement photographs.

Based on the relationship between image intensity (shades from black to white) and cloth-body distance, Air Force Academy professors and students built a cardboard model of the shroud's figure. They used slices of 1/8-inch-thick cardboard to build up layers (similar in appearance to a topographical map) that form the frontal image of a 5-foot-10 man in a state of repose.

As the day of examination approaches, financial support for the American science team is still uncertain. "But we're going ahead with our plans," says Lynn, "because we are certain the funding will come from somewhere."

The cooperation of major business corporations has been tremendous, Lynn reports. Photographic and electronic equipment companies, including Polaroid, Kodak and the Brooks Institute of Photography have agreed to lend or donate facilities and equipment for the tests.

All the participants are donating their time, but money is needed for purchasing some equipment and for transporting people and equipment to Turin. Funds also are needed for the months, possibly years, needed to analyze the data.

Lynn and Lorre expect to provide a "quick look" report of their findings soon after the Turin exhibition. Both men speak of the event with expectation, still in awe of witnessing how technology is unlocking closed doors of history.