# STURP 1981 Symposium: Speakers, Key Findings, and Collective Inferences on the Shroud of Turin

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*Speakers, Key Points, and Collective Inferences*




John Jackson, John Heller and Prof. Luigi Gonella (Scientific advisor to the Archbishop of Turin) All Photos ©1981 Barrie M. Schwortz Collection, STERA, Inc. Source: Link

## Key findings from the recordings from 1981 ( Link )

## Part I — Speakers and Their Inferences

### Physics and Image Formation

🔬 **John Jackson, Eric Jumper, and Don Devan** — *Physics / Image Formation*

- Jackson concluded that the image "does contain distance information" and could "not be the result of an artist... or a direct contact process" based on the resolution of the facial features.
- Jackson maintained the "assumption that a cloth draped over a body" and posited that to explain the image's resolution and lack of distortion, the image formation mechanism must have been some kind of "vertical mapping" or "parallel projection" originating from within the body.
- Jumper and Ercoline concluded that the image's measurements are "consistent with a body under a cloth," estimating the man was 5'8" and 155 lbs, with detectable distortions in the cloth drape.
- Devan noted that "none of the photographs have any way contained in the information... to try to relate what one sees on the image back to a more measurable quantity," which was a key motivation for adding "step wedge" calibration targets to the photographs.

## Analytical Chemistry

### 🔬 **Don Janney** — *Analytical Chemistry*

- Janney reported using a "micro-spectrophotometer" to analyze the sticky tape samples. He concluded the image area "does not look like it's a paint or a pigment or a dye" and is more consistent with a "scorch" or chemical alteration of the linen's cellulose itself, though he emphasized his analysis had "barely scratched the surface."

## Forensic Pathology

### ⚕️ **Robert Bucklin** — *Forensic Pathologist*

- Bucklin concluded that the person on the Shroud was "a crucified person," based on the pattern of wounds. He attributed the cause of death to "congestive cardiac failure related to respiratory difficulty from posture in a position consistent with crucifixion."

### ⚕️ **Joseph Gambescia** — *Pathology and Wound Analysis*

- Gambescia focused on the anatomical plausibility of the crucifixion, concluding that to support a body "two nails were used for the foot" and that the awkward bent-elbow position seen in the image and in art is "correct" and helps maintain the body's position.

## Infrared Spectroscopy and Thermography

### 🔬 **Joseph Accetta** — *Infrared Spectroscopy and Thermography*

- Accetta concluded from infrared spectroscopy that the "image area... looks very similar to a scorch." Blood areas, however, were "not too dissimilar" from a laboratory blood spectrum, but large differences indicated it may be a "composite of blood [plus] some

other substance." A thermogram (heat picture) showed the image in infrared was "very similar to the image in the visible region" with no anomalous details.

## Spectral Reflectance and Fluorescence

### 🔬 Roger and Marty Gilbert — *Spectral Reflectance and Fluorescence*

- The Gilberts' spectral and fluorescence analysis concluded that the body image "does not look like it's a paint or a pigment or a dye" and that it acts as a "filter" that quenches the cloth's natural fluorescence, similar to a scorch. They found the blood image did display "absorption peaks" consistent with hemoglobin, but not in the same positions as a fresh sample.

### 🔬 Sam Pellicori — *Spectral Reflectance and Photomicrography*

- Pellicori reported that the "body image resides only in the upper fibrils" (the topmost surface) and that it consists of "discolored fibrils" with "no particulates" — this was a key finding as it eliminated most pigment-based explanations. He concluded the image is a "dehydrated oxidation of the cellulose" itself, chemically speaking.

### 📷 Vern Miller and Sam Pellicori — *Photomicrography*

- Miller and Pellicori showed photomicrographs proving the image was limited to the very surface of the cloth, while water and blood stains penetrated to the back. The team concluded the image "does not penetrate" and is not a result of direct contact with a liquid or powder.

## Chemistry and Project Summary

### 🔬 Ray Rogers — *Chemistry and Project Summary*

- Rogers served as a primary synthesizer of the team's findings. He began his summary by reminding the audience that the "problem is to observe it [the Shroud] and try to explain why it looks the way it does."
- "No paint, pigment, or dye was found" in the image areas and the "image is due to a change in the cellulose itself," likely a product of dehydration and oxidation.
- He concluded the bloodstains are "real blood" based on multiple tests including microspectrophotometry, porphyrin fluorescence, and protein assays.
- He affirmed that the cloth dates from antiquity based on the herringbone weave and chemical analyses, but noted definitive carbon-14 dating was still pending. Ultimately, Rogers stated the team could not explain "how [the image] was made" and often could not unite the physical and chemical findings to form a cohesive mechanism.

## X-Ray Fluorescence

### 🔬 Larry Schwalbe — *X-Ray Fluorescence*

- Schwalbe reported that X-ray fluorescence analysis showed strong "iron peaks" in the blood areas, correlating with what you would expect from blood. He found elevated iron, calcium, and strontium uniformly across the cloth, but attributed these to the flax retting process rather than to any image-forming pigment.

## Forensic Chemistry and Biochemistry

### 🔬 Alan Adler and John Heller — *Forensic Chemistry & Biochemistry*

- Adler and Heller were definitive, stating "the blood on the Shroud is blood" and that the body image is entirely "due to a change in the cellulose itself," not to any added pigment or paint. They concluded "this is not a painting." They also noted they could not determine the "mechanism" of the image's formation.

## Archaeology and Historical Context

### 📜 Maria Grazia Siliato — *Archaeology / Israel Antiquities Authority*

- Siliato provided an archaeological and historical context, stating that the man of the Shroud matches "the Roman custom" of crucifixion and that the "cloth's herringbone weave existed in the 1st century," citing examples from Antinopolis and Herculaneum. She also noted the team's chemical tests "show there is no evidence of aloes or myrrh" on the cloth.

## Historical Research

### 👳 Ian Wilson — *Historical Researcher*

- Wilson presented the historical thesis that the Shroud is identical to the "Mandylion of Edessa," a cloth kept folded to show only the face. He argued that the sudden appearance of a "face-only" image in Byzantine art, featuring peculiar markings matching the Shroud, indicates the cloth's existence centuries before it was publicly displayed in Europe.

## Part II — Collective Inferences of STURP

Across all presentations, the STURP team reported a remarkable combination of objective scientific facts. The table below summarizes the primary collective inferences and their supporting evidence.

| Topic | Collective Inference | Supporting Evidence |
|---|---|---|
| **The Body Image** | The image is not a painting. It is the result of a chemical alteration of the linen's cellulose itself, likely a product of dehydration and oxidation. | No pigments or binders were found in image areas; the image is limited to the topmost surface fibrils; the chemistry resembles a scorch. |
| **The Bloodstains** | The bloodstains are real blood, confirmed by forensic chemistry. | Positive tests for heme, porphyrins, protein (albumin), and characteristic absorption spectra; accurate forensic and pathological correlation to wounds. |
| **The Cloth (Age)** | The cloth could be from the 1st century; definitive dating awaited carbon-14 tests. | Herringbone weave found in 1st-century textiles; natural calcium/iron deposits from ancient flax retting; no anachronistic materials found. |
| **The Human Form** | The image depicts a real, crucified human male, with all wounds anatomically and forensically consistent. | Anatomical details (blood flows, nail placements, scourge marks) consistent with crucifixion; blood is present and flows according to gravity. |
| **Image Formation Mechanism** | The exact mechanism is unknown and remains the primary mystery; however, the evidence strongly implies it was a body-specific, topochemical process. | No known simple mechanism (paint, contact, scorch, radiation) reproduces all properties: the body's distance data, the chemical change, the surface-only nature, and the lack of distortion. |
| **Historical Identity (Hypothesis)** | The cloth may be the Mandylion of Edessa, preserved folded and matching artistic records, suggesting it existed in Byzantine times. | Anomalous 'Vignon markings' align with the Shroud's image; the 6th-century appearance of a 'face-only' iconography matches a folded Shroud; literary and artistic traditions align. |

## Part III — The Overarching Conclusion

The STURP team's final position was not a single, dramatic pronouncement of authenticity but a presentation of objective data that challenged both the forgery hypothesis and simple natural explanations. The image was scientifically inexplicable by any known 14th-century (or modern) technique, and the blood was conclusively real.

However, the team formally refused to state that the Shroud was the authentic burial cloth of Jesus of Nazareth. This was a deliberate, philosophical position driven by the constraints of the scientific method. As Ray Rogers, the team's chief chemist, summarized, the goal of science is

not to prove or disprove faith, but to observe an object and try to explain why it looks the way it does.

While the data was consistent with the Gospel accounts of the Passion, the team recognized that such a conclusion is not a scientific question and lies outside the domain of objective scientific proof — a position that has come to define the modern Shroud debate.

Transcripts of the recordings

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The Thank you. I think what you're talking about is the technique that derives itself from the variation

00:00:53

between the shading, basically the color is to take the image shading on the chart,

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an input, create a unique surface of the original core of the image, and then from the and also

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Tom DeMahalla wanted me to announce that the press is invited over to the Bradford House

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after this conference to view the exhibit and we can answer some questions there about

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it as well.

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I would like to ask Reese Norris to talk about the book.

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This does not necessarily mean that it's the end of the scientific questions, but I know

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some of you do have to leave, so, Reese?

00:02:13

Ladies and gentlemen, my name is Reese Norris.

00:02:17
I'm from Glastonbury, Connecticut, and I'm the attorney for the Shroud of Turin Research

00:02:21
Project.

00:02:22
I have a statement to read regarding the book entitled Verdict

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on the Shroud and certain publications. I apologize for not having copies for you. I think you'll

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understand the reason when I read the statement. We have been working frantically throughout

00:02:40
the week. The most recent developments coming from federal court just literally hours ago.

00:02:47
So it would be totally impossible to have updated this report for you as many times as such an

00:02:55
update would have been required and read it to you.

00:02:58
And before entertaining questions, I'd like to read the statement, if I can.

00:03:00
could. Yes.

00:03:06

No, I believe I will indicate my counterpart in Ann Arbor, Michigan. The Shroud of Turin

00:03:13

Research Project wishes to formally comment on the publication of a book entitled Verdict

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on the Shroud by Kenneth E. Stevenson and Gary R. Habermas. The Shroud of Turin Research Project wishes to emphatically state that this

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book does not represent the findings of the Shroud of Turin Research Project and is neither authorized

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nor approved in any fashion. Author Kenneth E. Stevenson has identified himself to the media

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as the official spokesman for the Shroud of Turin Research Project.

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Mr. Stevenson is not the official spokesman for the Shroud of Turin Research Project,

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and his resignation as a member of that project has been demanded.

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Co-author Gary R. Habermas has identified himself in the publication, as well as to the media,

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as a research consultant to the Shroud of Turin

00:04:06

Research Project. Mr. Habermas is not a research consultant to the Shroud of Turin Research

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Project, and in fact, there is no record of the Gary R. Habermas in the official records

00:04:17

of the Shroud of Turin Research Project. The book entitled The Verdict on the Shroud" acknowledges doctors John Heller, John Jackson, Eric Jumper, and Ray Rogers as assisting in the preparation of the manuscript, when in fact these scientists, who are all members of the Shroud of Turin Research Project, did not assist in the preparation of this manuscript.

00:04:42

in the preparation of this manuscript. Any statement by the authors or publishers of Verdict on the Shroud

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which represents that the book reports the findings

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of the Shroud of Turin Research Project

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or is in any way affiliated with the Shroud of Turin Research Project

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is false and misleading.

00:05:00

The Shroud of Turin Research Project, with the great assistance

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of Attorney Bruce Wallace of Ann Arbor, Michigan,

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obtained a temporary restraining order against the publishers and authors of this book,

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restraining them from selling, promoting, or distributing this book,

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pending a full hearing to be conducted before the Honorable Ross W. Campbell, circuit judge, Ann Arbor, Michigan.

00:05:27

This afternoon, a federal United States District Court judge in Detroit, Michigan, dissolved

00:05:35

that temporary restraining order and entered an interim order pending a full hearing on October

00:05:41

13, 1981 to the following effect: One, that the publisher forthwith prepare inserts

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to be delivered for each outstanding copy of the book,

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stating that the book is in no way an authorized publication

00:05:57

of the Shroud of Turin Research Project.

00:06:00

and that the acknowledgement page delete reference to Drs. Jumper, Jackson, and Heller.

00:06:08

Two, that the publisher forthwith reprint the dust jacket of the book

00:06:13
to delete all records to the Shroud of Turin Research Project.

00:06:18
Three, that in all future copies of the book,

00:06:21
the publisher delete reference to Drs. Jackson, Jumper, and Heller in the acknowledgement.

00:06:27
The Shroud of Tern Research Project

00:06:29
is presently negotiating with the officials

00:06:31
of the Italian church and the exiled King of Italy

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for permission to conduct carbon-14 testing

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upon the Shroud of Tern.

00:06:40
And we wish to assure those officials,

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as well as the public and the media that the book entitled verdict on the

00:06:48
shroud does not report the findings the shroud of turin research project thank you very much

00:06:58
that will be in the united states district court detroit mission

00:07:02
Detroit mission I don't want to go into the details

00:07:12
any more than I have because

00:07:14
this matter is presently

00:07:16
in the midst of litigation

00:07:18
and I feel that that statement

00:07:20
suffices to state our purpose at this time.

00:07:35
Well, I don't want to address myself to that perhaps. I'll leave that to you.

00:07:37
No. We certainly were not intending anything at all.

00:07:42
I think-- Larry, you want to talk to me about that? I'm taking my own disciplinary action.

00:08:14
I'm asking that my foreword be deleted from any future printings in the book.

00:08:20
Yes, sir.

00:08:42
I reviewed the scientific data as it was discussed in Chapter 6 and made corrections.

00:08:50
I think with the recent developments, it's become an embarrassment to the project,

00:08:55
and I think it's hurting our credibility.

00:08:58
Did you notice?

00:09:00
Was I aware that my forward was going to be included?

00:09:09
Yes.

00:09:11
What is it about the manuscript that makes it embarrassing?

00:09:24

What is it about the manuscript that makes it embarrassing?

00:09:35

It pretends that the Shroud of Turin Research Project's conclusion is that the evidence can only be explained by the resurrection, and that's not true.

00:09:49

Had I read the entire thing?

00:09:50

Not very carefully.

00:10:34

I don't believe there's any further comments from Mr. Schwalbe. No, it's not on the other side of my part.

00:10:39

Yes, in the original papers, we prepared on rather short notice.

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We prepared the entire reaming of legal papers within 24 hours.

00:10:49

Dr. Rogers was not acclaimed for that matter,

00:10:51

and that's why he was not included.

00:10:54

The information, as I report to you, is absolutely correct. One other question.

00:10:56

You know, the story about this battle

00:10:58

is about the same in the story.

00:11:02

In the end, in the idiom,

00:11:05

it may be the one who played in some other reports. I'm not even going to address myself to that question.

00:11:31

I don't think it's a problem for me to do it at this time.

00:11:33

I think the statement that I've presented is the statement which this project wants

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to present to the press at this time we feel that we need all i will say is that he is dr buckham

00:12:00

Thank you. That's an accurate quote.

00:12:30

I wrote the closing, the epilogue for the book.

00:12:36

I had an opportunity to read the manuscript before I did.

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I didn't agree with everything which was written in the book.

00:12:43

I didn't agree with everything which was written in the book,

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and in my few words at the end,

00:12:53

I made an attempt to state the position of the Shroud of Turing Research Project as I understood it in relationship to that particular question.

00:12:58

I felt that it was inevitable that there would be some connection made

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between the scientific work done by the group and the matter

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of the resurrection. But I very carefully expressed my opinion that the group as a whole would not

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take a position in that respect, nor would any church group that I was aware of.

00:13:29

The opinion I expressed was my own, and it stands as that.

00:13:40

I believe the statement says that there is nothing in the, as far as I'm concerned personally,

00:13:47

there's nothing in the scientific work which has been done which would preclude the resurrection.

00:13:55

In no way did I ever indicate, nor will I, that the work done by this team is going to prove that the resurrection took place.

00:14:05

worked on by this team is going to prove that the resurrection took place.

00:14:14

I'm a doctor of medicine, currently the deputy medical exam for LA County.

00:15:00

Robert Bucklid, UCKLIN. Thank you. Excuse me, but I think that question is out of order. You're talking about something that appeared in a

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in a

00:15:02

disreputable piece of

00:15:04

journalism.

00:15:06

I think that that's not

00:15:07

it has nothing

00:15:10
just a moment.

00:15:16
My name was brought up in Anna Marie Rogers.

00:15:18
I would also like to point out

00:15:20
that Bob Buckman is not a member

00:15:22
of Stirk.

00:15:25
He was not part of the observations in the Palace of Turin.

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He has not been a member of the chemical,

00:15:33
physical observations of the STERP program.

00:15:37
If he's recognized as a member of STERP,

00:15:39
he's not recognized as one of the scientific members.

00:15:43

As far as I'm concerned,

00:15:45
I'm madder than hops about my name not showing up in that disclaimer.

00:15:50
In October of 1979, when we had our first get-together

00:15:54
and the question of people writing books came up,

00:15:57
I was the one, I was the first one who said I wanted nothing,

00:16:01
whatever, to do with any popular books on the subject.

00:16:05
I wanted nothing to do with it at all.

00:16:07
I would do my talking in the scientific literature.

00:16:10
And how in the world I end up in an acknowledgement of that thing,

00:16:15
I'll never understand.

00:16:17
But I want my name absolutely out of that in all ways.

00:16:22

in all ways.

00:16:32

When we were in Turin, we needed somebody, pardon me,

00:16:33

to fend off the press.

00:16:35

We needed to get our work done.

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We needed to have a little not peace and quiet.

00:16:39

That was impossible.

00:16:42

We needed to do a job in a very limited amount of time.

00:16:46

Ken was the one we nominated to protect us. Since then, no, he has not been ever an official spokesman

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in the sense of reporting what we think.

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I think if you asked what we think,

00:16:55

every single one of us would give you a different answer.

00:16:58

We have no spokesman.

00:16:59

We couldn't possibly have a spokesman.

00:17:03

We are going to stop answering any further questions on the book. We had a

00:17:10

long discussion at the private meetings this morning, which commenced at 9 o'clock. We

00:17:14

spent a lot of time, spent a lot of time over the last week on this issue. The statement

00:17:20

I read accurately reflects the position of the Shroud of Turin Research Project, and I think that's

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all we need and want and desire to say at this time.

00:17:30

No more books.

00:17:35

No more books. How many of you had a spiritual experience because of your research? Raise your hand.

00:18:00

I'd kind of like to clear the air here.

00:18:08

Stirrup is not just a list of names on a list, it's not a collection of names on a list,

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but it's a group of living people who are trying to accomplish their objective. We see ourselves as a scientific group

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that is looking at the Shroud of Turin from a scientific point of view.

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We're using scientific data.

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Questions about who belongs to Sturrop and who doesn't

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is really an issue that is probably not that well defined because we are simply a group of people

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trying to produce a better understanding of the relic, sorry, thought known as the Shroud of Turin.

00:18:59

As far as the religious aspects of people, you know, I said we're a group of living people,

00:19:08

of people. You know, I said we're a group of living people, and living people, though we may be scientists, can be human beings and have religious points of view. And I can assure you that Stirrup

00:19:14
has many different kinds of religious points of view, all the way from fundamentalist-type

00:19:21
Christians to Roman Catholics to Protestants, Jewish, agnostic.

00:19:28
We've got them all.

00:19:30
I think of that as our strength, because I would hope it would be viewed as something

00:19:37
that would help us to be objective in what we try to do as scientists.

00:19:42
And I think it does.

00:19:44
We're not trying to promote a religious point of view,

00:19:48
although everybody and anybody on this project

00:19:51
is allowed--

00:19:52
I mean, certainly can have their own religious point of view

00:19:56

and live with that.

00:19:58
So we're not trying to present an image here

00:20:00
of being different than anybody else.

00:20:03
We're simply scientists who have come together

00:20:05
to try to investigate something we find very interesting.

00:20:11
We have time for one or two quick questions, I'm told.

00:20:14
Oh, OK.

00:20:15
Let me make one statement to correct the record, Don Lin.

00:20:19
Bob Buckland is a contributing member of the project.

00:20:22
OK. I don't think that's a possible thing to ever come to a conclusion on.

00:20:47
I don't think the classical scientific method can answer who it was.

00:20:51

I don't know for sure that we can even say, well, no.

00:20:56

The answer to your question specifically is no. I don't think we can.

00:21:00

Sir? I don't think we can prove what you first said would have to be proved before we can say this. I don't think classical scientific method can prove that this was

00:21:47

a body of a man that was crucified. I think we can indicate probabilities perhaps, but

00:21:57

we can prove much more easily what it wasn't than what it was.

00:22:01

I think we're going to have to call a press conference to a close.

00:22:07

We're on an extremely tight schedule.

00:22:09

We've missed our first three buses.

00:22:10

We have one remaining.

00:22:11

If we don't get on it, we all walk.

00:22:13
So we appreciate your time, and I hope you understand.

00:22:25
I might add, all the members of the project, the bus leaves at 5:30. Let's go get the party.

00:22:55
Uh-oh. Oh, that's a good idea. - -

00:24:00
Yeah, here. Thank you. The The Thank you. *Skitching* Thank you. -

00:27:00
Thank you. Okay. Thank you. The *Dramatic music* *crying* *crying* *crying*

00:28:46
*crying*

00:28:48
*crying*

00:28:50
*crying*

00:28:52
*crying*

00:28:54
*crying*

00:28:56

*crying*

00:28:58

*crying*

00:29:00

*crying*

00:29:02

*crying*

00:29:04

*crying* *crying* Oh, yeah. Thank you.

Transcribed by https://soundwise.ai

00:02

that the human eye can discern a density difference of 0.01.

00:07

Therefore, if that's true, the number of discernible shading levels that the artist would have to be able to work with if he's going to do this with some kind of eye-hand coordination technique would be the amount of density of the difference of the image divided by the ability for the eye to resolve that density at 0.07 over 0.01 is seven. So he has seven levels of shading that he can work with. That means, and if we say, if we take the 3.4 centimeters that's encoded into this amount of reflective density, that means that the human eye would be able to discern, putting the image onto the shroud as it appears on the cloth, an effective distance of 3.4 over seven levels, or about a half a centimeter.

00:58

It would be like trying to create a sculpture of a three-dimensional face in the levels of the shading using a half a centimeter chisel, not a very fine one.

01:09

Of course, you have problems with lips because they're, for example, they have distances less than that. To put this another way, I have another slide.

01:20

I took a human face, actually it's mine, and it's in the dotted lines right here, and I offset them by the half a centimeter.

01:33

What that means is that any line that you can draw between those two boundaries is equally probable as any other line that you can draw from there, and that's those set of profiles that could be generated this way are the kinds of things that you could expect from a because artists were going to try to do this. Next slide just shows the solid line.

01:56

Gosh, let's see. Oh, yeah. Okay, there's forehead. Here's his sort of nose, and there's the lips. Now, this is just an arbitrary drawing on my part, but just to illustrate the point that this would be presumably a possible outcome that an artist would have in trying to encode this distance information.

02:18

Okay, next slide. Oh, by the way, could we back up that slide once more, please?

02:25

I would also like to point out that there is still a correlation, I mean, that we could expect. There's evidence of a kind of a nose and some lips and so forth. I mean, there still is correlation, but the question is, is the correlation equivalent to that which we see on the shroud, which I have just shown you on the VP8 images. Next slide.

02:46

Well, I think what I thought was a relevant thing to do in light of this was to try to do more controlled experiments rather than simply look at images. In other words, we might be able to suggest that an artist may not think of encoding the distance information, but what if he did? What if he thought of it? Could he do it, is the point.

03:13

So what I did is I took the same statue face that I showed you before and I asked two artists to try to construct this face for me and shade it. In other words, try to encode the spatial geometry of that face into the relative shadings of their drawing. The artist that I used, is that 10 minutes?

03:43

The artists that were used were police artists, certified police artists, because I wanted somebody who doesn't put creativity into it but actually does this with as much realism as possible.

04:07

Now, I also gave them the constraint of working within that density variation of 0.07.

04:13

Actually, it was 0.1, a little bit higher than I gave them. And we used the density step wedge to establish that they would work within those limits.

04:23

Now, I'd like to show you the results of that. And by the way, the density variation was done on a piece of paper that had the neutral density of

04:34

pure linen as measured by Samuel Pellicori, who you'll hear from later on in the symposium. Next slide.

04:44

If you can see it, this was the first artist's attempt right here. The peak of that node is no greater than 0.1 density units. We're trying to make this like the image on the shroud in terms of density. Okay, next slide.

05:04

This is a contrast enhanced picture of what he did.

05:09

And it's also done in negative. This is his face. Next slide.

05:15

This is the VPA of it. Next slide shows it from a rotating point of view.

05:25

Next slide.

05:28

This is the profile. Here's the head.

05:31

His nose is kind of flattened here. There's the sort of lips and mustache and then the beard of the statue. Next slide.

05:40

Here's the second artist. There's his image, nose.

05:49

I have to apologize. I wasn't able to get a VP8 of this prior to the conference. I have a picture of it, which I'd be happy to show anybody who would like to see this.

06:00

I would have to ask you to take my word that it is being formed very severely also. Next slide.

06:09

This is his positive negative, the negative picture. Next slide of his.

06:20

The next one was an image that I did. I wanted to control it. I thought it would be worth having a hack in there to try it too.

06:28

But at least I have done a lot of thinking about this three dimensionality aspect of the image. And so I thought maybe I'd like to try it too. I'm not an artist by any means. But that was my attempt. I overshot the density limits by about a factor of five.

06:41

But anyway, I'll show you the result. Go ahead. Next slide. There's my very wonderful negative picture. Next slide shows my VP8 of it.

06:58

Next slide.

07:02

OK, then I said, well, OK, maybe I made it too hard on them. Maybe what I should have done is to give them the distance information in the first place. In other words, if I give them the contours of an actual human body, well, better, I thought, I'll do better than that. I'll give them the actual shading distribution of a photograph taken with a phosphorescent head. Next slide.

07:27

That's this one. I gave them this photograph. This has distance information encoded into it. Let me prove that with the next slide.

07:37

Okay, there's what the VP does with that one.

07:41

Okay, I then did not impose any constraints on shading. They could go to however dark they wanted to make it. I simply asked them to copy that photograph. Next slide.

07:54

This is the positive, negative, or the negative of that image with its shading.

08:03

The next one is the VP8.

08:08

Next slide is the other artist who copied the photograph. Next slide is the VP8. Okay, next slide.

08:24

gives us again the image itself, the picture that they were looking at for comparison. Next slide. I think we're going to have to transfer to the next tray, please.

08:45

So with all this, I have a hard time

08:51

seeing how this image could be the work of an artist by eye-hand coordination. Was that five minutes, John? Yep. Nope. You have to advance it to the... somewhere in there.

09:24

Is that the start of it?

09:26

Okay. Well then, if I look at the artist hypothesis, let me look at a couple others.

09:33

One hypothesis would be that the image is the result of a direct contact mechanism. That is, where the cloth touches the body, you have an image. Where it does not touch the body, you don't have an image. There have been several examples of that which I can look at with the VP8 also.

09:47

There's the shroud image for comparison. Next slide.

09:53

This is a bas-relief of Bing Crosby that someone did. The cloth was placed over the face and then the image was transferred to it. Let me show you the positive-negative characteristic.

10:14

There's the way the image looks. Here's the negative of it.

10:19

By the way, this was done by a man named Joe Nickel.

10:22

I wanted to mention the name to give credit.

10:26

This is pretty good, I think. But let's look at the VP8.

10:33

So I'm disoriented. I think this is the face here. Well, anyway, next slide.

10:41

Here was a direct contact mechanism.

10:46

The positive and negative. VP is next one.

10:51

Looks like that. Next slide.

10:56

There's another one that was done. I believe this was Rodante who did it.

11:01

Next slide. We'll show the one on the right. There it is.

11:07

In short, direct contact mechanisms do not seem to explain the nature of this image. Next slide. There's another direct contact mechanism. Okay, next slide, please.

11:24

Okay, if we look at a few radiation-produced images, I took photographic film over the phosphorous in the face, draped it over it. What you get if you just drape the image over it, you get an image which is totally blurred, totally without any image shading, and it...

11:45

Looks like this. If we put an attenuating liquid in there, we can get some resolution, but we have what looks like distortion in the image. Next slide, I think it shows the VP8 of the one up in the right. Looks like this.

12:01

Okay, I think I heard John tap. Did I hear you tap? Yep. That was the final tap. Right. You're telling me to get off. Okay. Could we go to the last slide? i think it's the last slide no it's the uh no it's not the last slide but it's it's it's about five from the last it's it's a conclusion slide i'd just like to just show that to you and i'll stop go forward forward some more just just move yeah

12:45

Are we shot? Well, I'll try to summarize the conclusions. Why don't we just turn the house lights on and I won't bother to show you that slide. Okay, so it's my opinion that the image on the shroud, first of all, does contain distance information, distance with respect to the body surface relative to expected clock body distances.

13:13

This doesn't prove it, but

13:15

And I can't say that as a proof, but it's the only way that I can see to really explain what we see on the Shroud. I don't see that the image could be the result of an eye-hand coordination. I don't believe an artist could do it. I also don't believe that the image on the Shroud could be the result of a direct contact process.

13:37

Radiation has its problems as well.

13:42

So I can't tell you what caused the image, unfortunately, but that's what we have tried to do. And I thank you for your attention.

13:52

For those of you who aren't familiar with some of the terminology, I'll explain a little bit. Image digitization, the first step in this process, requires taking an image, in our case, we are photographic negative to work with, putting it through a machine.

14:18

There's an example of one.

14:20

It's basically an automated micro-densitometer, and it works like this. You shine, you focus a very tiny spot of light, maybe 25 microns, onto a piece of film at a spot.

14:35

You record the amount of light that is transmitted through the film at that point. That's measured and recorded numerically onto magnetic tape. The machine moves over maybe 20, 25 microns, whatever you want, and makes the same transmission measurement at the next point. And this is repeated over and over again until you have scanned across the entire negative. For things like the shroud images, we will run as many as four million points out of an image. The general images you work with are on the order of 2,000 picture elements squared. This takes a while. The machine does most of the work, but it is a slow process. Anyway, when you get done, you end up with a set of numbers

15:23

that represent the intensities in the image at this matrix of points within the picture you have. This data that we have, Vern Miller, in fact, will talk about the photography, the pictures that were taken. I'm not going to talk about basically the data we have to work with.

15:48

What we have done so far, we have scanned the ultraviolet medium resolution data, the blue, green, red images of what we call the quads. That's when we were able to capture the entire shroud in four pictures.

16:08

and then some of the medium resolution data at two of the bluer wavelengths.

16:15

This is probably a tenth of the total data we have. So the whole process of digitization and so on is not very far along, so the rest of it is not very far along, and in fact, There is more work on the digitizing going on at Los Alamos, I believe at EG&G, and eventually we will get all of the data that we want, but we are only maybe 10, 15% alone.

16:45

Okay, that's creating the data set to work with.

16:49

The meat of image processing, though, is the actual process of extracting the information you want and displaying it. And that's kind of a key thing, is displaying it in a manner that is easily, easy, most readily amenable to interpretation.

17:09

Whether it's a simple enhancement where you increase contrast, much as you do photographically by going to higher gamma, in the machine you can increase contrast.

17:20

Or you can go to fancier things like picking out frequencies, picking out colors, and so on like that. But basically, you extract information you want and display it in an optimum manner for interpretation. That is the object of all of this work.

17:39

Some of the simplest things that were done

17:42

And I really don't have any show and tell stuff from this. But the simple things were detailed enhancements. A little bit of work has been done on that.

17:54

Oh, let me have the next slide. Just...

17:58

for those of you who are not familiar with it the actual process of image processing most of it now is done what we call interactively where the analyst sits down and plays with the data puts

up the image he has to work with he does some processing on it displays it and this iteration goes on until he arrives at what he wants

18:20

I should have had a slide of one of the guys working with the shroud data, but unfortunately, Vern Miller's got all those good ones, so I have to wait to have him show them. But that's the process that goes on. So the creativity comes out of the analyst's brain. The mechanics is done by the computer and the display equipment.

18:40

Now, the detailed enhancements, as I said, there has been a little playing around going on at JPL. Some more has been done at Los Alamos.

18:51

There hasn't been major significant things come out of that, except for one thing. Can I have the next slide?

19:03

That in doing, this is the wound on the side, the blood stain, from the side okay uh in doing kind of detailed contrast enhancement stepping through the intensities you find that this is pretty uniform intensity all the way through here except for a kind of a elliptical maybe sort of kidney shaped area here is slightly more intense and in fact i think i saw the same effect

19:38

in some of Bill Modern's previous slides. Now what that means, I don't know, but there is a slightly heavier stain up in that upper area. We want to do the same kind of thing in the foot area, in the, in fact, in all of the wound areas and see if there's any more detailed information that can be extracted, but that work has not been done yet.

20:07

Another one of the tasks that we had to do before we can really get into the meat of the work, can I have the next slide, please, is when we took our photographs, Vern did a superb job of setting up the equipment, of doing his homework, and we produced the most uniform illuminated, uniformly illuminated images we could. However, when you do a detailed enhancement and really increase the contrast, you see that the images, there was a much more illumination, they're brighter in the center, and it falls off to the edge. Now, this doesn't really hurt your enhancement in a single image. but it totally distorts any comparison of images any color analysis or any uh quantitative analysis similar to what john jackson showed so one of the

things that had to be done was say okay can we simulate or create images that as they would have appeared

21:18

with uniform illumination.

21:20

So some of the work that was done, next slide, was to take a series of images, and in particular this represents the green in the quads, take a series of images, take out details, smooth them, average them, and create a model of the illumination field. And that's what you're seeing here is an enhanced

21:44

model of the illumination field. Next slide. That model is then subtracted from the image to produce what I call a simulated uniformly illuminated image. This is sort of what the image you had would have looked like if you had a nice, flat illumination.

22:05

Given this data, you can now proceed to do things like color and quantitative analysis and comparison between images.

22:15

Next slide. All right, so another aspect of the work that was done is basically to respond

22:28

to request from other people. In particular, John Jackson, in his previous talk, talked about the 3D work, that three-dimensional analysis, if you want, or the analysis of the distance encoded into intensity. What we did was gave him digital numbers quantitative numbers of the intensities at various places in the image in particular this is a graph an overlay of the lines on which john was given the detailed numbers so in addition to getting numbers he gets a printout or a picture that looks like this that tells him where those numbers come from next slide the most fun in a lot of this work is color.

23:22

Not real color. The photographers produce good, pretty real color. But the fun comes in using color to identify areas, to exaggerate things in an instance like this.

23:43

you do the same thing with color that you do in contrast enhancement. You increase what may be subtle differences between color, you greatly exaggerate them, and make small color differences stand out. In particular, this is the upper body image from the quad images, where we have taken a red, a green, a blue, a lot of color image,

24:13

done the the um illumination flattening if you want combine them to create color image and then do the exaggerated color now you can see in particular the blood stains really stand out that was the intent of this we drove the the redder parts of the image to very red the bluer parts of the image to very blue unfortunately we found that we did this you've got this kind of a shading from blue down to green which said it wasn't quite right there was something wrong so we had to see if we couldn't correct that and in fact in a fair fairly recently like last week we went through and

25:07

Didn't correct it exactly. We found that in the scanning process, one of the sets of quads was shifted incorrectly. We didn't go back to zero. We made another compensation for that.

25:22

Next slide, please. Went through and smoothed it out. And I will show you those exaggerated color. This is the dorsal image, the upper body. Again, and you can see the very red, the almost

25:37

well, reddish purple, are blood. I mean, they are the, that correlate with the things called blood stains on the cloth. You can see that in the scourge mark areas, there are blood stains, and the top of the head and so on, all the way down, next slide.

25:57

This is the dorsal foot area. And one thing these images do,

26:06

In looking these over, you will often see something which is subtle, which is in the raw images, but it is either too faint or kind of so close to something else that you really don't notice it. And we have found in these images

26:25

areas that were not really readily discernible in this in the black and whites or in the color the color photographs yet when you go back yeah you can find them so

26:37

You use these kind of images to highlight things, then you can go back and do detailed analysis later. Next slide, just for your, this is the dorsal foot, or the frontal foot area, and next slide, let you look at that one for a minute. I think that one's kind of pretty.

26:57

All right, the third area of effort, and I put this in here kind of

27:06

because it represents not only significant effort but I think a significant item in this whole shroud project what I call other is basically responding to requests for information about the shroud and about the project now that doesn't sound like much until you realize that we've had over a thousand requests for information now this is service to send out references and so on like that and request for talks i think if there's one thing that has surprised me more than anything else out of this shroud project it is the incredible interest both in the technical community and the normal and the uh everyday people okay that normal community is probably closer to right

28:05

Sorry, fellas. The interest has been, to me, incredible. I have given talks, somewhere upwards of 75 talks over the last three years, from groups of people ranging from 30 to 3,000, from local church groups to, in fact, the staff at NASA headquarters.

28:37

In places like Goddard Space Flight Center and Ames Research Center up in the center, Goddard is out in Greenbelt, Maryland.

28:48

I gave talks in what they call an engineering symposium or the technical colloquium, whatever the particular local institution has.

29:00

In all cases, They had the most or the largest audience that they had for the Shroud talk that they had for any talk they've ever had. And the feedback, the response was greater than anything they ever had.

29:22

In a specific example, and this is NASA headquarters in Washington, D.C., they asked me to give a talk at 10 o'clock in the morning.

29:33

We filled the conference room, which was on the order of 250 people or something like that. It was filled 15 minutes ahead of time. So they said, well, could you give another one at 2 o'clock? Sure. So we repeated it 2 o'clock. Again, the conference room was full.

29:48

He said, could you do it again at 4 o'clock? And I said, sorry. That was just about out of gas by that time. I had to go back home. But that's indicative of the amount of interest, as I said, both in the normal community and in the technical community. That, I think, is very significant. It is surprising to me.

30:13

But it's very pleasing. But it says people want to know, no matter how skeptical, no matter, in fact, it's kind of interesting at work.

30:26

We run into the people who are, you know, this is all garbage as far as they're concerned. But yet, they want to know what the latest information is. And that's always fun. Thank you. So that's kind of really all I've got to say from my part of it. From our aspect, the image processing, image analysis is really, we have barely scratched the surface.

00:01

We have not done a great deal of work on computer analysis of the image in New Mexico.

00:20

We are very severely constrained there by the contract between our employer and the Department of Energy. Namely, we are not permitted to use any of the government equipment for this work.

00:34

So what little we have done has largely been places we've been able to beg a bit of computer time and other facilities. or a small amount of analytic work trying to outline what I believe is and is not a reasonable thing to do.

00:53

What I want to bring to you this morning are a few thoughts on what it does or does not make sense to do with computer image analysis. Don, put it closer to your mouth, please. Very early on when we started this project, we had great hopes that we would be able to bring forth very fine detail in an image. For example, questions such as, can you find more features around the wounds that can be compared with modern pathological evidence?

01:37

Can you bring out any more detail in blood flows?

01:42

I believe from what work we have done that this type of classical image enhancement is going to be an exercise in futility. As Don pointed, the other Don who was just up here, Don Lynn pointed out in his very nicely done color images

02:05

Images of that type are very useful for going back later on and locating or for locating in gross regions that you maybe want to study further.

02:20

However, with the very high quality photography done by the staff from the Brooks Institute in Turin, I have yet to find anything in these enhanced pictures that you are not able to find on the Brooks originals once your curiosity is tweaked sufficiently that you know where you wish to look on the original.

02:46

So for this reason, I think any of you who are believing that computer image enhancement is going to bring forth detail on some particular feature that you wish to study are probably going to be disappointed. What good, then, is computerized image analysis on these images? As the previous speaker pointed out, you can extract vast amounts of numerical data.

03:23

part of the solid physical information which you must be able to explain quantitatively with any model you choose to adopt for how the image may have been formed. So that, I think, is going to be one of the great promises of computerized image analysis, simply the extraction of lots of data for comparison to various models of image formation.

03:56

The other promise of computerized image analysis has to do with analysis in detail of the color of the image. As Don Lynn pointed out, in any one color, you can think of different intensities of image.

04:21

And I want to speak of intensity rather than darkness, because darkness implies to us a color difference. But by intensity, I mean two things which are the same color, but one is more intense. In black and white, I think we can easily feature what I am trying to say. In black and white, you say an image is darker or lighter, but you're not implying any color difference. transform this notion in your thinking to a non-color difference in a specific color.

05:00

The eye is an exceedingly poor measuring tool for this kind of analysis. The computer, on the other hand, can discriminate different colors in the image because we did take photographs in a great number of different color bands.

05:21

So by taking these photographs from the various color bands, merging them in the computer, we can certainly define a color quantitatively, thereby overcoming the limitation of the eye. And we can say, are different regions of the shroud the same color? Does something in the image have the same color as the background of the cloth? Does one part of the image have the same color as another part of the image, thereby numerically overcoming the severe limitation of the eye as a color measuring tool?

06:06

I do not, however, believe that we are going to be able, in New Mexico at least, to arrive at the full potential of this as an analytical tool until we are able to solve our problems of getting a very capable computer on which we are able to do this work.

06:30

Therefore, my report is primarily, I think, one of a limited amount of frustration because we have not accomplished more.

06:39

a statement of limitations on where I think the whole technique can go, as well as a statement of what I think it really is good for. One of the things I mentioned it was good for was extracting lots of data for comparison to various image formation models.

06:59

Among other things, Don Devan, the third Don of this bunch, has been thinking about image formation models. So, Don, will you come take this over?

07:21

Don Devan from Oceanographic Systems. Thank you, Don 1 and Don 2.

07:27

I'm not sure whether I'm technically considered a part of the normal community or normally considered a part of the technical community. I don't think it matters. As John mentioned earlier, my association with John Jackson goes back as early, I think, as almost anyone else's in the project. So in addition to the several kinds of interests I have and the unfolding of it, I have a paternal one. I remember, I guess whimsically, seven years ago, thinking with John, and it wasn't even a pipe dream then, it was some level below that, we've seen there are in existence some number of rather elegant pictures of the Shroud. They're beautiful to look at, they're full of information, but from an analytical point of view, they all lack the same thing.

08:15

None of them have any way contained in the information, supporting information, to try to relate what one sees on the image, a quantity called film density, the gray shades, the differences in black and light or in colors, back to a more measurable quantity, something which might be able to shed some light on what happened or how did it happen or how much of it happened to make those variations in staining and intensity and coloration that we call the image.

08:47

We decided that if we ever, some years,

08:50

actually more than we ever, more than it turned out to be in the future, could take another set of photographs that the hero of that set of photographs, the new type of image would be something actually rather simple. You've seen them on some of the slides. It's a little device called a step wedge. All that a step wedge is is a series of gradating shades, graduated shades of gray, each one of which reflects more or less light than the one ahead of it,

09:21

and a known amount of light more or less than the one ahead of it. In other words, we now know in addition to how the film operates, how much after the whole photographic process, the light illuminating the object, the light reflected back from the object into the camera, the mechanics and the chemistry of creating film, of developing film to create these shades of gray or of color,

09:45

we now will have some way of knowing how much light came point by point from the object being photographed. And we'll have one other thing, which is new to the history of shroud imagery. We'll have some way to do external experiments, and in a sense make shrouds or make pieces of shroud or make shroud-like, hypothetically shroud-like stains, and then relate those back to the shroud itself. You might say that shroud images are answers in search of questions.

10:22

The process by which we do this is conceptually a simple one. I wish I had some more graphics to enhance the presentation, but I think you'll understand it. In the laboratory, under some hypothesis of image formation, a series of

10:39

just call them stains, will be made of discolorations on perhaps old linen using whatever approach the chemists decide is a rational attempt to explain the mechanics by which the shroud stains were made Along with that image, we will, alongside of that piece of linen or cloth, we'll place the same step wedge that we photographed time and again with virtually every shroud photograph that was taken and we will then photograph those two side by side through the same camera setups, the same filters, the same lighting, or as close as we can approximate to all that, as we did the shroud itself.

11:22

What we then have is some means to, in a sense, recreate the shroud image, to create a new shroud image, but now instead of the units, instead of the way that we measure the image quantitatively, as Don Lin described,

11:37

Instead of measuring those in terms of how dense the photographic negative is we'll be able to transform those measurements into how much of agent X or what quantity or what intensity of Agent X or agent X is whatever we put on the cloth Would have had to have been incident on the shroud Point by point in order to make that image Then we can start perhaps asking

questions about as to, well, what does that mean? What is this new image calibrated in some physical unit instead of the film density unit? What could have made that perhaps?

12:15

When one goes through a process like that, the parts that become interesting are the parts where something is changing.

12:23

In terms of John Jackson's three-dimensional presentation, the curvature around the fingers, around the space where the nose departs from the face, the shape of those edges, perhaps I should say the intensity of whatever the hypothetical image-causing mechanism and substance were, become things that can be directly compared or perhaps indirectly compared with hypotheses.

12:52

To do this, as you might be able to understand, is an error fraud. It's a difficult process. A lot of assumptions have to be made. It takes quite a while to understand it, to correct it if necessary, to proceed from general attempts to more specific attempts. We don't anticipate having results from any of this kind of analysis for quite some time. I think you will all have to bear with us

13:19

It does give us a way to perhaps bring together the two parts of the shroud data analysis. Someone once said, and accurately so I think, that we can have done, as you'll hear later, we think a nearly definitive job in understanding the chemistry, understanding what happened to make a discoloration something visible on the shroud in the first place.

13:41

We can create a number of possible hypotheses physical hypothesis for making shrouds in the first place.

13:50

What we haven't yet been able to do is to combine a chemical hypothesis with a physical hypothesis to fit them together and say, yeah, that's convincing. That could have happened. And what I'm saying in a nutshell is that there is some hope, perhaps, or at least some avenues to explore with the imagery, the calibrated scientific imagery to begin to address that so far hardest of problems to solve. So bear with us. You'll be the first to know, I suspect, if we come up with anything exciting.

14:29

Next we'll hear from Dr. John Jackson again. He's going to give two presentations, which I'm going to ask him to combine into one because we're running late. One is image resolution characteristics, and the other is body-to-image mapping direction.

14:50

And, John, you're stuck because of the constraints of time to about 35 minutes for both. Can you interlock them?

14:58

Well, I can do anything. If we can go to the end and pull this off, I think we can... We'll try to do this. Pull the mic out and put it here.

15:07

Like this? Right. Before I begin, I was...

15:14

asked by an English professor if I really meant that stirrup was irreligious. He said that means against religion. What I meant to say was non-religious.

15:27

Okay. Can we have the first slide, please?

15:33

Now, it's just before that.

15:36

Okay, and dim the lights, too, please, in the house.

15:41

Okay, first paper Image Formation Considerations with Respect to Resolution of Shroud Image. This will be a paper dealing with looking at the shroud from a physicist's point of view. Next slide.

15:59

And it has to do with the notion that the shroud image is very highly resolved.

16:06

We don't see a whole lot of blurring, for example, on the image. Look at the lips. in particular.

16:15

I think that has physical significance and I'd like to show you what I think that means. Next slide.

16:22

I'm going to assume this is an important point for the purposes of this discussion that a cloth draped over a body shape and then look at several possible image formation mechanisms with respect to that assumption and then ask are these mechanisms capable of giving you the resolution of the shroud image. But I am making the assumption that the cloth drapes over the body, over a body shape of some kind. Next slide.

16:54

Okay.

16:55

In particular, we have a profile of a facial form underneath a cloth drape. This form was in fact produced by biostereometrics data, which I will describe to you in just a little while. The thing we're gonna ask is,

17:14

how does information go from the body surface, in this particular example, the lips, and get distributed in some fashion onto the cloth.

17:23

We can postulate physical mechanisms by which that might happen, and then ask various questions about it. In particular, we can ask what kind of resolution are we going to see associated with that kind of a transfer process. Next slide.

17:43

In this

17:44

particular model that I'll use.

17:46

I assume two surfaces for computations. The first surface down here, surface one, will represent the body. The surface two will represent the cloth. I have a specific geometry in mind, a coordinate system, where I put the origin at some point that I want to think of as emitting particles, let's say, of information that are going to transport themselves and arrange themselves on the cloth surface, surface two, to create shading of some kind. Next slide.

18:24

Now I know this is supposed to be a not too technical talk, but I just can't resist. I'll just give you a few highlights here just to show that we do have some physics involved in here. The two mechanisms that I want to consider in sort of a generic sense are diffusion and radiation coming off of a body surface and creating an image. In diffusion, the particles get to the cloth by what's called the diffusion equation.

18:58

The relevant thing here is the variable C, which is the numerical concentration particles per unit volume at any one given time in the

19:08

as the transport occurs. The solution for this varies with position and time according to this relationship and knowing that then you can calculate using a fixed law of diffusion through a surface what the particle distribution will be on the cloth surface and if we normalize that numerical distribution with respect to the total number of particles that will go to the cloth, then you can get a probability distribution as to any one given particle attaching itself to some point x, y on the surface of the cloth.

19:50

Little d, which appears here and here, is the distance between the cloth and the body. That can be whatever you want from a mathematical point of view.

20:00

In radiation, the computation proceeds differently. You say that there's a certain number of particles that are emitted from that surface.

20:12

And I'm going to assume that they can be emitted anisotropically.

20:19

And I control that anisotropy with the parameter index little m. And let me show you what that actually does in graphical terms. Next slide. Okay, little m controls how particles are emitted.

20:34

If they're emitted with a very high M, the particles are emitted mostly in the forward direction, normal direction to the surface. If they're emitted with a low M, the anisotropy is less. And finally, if M equals zero, you're totally isotropic. And there's no reason why I can't have fractional values of M, which give you something like this.

20:57

Distributions with particles are emitted more in the horizontal direction than in the vertical direction.

21:03

For example, radiation from metallic surfaces is like that. You have more radiation parallel to the surfaces than you do perpendicular. So we can include a lot of these in this generic model.

21:15

But M is the parameter that controls the anisotropy. Let's go back to the previous slide, please.

21:22

Okay, well once the particles are emitted with whatever pattern they are going to be emitted with, and I can choose that, I let the particles be absorbed in the intervening space.

21:33

For example, there is air in the assumption that a cloth covered a body. Air could act as an absorber of radiation. Okay, but I'm going to account for that with this little coefficient, little k. Once the particles arrive at the cloth, they can get absorbed, and I have no penalty mathematically for assuming that the absorption is anisotropic, that it would be absorbed at a, well, more of a perpendicular normal direction of the surface than otherwise.

22:01

Putting all this stuff together and then normalizing, like I did up here for diffusion, I can then calculate a sort of probability image for a particle of radiation information, let's say a photon or whatever, for attaching itself on the cloth. The distribution looks like this. It looks, and it is, more complicated than for diffusion. But interestingly enough, if...

22:29

We let the parameters M, N, and K be zero, every one of them. This distribution becomes identical with this one.

22:38

So I will only deal with this solution.

22:43

And we realize that when we deal with diffusion, we just simply let M, N, and K be zero, and we're there. We're talking about diffusion as well, or isotropic unattenuated radiation. Next slide. Next slide after this one.

23:02

Okay, now we told you how I'm going to model one particular particle making an image of itself onto the cloth surface Now let's consider the relevant problem of two points because I want to ask the question about resolution How well are two points resolved onto the cloth surface?

23:20

Okay, I'll have two points here a and little B. I'm sorry a and B separated by a distance capital D the cloth the body distance again is little D and These points will make the images of themselves on the cloth surface as we've shown, and I can plot the relative shading that is induced by this, by these patterns, by mathematical functions that look something like the following. I'll let f sub a b be then the joint probability function for particles making their presence from these points onto the cloth surface irrespective of which point they came from. Next slide.

24:01

Okay, now what does all that stuff look like? Well, okay, you've got a mathematical function here that describes this. It's simply a sum normalized with a factor of one-half to the two probability distributions that will show the attachment. And then, given this probability function, I want to say that

24:25

The number density, or I can write that the number density on surface number two, the crop surface, is simply the number of particles that are involved times that probability function. That is simply a definition that I used before.

24:40

Now, we don't look at particle distribution when we look at the shroud with the microdensitometer. What we look at is reflectivity.

24:51

I think it's reasonable to assume, and I will assume, that the reflectivity distribution is simply a monotonically increasing function of particle density. The more particles you have, be it diffusion or the result of radiation onto the cloth, I will assume the simple function that the reflectivity is simply a function of whatever number of density you have.

25:13

Now, the condition for simply just achieving resolution of an image is given by the second derivative of this reflectivity. Let me show you what that means graphically. Next slide. Okay, we have several distributions here.

25:39

And the second derivative means that the inflection point here gets level. At that point, you can no longer tell when you're dealing with two particles because the essential distribution here is, as we see, one particle from one distribution. Next slide.

26:01

Okay, this is the solution which I won't bore you with. Next slide. I'll show it graphically later. I did some experimental results to verify that solution. This is radiation, and what we see is that the radiation images will blend themselves into resolution. We want to resolve them at roughly a distance equal to the distance of separation from the cloth of the body, which is consistent with the model. Next slide.

26:32

This is, again, we have the same results for resolution. We can see that we have no resolution here. We begin to have it here. Next slide.

26:42

Okay, what is the resolution of the shroud image? Well, we've got the hands, which certainly can have resolution of the fingers, but that's not a very well-defined point, so let's go to another place. Next slide.

26:57

Here's the face.

26:58

And that has the most variation, but I believe that the place on the shroud that has the most sensitive or has the highest resolution that we can tell for sure, I think, is the lips area. It's also fairly well defined because the cloth touches at that point and then makes a curvature over it.

27:20

So relative to that point, and we can see that the image there is resolved, I think we can ask, could diffusion or radiation do this? Next slide.

27:31

In the context of the models I presented, this is the graphical solution of those equations that I showed you. Basically, it says that if you take a certain value of anisotropy and a value of absorption, you will have to have a certain

27:47

You have to have certain values here in order to achieve a certain resolution given by the ratio of the distance of separation of the points that you're trying to resolve divided by the distance of across the body separation in terms of this. It turns out that the shroud image, as I measured from photographs and doing biostereometrics and data measurements across lower bodies, that the image on the shroud has a value that falls somewhere in this vicinity over here. And that's just for minimum resolution.

28:20

I therefore don't believe that isotropic, I'm sorry, it falls over in here someplace, in this area, for minimum resolution. But in that respect, I don't see that isotropic radiation or diffusion could in any way explain the image because of the resolution properties.

28:39

Also, we were at the very limit of resolution as far as these calculations are concerned, but the images of the lips are very well resolved, and I suspect that we're operating in an area somewhere probably up in, you know, this way. So, next slide. Next slide.

29:03

My conclusions would be then, I believe, the molecular diffusion isotropic radiation are incapable of explaining the resolution of the shroud image and that anisotropy is an emission absorption of the cloth or attenuation of radiation could give required resolution sufficiently strong but probably produce unacceptable geometric distortions in the image and this will be discussed a little later in the presentations okay next slide

29:30

Next. I think I've skipped one or two.

29:34

Okay. The last presentation I want to make is concerning some plots on the mapping direction from body cloth surfaces implied by the two-dimensional layout of the shroud image. Next slide.

29:48

Again, I will make the assumption that a cloth draped over a human body shape. Next slide.

29:56

Given that assumption, one might ask, what is the mapping, in other words, what direction would the body image go onto the cloth image? That has not been a question we have addressed, but I think it's a relevant question, and it could be quite useful for further information analysis. Next slide.

30:17

Okay, the backup one, please.

30:21

Okay, first of all, we can say about the mapping function that I think we can say it's a one-to-one mapping because the image is highly resolved. One point of the body maps to one point of the quad. I think it's also fair to assume that the mapping function, whatever it was, that acted to produce the image was something that acted from the surface only. It contained surface information and no other information, say, underneath the surface of the body.

30:51

Okay, next. Oh, and then the last one is that the image is bilaterally symmetric.

30:58

Okay, I can show that on the next slide. If you take two images of the face and their transparencies, reverse them, you have...

00:03

or will preserve or produce an image that has that bilateral symmetry associated with it. Three mappings which can do that would be if you always map normal to the body surface, if you always map normal to the cloth surface, or if you map normal or parallel to the axis of symmetry.

00:25

And what's interesting is that when you do this,

00:28

the location of this point will map to quite different areas on the cloth.

00:33

And it seems to me that what we ought to see here is a, we ought to be able to detect this, because it does appear that in regions where you have large deviations in slope of the cloth and body, we ought to be able to see that. But over most of the image, the body surface and cloth surfaces are fairly flat, and you probably could not detect it. So I'd like to just show you just a few things on this, then that'll be it. Next slide.

01:01

Okay, we constructed a, to do this we had to get a cloth drape of a cloth over a body surface. Eric Jumper and I made a model, a cloth model of the shroud. Next slide.

01:16

And with the help of our team member Robert Buckland, we configured bodies into the cloth. Next slide.

01:26

The volunteer subjects at the Biostereometrics Laboratory in Texas. Next slide. We covered them with a cloth, with our cloth model. Next slide.

01:38

We made sure that the image that we had on the cloth was over the corresponding body parts. Blood images had to make contact. And then we have the cloth drape. Next slide.

01:53

the image was then photographed biostereometrically and when you do that next slide uh first of all with the cloth in place and then with the cloth removed next slide next slide these are live bodies too by the way uh when you when you do this look at the stereometric pictures you can have then distance information or i'm sorry surface information of the body surfaces next slide

02:24

And this was the results. These are five individuals, five subjects, and this is the way their profiles at the nose looked like, and these were the way the cloth draped over it. I wanted to show this to you to get a feeling for the kinds of deviations in cloth draping body and nose surfaces that we're dealing with. Next slide.

02:44

Now, if we take a look at the face profile,

02:50

This is an actual model. In fact, this is the largest nose that we had in our experiments.

02:59

I'll show you the shortest and smallest nose in just a minute, but I have a microdensitometer trace of the shroud image above it to the exact scale as we have here.

03:10

Now there's your nose, there's your cheek, if that's the bruised cheek, here's the other cheek, and here's your hair. This is right at the level of the nose.

03:18

Now if I project down where the

03:21

location of the nose ends relative to the cheeks, as we would see on the image, bring it down to here and then locate it at a point where this distance along the curvature of the cloth is equal to the distance horizontally, then we can position where this point would lie onto the cloth and then simply compare it to where it lies in our experiment.

03:42

And these then produce the mapping function for that nose under this cloth relative to this image, to the shroud image. Next slide shows the same thing except with the small nose.

03:57

So you kind of have the same thing here.

04:02

What I see in this is that I don't see any way that that image on the shroud could be the result of, if we assume a cloth draping over a body, that it would be the result of a normal mapping to a body surface. I don't see how it could be a normal mapping to the cloth surface.

04:18

And what it looks like is that it's essentially trying to be parallel to this axis of symmetry here.

04:25

So I think if we're going to say there's a body under a cloth, to my thinking, we would just about have to say that the projection looks something like this. OK, next slide.

04:38

We look at the knees. These are from the biostereometrics data as well. Here's your microdensitometer trace. Actually, it's an interpolated curve from data from the jet propulsion laboratory. The dots were around the points here. Again, you have your knees and the images of the knees here.

04:56

appear to be essentially over the knees that you see. I don't consider this as convincing as the previous slide because knees can be separated apart. People can have different kinds of knees. You ought to see my knees, for example. Next slide.

05:14

But I think one interesting thing is the hands, another point of cloth contact. Let's go to the next slide. Something that has puzzled me for a long time

05:25

is this right here. Right here, where this top hand goes over the bottom hand. There's a blanking of the image at this point. There's also a blanking of the image in this area. It runs up the sides of the forearms too. Next slide. This is a computer picture that Don Devan made for me.

05:47

one of our very first, but it turns out this, and because of the shading, this is a dark area. You have this blanking area out here and going up in this area, but the main point is right here. This is what I want to talk about. Next slide.

06:01

Again, there's your blanking. This is Don Lynn's, second Don or first Don, I guess.

06:08

And again, we still have that blanking effect. Next slide.

06:12

This is a biostereometrics curve of the cloth over the body.

06:18

And the top of the hand, where that blanking would occur, is right in this area. Now, I don't know of any way, in my own thinking, to reasonably explain how you get that blanking effect on that bottom hand, other than if the cloth was sort of against the...

06:42

having a fair amount of slope relative to the hand, such that an image was not produced. And this would be consistent with the notion that this image was parallel to this axis of bilateral symmetry, or in the prone position, if you assume a prone position, vertical.

07:00

If that's the way the mapping occurs, then we would not have image formed in that area. Next slide.

07:08

And it's possible that maybe that's the reason why we don't see

07:11

any images along the side of the body or the top of the head with the exception of the dorsal image of the foot. But when you put a person in the cloth, those feet are almost horizontal. They just naturally lay in that direction. Next slide.

07:26

Okay, you might ask, what does an image look like that is projected parallel to the axis of symmetry? Well, we have biostereometrics data. I constructed a

07:38

a contour cavity of the cloth drape, could put a little cloth model in here and then project the image, next slide, onto that cavity, and then I can construct, or I can draw the image, next slide, on the contours. This is the one we started with. It's the drawing of the same one you saw before. I project it onto the cloth, unfold the cloth, and this is the way a distorted image would look if you're dealing with the parallel projection mapping. It looks fairly distorted, especially down here, relative to the shroud, but we have to be careful because we see the image by, I believe, distance from the cloth to the body, and it fades out, so we don't know exactly where the, but these are absolute boundaries, and where the discernible boundary would be would probably very likely be within, well within these boundaries here.

08:33

Bill Urkelein, We'll talk about cloth drape distortions a little bit later. Next slide.

08:40

So my conclusions are that the image is, what I believe, what I think is, the image is not the result of a mapping normal to the body surface if we assume that there's a cloth draping over the body. And I want to make that clear that it is based upon that assumption.

08:55

The image is not the result of a mapping normal to the cloth surface but it does seem to be if we assume that the image was created with a body-shaped line as it would be suggested in the

shroud horizontal by a kind of vertical mapping okay now the final slide these final two slides let me try to put all this together the last three talks that i gave as to what i think would be kind of a mnemonic i guess you might say sort of a graphical scheme for trying to illustrate how the

09:28

how one might go about creating an image on a shroud. I'm not saying that this is the image formation mechanism, and I'll tell you why in just a minute, but if you were to take, if one were to take a body surface, and if you were to take a series of little flux lines, and let's map them vertically, but attenuate them with distance away from the body surface, and then count the number of flux lines that penetrate the cloth surface,

09:59

then you can create a little histogram of intensity. And if we take the limit as the number of flux lines goes to infinity and the amount of intensity shading that each flux line gives you goes to zero, you can create a continuous distribution, which I sort of sketched in would look something, probably something like this.

10:21

I'm not saying this is the image formation mechanism. I'm just offering it as a graphical device for tying together the things that i think i see on the image on the shroud that's no different than in the next slide something that happened uh was told me who's a who's a greek who was trying to model how planets went around the earth he could see planets moving around in the skies and the planet would move around and he described these by epicycles moving around the earth this gave a very good understanding as to how planets move but with the work of Newton and then later Einstein in this century, this model was not the basic physics of what was going on, but it did give you one person, anyone, an insight as to what's happening.

11:11

I believe I hear John frantically knocking on the microphone, so that will conclude my presentation. Thank you.

11:28

it occurs to me that some of you normal people might from time to time have questions of us abnormal people as to what all of this means or what it might mean or how we think about it and if I had some house lights it might help me think how because i'm trying to find out whether or not there's any provision in here for a question period sooner or later so that you can ask the questions which are sure must be developing some of the questions i think will come out of some of the answers may come out of some of the later presentations but i don't really see

12:19

You know, there's a summary, but I don't see a question period, so maybe the powers that be might consider at some period in time to permit the audience to ask questions of the abnormal people as to what we think some of these things mean. In the meantime, this ends our morning session, by golly, at noon.

12:43

And session number two begins at 1.30 this afternoon, same place.

12:50

and more information in different areas. Thank you all.

13:07

Geometric distortions induced by cloth drapes. They're both with the Air Force Academy. Bill, are you the first one on? I'm the boss.

13:16

All right. Fall down, and Bill works.

13:24

Thank you. It's Bob. First slide, please.

13:33

We have the lights, please.

13:38

The topic of this talk is the examination of the Shroud image for possible geometric distortions due to cloth drape. Next slide, please.

13:47

You might remember this slide from the last speaker.

13:52

In his talk, Dr. Jackson indicated from this work that he did that you might expect distortion of the image due to the fact that the cloth draped over the body when you flatten it out would give

you a somewhat different perspective on the body image than we have if you just took, say, a photograph of the body lying flat. uh we set out to establish this or to check this out and essentially that's what we we intended to do was to take a group or a sample of individuals take them lie them down put mold them to the body position indicated on the shroud and then make measurements using a photographic just taking a picture of them from above so that we eliminate as much as much of the distortion as possible

14:42

and then compare that data to the data on the shroud.

14:46

Now, normally speaking, we might go to anthropometric tables, but anthropometric tables normally are not based on an individual in a position somewhat as that on the slide. So we had to select our own population and to mold them to that image. So if we go to the next slide, please.

15:05

We had a unique opportunity to do this at the Academy. We had a summer workshop where we presented information on the shroud for some visiting high school students. And so to gather some data for them to work with, we asked for cadet volunteers. We selected cadets who were 175 centimeters tall, plus or minus five centimeters. And we subjected them essentially to a molding process where we lay them on a model or a replica of the shroud and position them so that they were as much as possible in the position of the image that we see from the shroud as we could get.

15:41

Some critical points were the knee positions and the head position, the overall shoulder tilt, hand positions. Next slide, please.

15:51

We also use the top part of the shroud to try to mold, make sure contact points were as much in alignment as possible. Next slide.

16:02

Here you can see Bill Ertline, again, making sure the arms fit the position, making sure the hands cross as close as possible, trying to reproduce the image on the shroud as closely as possible with positioning the cadets. Next slide.

16:18

Now, we did this on a diving platform. There were two reasons. One is it gave us ready access to cadets who were clad as minimally as possible for this kind of presentation.

16:30

The other thing was it also gave us a way of positioning the cadets in a horizontal position and then getting a vertical height above them so that we could shoot down and get essentially a plainer photograph of their position. Next slide, please.

16:48

And this is pretty much what a typical sample looks like. You'll notice two measuring bars. There is a meter stick running up the length of the cadet, and across the bottom is a 70 centimeter stick, which we could also use as a reference.

17:01

This also showed us whether we were getting distortions horizontally versus vertically. And if you notice, they're also on a square tile background, which again gives us some indication if we start to get aberrations because of the optics of the camera or whatever.

17:15

Each cadet is numbered. You see his number down in the corner so that we can refer to that later. We also recorded their weight, height, and I think those were the only two parameters that we kept track of. Next slide, please.

17:29

We'll just flip through a few slides here and just show you some of the samples that we have. You can see that they vary quite a bit in height and weight and overall body. body law for body bill but their basic contours in their basically form to the contrary the shroud as close as possible you just look through the next couple slides please okay fine thank you

17:57

Now, after we collected the data, the first thing we did is we reviewed the slides that we got with the people. We had gathered some people to help us do the measuring. Of course, we had to take measurements from the slide data. And the first thing we did is we had to choose which slides we wanted to use in the sense that some of the positions, some of the people had slipped their positions during the photography session. For instance, we lined them up, and while the photographer was, we were removing the shroud and what have you, or the cover,

18:27

their hands had slipped. Either their hands had slipped down the wrist or their hand had slipped in the body.

18:33

Head tilt changed.

18:35

One critical thing was the position of the nose. The person had to be looking essentially vertically upward if measurements from, say, nose to knee were going to be meaningful. If the person is looking too high or too low, that's going to change the position of the tip of the nose, which was a key measuring point.

18:51

So we took essentially a ballot of those people who were going to do the measurements, comparing directly the individual sample with the front image of the shroud. And this gave us a pretty good chance to rule out people who had obviously changed their position during the photographic session. We ended up with about 50 samples, which we then measured, which if you please flip the slides, the next three or four slides are just showing some of the measuring. And then we did the data analysis on those 50 samples.

19:27

We took various sample points. Okay, please hold there. And those were based on looking for positions, looking for measuring spots where we either expected maximum distortion based on that initial slide or positions where we expected minimum distortion so that we could then compare the averages that we got to some anthropometric data that Bill's going to talk about now.

19:57

What does all this mean? And I guess I want to answer that question first. And it's basically this.

20:07

If the image on the shroud was caused by a body shape or form, however you want to say it, then you have to be able to detect some type of distortion if you have the entire image on the shroud. It's just physically impossible not to have that. If I can make a little analogy here, next time you come out of the shower, if you have a dark towel, put some talcum on your body and just kind of drape the towel around it and take a look at the result you see on the towel. And you'll notice that you're whiter in certain areas. And this is kind of what the second slide you saw showed, and that's what John Jackson showed earlier, that there is regions you would expect to

find distortion. And I'll talk about those in a minute. But basically, the data we have, we wanted to compare it to something. Well, all we had was our cadet sample, so we had to do a little research there, and we found that in the mid-60s, the Air Force did a large survey and determined some anthropometric data to determine what an average person measured.

21:13

They kind of gave you the range of certain parts of his body. It's for cockpit design, human factor engineering. And the next two slides kind of show some of that. Just zip through those, and I'd like to get right into the data. You can get the measurements across the body and width of the head and hands, fingers, lengths, things like that. Okay, go to the next slide. Now this is what we got. These are our results. And basically, in the first column,

21:50

is the Air Force Systems Command, the anthropometric data, then our cadet average, and then what we measured on the shroud itself. We had a scaling factor to make sure we had everything scaled to real life. And basically, the width of the hand, again, the width of the hand, and if a cloth draped over a body at the width of the hand, you would expect minimum distortion.

22:14

The systems command average is 8.92 centimeters. You can see the cadet average here is a little larger than that, but within a standard deviation. And the width of the hand, this is the top hand on the shroud across the knuckles, measures about 8.3 centimeters. So you see that this is a little smaller than this measurement, but still everything is within about a standard deviation. Nothing significant there.

22:40

Now, I'll come back to this slide. I want to go forward a little bit to give you an idea of what we've done here. Go to the next slide please.

22:48

Again, we're measuring across here. Go to the next slide.

22:54

Again, across here on the hand. Go to the next slide. and again to use that the I got the reverse there but what we're measuring here is the width across the hand the knuckles and you can see by the area this slide here without the grid system on you can see that in this region throughout the body there is minimal distortion you would not expect to find distortion there

23:23

And also, if you just do some rough calculations on that, you find that going from top to bottom of the image, you find that from the real person, it's about 3% distortion. Going horizontally, though, you get significantly more. You get about 9% distortion.

23:43

So what we're saying is 3%, in this region in here, along this central vertical axis, There is minimal distortion, or distortion is so small that you can't detect it from any noise you're gonna pick up in your experiment.

24:00

However, when you go this way, you can start picking up some distortion. There's about a 9% variation in the change here. Now, if you can quickly go back to the data slide, about three slides.

24:14

Again some other measurements we had as you can see this was kind of the width of the face as you look on it and on the shroud this was a little difficult to measure because if you remember the shroud slides the facial feature kind of disappears as you get close to the hair but basically you can see the systems command measurement the cadet average falls reasonably close and the shroud is a little bit wider.

24:36

Again, you should expect something here. And again, this is an approximation. But like some other regions we measured here, middle of the eye, right across the nose, down to the crotch, on the systems commands here, the cadet averages here, and the shroud here. Top of the head to the knee. Very, very little change here. Now, here's some of the significant ones.

25:00

The hip breadth, the width of the hips, the systems command measurement, the cadet average,

25:06

and then the shroud measurement. You notice you get about three standard deviations outside the average here.

25:13

And also the right forearm, now we estimated again the position of the elbow up to the fingertip of the extended hand. You find that here's the Air Force Systems Command measurement, the anthropometric data, our cadet average within the standard deviation, and then the shroud measures significantly longer. And if you, real quick, slip back up to that slide of the black on whites, the white on black above.

25:46

Right there. On this slide, what it's showing you is a measurement from about here, we estimated that on the shroud, down to where the tip of the fingers would be. All right, now here you'll notice the person posing here, the fingers did not quite get over into this region. You can't really pick up the distortion that well. However, if you look on the shroud, you can see again. Now, you can't determine exactly, but you can kind of see the fingers look a little bit longer in that area. And you would expect that. That's what this slide shows. As you get into this region, you start picking up distortion.

26:20

And just flip it back to the data, and then I'll get to the conclusion here. Just go back again. I'd like to show you the comparison of one other item.

26:28

And we have this for about 27 different points. I'm just giving you a recap. And they all are consistent. Where we expect distortion, we are picking it up. We are picking a larger measurement here. Where we would expect minimal distortion, that is also conforming.

26:44

Now, the middle finger on the average of the anthropometric data, 9.8, focus a little bit, the cadet, about 9.86 again. And what appears to be the length of the finger on the shroud, the middle finger of the extended hand appears to be about 12 centimeters. And again, like I mentioned, I showed you on that other slide that that is in an area where you would expect distortion. So what did we conclude from all this? If you'd go to the last slide, please.

27:15

Save a little bit of time right there.

27:18

Here's what Bob and I concluded from this. Basically that because of what we feel is detectable distortion on the cloth through the measurements that the image was formed by a cloth draped over a body. That's what Bob and I kind of concluded on that. Now I'm not saying

27:37

That's the conclusion that STIRP is putting out. That still has to be argued with and things like that. But that's kind of what we're saying with the numbers we've got.

27:46

And the other one is, if you want to do a little approximation there, if you have a 3% distortion in the lamp,

27:52

You can estimate a different size because I feel there is some distortion there. There could be. It seems to be detectable. And we feel a better approximation. The height is about 5 foot 8 inches. And then if you kind of interpolate from there, given those measurements that we're getting on the shroud where we'd expect a little distortion, you can use the anthropometric data and you can get about an average weight and you get about 155 pounds if you do that. So we feel that the...

28:20

That's a better approximation of the size of the man on the shroud. That's it. Thank you, Bob. Thank you, Bill. Our next two talks are going to be on the pathology and the forensic pathology on the shroud image. They're going to be given by Dr. Joe Gambisha.

28:46

who's at the St. Agnes Medical Center in Philadelphia, an internist, Professor of Medicine Hahnemann, and by Dr. Robert Buckland, who's in the Los Angeles County Medical Examiner's Office and a professor of pathology at University of Southern California. Bob, I believe you're going first.

29:16

Thank you very much, Alan. Time is very precious and we have an awful lot of material to present in a very, very short time.

29:22

Joe and I have divided this up and I'm going to give you the basic pathological aspects and Joe is going to concentrate more on areas that he's had personal experience and some investigative work with. One of the requirements of a forensic pathologist is that he take a totally objective approach to situations. Very often we're presented with a body

29:46

injured, but no details of what happened. It's up to us to decide as much as we can about that particular individual. We have to decide first, is it a human? Is it a male? Is a rigor mortis present? How long has he been dead? What does this particular wound mean? What might have caused it? And we have to do this within the realm of medical probability. We've got to be more likely correct than incorrect. Sometimes that just means 51% right, and that's not a very good right average. But by the same token, that is what the requirement is. You've heard quite a bit of medical stuff already, and let me see if I can concentrate and bring some of this into focus. The first slide, please.

30:30

And the lights.

30:32

This is the front view of the body. You have the lights on?

30:42

As you look at the body as a pathologist, you're first convinced that I'm convinced it's a human body. The measurements fit pretty much into the proportions that you would expect of a body, and two of the speakers before me have indicated that this is true, particularly emphasizing the injuries. Each wound makes its own particular kind of...

00:02

the lower parts of the legs. If you look at these closely and with some of the photographs which come out of California, Santa Barbara, these are very precise lesions. They show a puncture type injury with the skin denuded and accumulation of blood and serum on these areas. Fine details show fine linear scratch-like projections which extend from these, which gives us an idea what the instrument might have been which did these. And next slide. is a diagram of what this instrument may have been it has two or three projecting bits of metal or something something similar was bit into the skin and made wounds of this kind and this is the way they look on the shroud photos the next this is the region of the wrist and it's very clearly

00:56

a mark which is not in the palm of the hand. The palm of the hand would be about in here. You can see the four fingers very clearly. You will notice that this particular mark has two projecting blood streams which flow from it. You know also the blood doesn't run sideways. So if you can elevate this arm to a position where these run up and down, you have the position at which the body assumed when this injury was made. The same is true here on the flea, blood stains on the forearms. And as Dr.

01:26

Gambizio will point out to you later the arms are not in the straight out position. They were bent and the blood flow mimics that particular position.

01:36

Next. This is that mark under more detail showing some of the thread marks and these two projecting strands. They're separated by a short angle which may mean that the body was in two different positions at the time that this injury occurred. Next.

01:53

Looking at the marks of the feet, we see a clear detail of the right foot and a lesser detail of the left foot. The next slide depicts the right foot in greater detail, heel, toe, a heavy stain of blood here, which Dr. Joel will talk more about, a heavy stain of blood here, indicating that something has perforated the foot at that point. Were there two perforations or was there one? And I'm going to leave that to Joe to talk about. Here's some blood which is spatially disoriented from the image. This blood was obviously covered with blood at one time and left a transfer of blood to the claw. The next slide.

02:33

is the left foot, which has a far less clear detail. This obviously was not in direct contact in the same way as the other foot was. And it's possible, as Joel will show you, to put the feet in a position that this sort of thing can take place. Next.

02:52

The wounds about the heads I pointed out to you are peripheral and also at the vertex of the scalp. Next is the back of the head, showing this circular arrangement and also blood stains high at the top of the scalp. Therefore whatever made these could not have been a simple circlet. It had to be something more like a cap which had projecting sharp pointed objects at the top and also around the periphery. Next. This is the last of the major injuries and this is the

03:27

injury to the side. It's on the right side. Some of the pictures that John Jackson showed you earlier show at the top of that wound an area of kidney shape which probably represents the point of origin of whatever made this particular wound. Now this is different than some of the other ones because this blood has coagulated. There's a separation in some areas of a watery type substance. You can see it well here.

03:55

where the blood has flowed out of a cavity and is separated into this peculiar pattern. We're doing a lot more work on the coagulation studies now in order to try and determine what the pathophysiology may be of some of this material. This slide is backwards, but I think we can still show you. This is a slide that Dr. Sava gave me some years ago.

04:21

Sava's idea was that during the injury of the individual in question.

04:27

By trauma to the chest, there was accumulation of fluid and blood in the chest cavity, and that the lance or some object passing through the tissue released first the bloody material and then the water as the level lowered. That's one explanation of how blood and water may have come from this particular wound. A more simple explanation,

04:52

is that there was simply a hydrothorax accumulation of fluid in the chest cavity related to congestive heart failure, and Joe will go into that in more depth, which resulted in a watery type material coming from the wound and that water we can still see on the shroud. The last slide is the flow of blood around the periphery.

05:14

it seems to be flowing from one side to the other there's a very definite separation here of a lot of material from service material some of this is water some of this may be a pleural fluid or or serum but this probably happened when the body was turned at 90 degrees and blood simply flowed out of the same wound in which the material came out from the front part of the chest so very very briefly that's a resume of the of the medical things i think without question We have a crucified person depicted here. I feel that the cause of death has got to be a congestive cardiac failure related to respiratory difficulty from posture in a position consistent with crucifixion. Joel, do you want to take over?

06:02

Thank you, Tom. Thank you.

06:23

You see, if you get applause even before you've said anything, that's faith.

06:30

And while you're speaking, you hear applause, that's hope. The only applause after you're finished is strictly charity.

06:39

Add the first slide, please.

06:43

Well, one thing that photographs do is to take a moment in time and they freeze it and then eternalize it and you can live that moment over and over again.

06:54

And this is a picture we took while we were in Turin. There's Michael Averde. He's four years old, they tell me now.

07:04

And some of the Stevenson children and Johnson and Jumper children. And the next slide, please. So we can let those over again. And the next slide. Dr. Jackson mentioned some of the problems we had, but before we go into that,

07:22

I don't know whether you can see the last pilgrim. I thought maybe we ought to write a book about the last pilgrim. The studies are over. All the tests are finished. They go back, and there's this little pilgrim. All the doors are closed. This is the cathedral in Turin.

07:42

Everything is locked up. There's one little pilgrim kneeling, saying her prayer. Now the next slide, please.

07:53

Everything was fine. We had 70 cases, they tell me, that had to be delivered to Turin, and 67 arrived, and the other three had gotten to Milan. So it was Father Renaldi, Mark Evans, and I that went to Milan. We'll have the next slide, please. Here we see, we're talking to the customs agent, and we're waiting now for the customs agent to come out, hopefully to release the

08:22

Three precious boxes without which nothing was going to happen. And the next slide.

08:29

And finally, Father Rinaldi, I think he pulled about 17 miracles to get through customs. And here are the cases. He is okay.

08:42

The release of the material. Have the next slide, please.

08:47

There, we finally got it. And here is the Father Rinaldi, Mark Evans, got the boxes that were so precious and so necessary.

08:59

Have the next slide, please. All right, I think there's a space between these slides. Have the next one.

09:08

One of the things that concerned me when I was first introduced to the cloths in 1955 was the footprints. Actually, Father Otterwein asked me if I'd be interested in pursuing pathophysiologic mechanisms of death of a person suspended from the cross. That immediately, as you can appreciate, raised certain ethical and moral problems.

09:46

And as we thought over the problem, one of the things that attracted my attention was the footprint. Orbea had postulated that there was one nail there. And as you read through all the reports, you found out that everyone was

10:08

citing one nail as being the method of transfixing the lower extremity.

10:17

I had some problems with that. Next slide, please. This is Barbé's postulated nail in the second interphalangeal joint here.

10:32

And I think you can see that a single nail there might raise some problems in supporting a person.

10:42

And let me show you some of the reasons I think that. We have the next slide.

10:49

Here's some of the stutter, sharpen it up a little bit. Now this, and then we have a bunch of

10:55

positions that we tried, which you'll see a little bit later. But here's the position of the foot with the individual standing on the ground, and you can see the angle that is occurring here. And the foot was flat on the upright wood. Now the next slide, please. In that position, he is flat. He's just now suspended from an upright with his legs

11:26

not touching the ground, but not with his left foot or right foot over the left foot. And you can see the position of the body up against the upright very snugly. And the next slide, please.

11:42

However, we found that as soon as you put one foot over the other,

11:47

the entire lower portion of the body and the pelvis began to rotate. It was impossible to keep this foot flat without causing a marked rotation of the lower part of the body. Have the next slide, please.

12:10

You can see exactly what's happening now. You can see the tension that's being put on this foot as we attempt to place the left foot over the right foot.

12:23

Now the next slide. And not only does that happen, but now the body is pushed forward so that the

12:34

The pelvis itself is rotated and the body is tilted forward in order to maintain this position of the left foot over the right foot. Now the next slide, please.

12:50

Now it's apparent that the secret of crucifixion lies in securing the lower portion of the body. And in order to secure it, we have to appreciate the anatomy and functional anatomy of the ankle joint. And here we can see the flexion and extension attributes of this joint. There's a limited hinge joint here, and here you can see that.

13:19

and there's a lateral and medial ability, and this is necessary if you're going to walk on any type of surface. It is this type of compensability in the joint that lets you walk on uneven ground, otherwise you'd be in considerable difficulty. The other thing I want to draw your attention to is the angle of...

13:44

support and how it is related to the tibia. And this is not in the area that Barbé has postulated. So placing a nail where Barbé postulated would actually cause a marked change in the supporting structure, supporting force of the body.

14:11

I use this as kind of an example. This is a 20th century depiction. But you can see immediately that any type of transfixion of the lower limbs in that type of fashion would certainly not be enough to really support an individual transfixed to a cross. I have the next slide.

14:37

So as I mentioned before, the whole secret then is to really secure the lower portion of the body. That could be the pelvis or it could be the ankle joint, the foot itself.

14:53

they're just not secure enough. And if you just try to secure the foot, they're going to get a change very similar as that seen in the guru world type of crucifixion. And I think you can appreciate immediately that keeping in mind the functional anatomy that we just noted about the ankle joint, that this would cause a considerable evulsion of that joint. And the next slide.

15:25

I think in support of that was the Yohannam of Jerusalem excavations, and you can see how they were necessary to secure rather securely the lower part of the anatomy in order to continue and maintain the agony of the crucifixion. We have the next slide.

15:54

If you were going to use then one nail, you would have to use the nail in this particular site. One nail would have to go through at least one of the ankle joints in order to maintain this security. Now the next slide.

16:15

if we look then if we phosphate that one nail isn't going to do the trick and this is the position of the nail that bar base will go and we inspect the footprint to any great extent we see that actually we have another flow of blood that is very similar to this one and we're in a position now that if we call this a nail mark, then one of the positives has to be that this could be a nail mark too. and this is in the position of the ankle joint and from the standpoint of securing someone on a cross this would be much more reasonable uh possibly to say that this is a nail wound and we could then

17:10

begin to see how an individual could be transfixed more securely. At the next slide.

17:17

If we look at the pictures taken in Torrent, we again see

17:24

the similar areas. We have the next slide.

17:28

And this is one of the down limbs that'd be this. And you can see, again, the two areas that are very similar. So we have to at least postulate that if this is a nail wound and this certainly falls into the same category, number one. Number two, this would give the lower limb a much more secure position on the cross. And in that fashion, the individual who's being crucified would be able to survive much longer than if he's just being suspended. And this would occur without revulsion of the ankle joint, although there may be traumatic revulsion just from the nail. Now the next slide, please.

18:18

If we look again a little more carefully then at the ankle joint, We find this is the area that our bank spoke about.

18:28

It's not really upside down. I tried to place it in an area, but I've got it upside down.

18:35

Anyhow, this is lisfax joints and this is choparts joints. And if you look at choparts joints in the ankle, you'll find out that there's a very easy access through the ankle joint and close to the calcaneus.

18:51

And very easily and securely anchor the ankle joint to the wood of a cross. May I have the next slide?

19:05

There's another view of the anatomy. You go through Chopard's Joint, you can see right through here, and it's a very, very excellent method. Or you can enter into this area here.

19:19

This is probably the area that was frequently entered, and probably the area which was entered when Yohannam of Jerusalem was crucified because that nail punctured the calcaneus bone. Have the next slide, please.

19:36

This shows the other portion of the ankle joint. It's not upside down. I put it in that position to keep it more uniform. And there's the opening on the other side of the foot.

19:50

And the next slide, please. All right, so our partiality is that in order to secure an individual on a cross, that in all likelihood there were two nail holes and not one, that this nail was placed in first, and then the left foot was placed over the right foot, and the nail driven through the left foot and the right foot together.

20:20

So there are two, four nails, two nails were used for the foot.

20:25

One primarily for the right foot to the ankle joint and then the second nail which transfixed both the left foot over the right foot and causing both of these injuries. Now the next slide please.

20:49

One of the other things we recognized, or appreciated, as we began to study crucifixions, was that the arms are always symmetrical. You can go through these pretty rapidly.

21:01

And all these depictions, conventional depictions, at the next slide, demonstrated a symmetrical placement of the arms. May I have the next slide, please?

21:15

Again, same idea. Next slide.

21:19

Here's one in the Turin Chapel, right next to the Guarini Chapel.

21:26

I always make a big thing about the architect of the Guarini Chapel, Guarino Guarini, because I'm here for Guarini.

21:36

My mother's a Guarani, and I like to think it was my great-great-great-great-great-great-grandfather who built that chapel. I haven't gone through it genealogically, because I guess I'll find a great-great-great-great-great-grandfather who was a horse thief or something.

21:51

This is just outside the Guarani Chapel in Turin. Again, the symmetrical position of the nail, of the arms. Next slide.

22:03

There's the Belanger crucifix and again symmetrical. You can see all these crucifixions showed a symmetrical arrangement. Next slide.

22:14

Ritchie doesn't though. Look at that. He's got a bent arm.

22:20

That's strange. But it's not so strange

22:25

I would submit to you if when you place the left foot over the right foot and rotate this pelvis with both the wrists being the pivotal points, the fixed points here, there is one thing that can happen. That elbow has to bend a little bit. And I think that this presentation is probably correct. We have the next slide.

22:54

And that explains the difference in these blood flows in the arms.

23:00

And what actually happened was that the elbow had to bend in order to accommodate itself to its change in the position of the pelvis and the entire lower body. And when the individual struggled at all and tried to raise himself up, the

23:22

Only thing that could accommodate itself to this change would be the bend in the elbow. Now the next slide, please.

23:31

This shows you, again, this is again from Don Lynn, and you can see the difference in the flows of blood. Now the next slide.

23:44

Now this is Monsignor Ricci's depiction of it, and I think Monsignor Ricci is right.

23:53

And the depiction of it, and I think we can explain why this is, why it's correct. I think it's the change in the position of the pelvis that causes this elbow to bend.

24:09

And the next slide, please. And the next slide. Now, the other thing we,

24:23

individuals, as I mentioned to you before, we have problems from a moral and ethical standpoint. How are we going to study the pathophysiology of death when somebody's being crucified? Being a member of a research committee, keeping in mind the Helsinki Agreement,

24:45

Being chairman of the Human Use Committee, I had a little problem with trying that kind of an experiment.

24:53

So we tried to get some secondary type of information. I'd like to just touch on some basic elements in respiratory physiology.

25:05

Here is your chest cage. When you breathe,

25:09

There are two major motions that occur in the chest cage. Your ribs go up and down with their pivot along the spine and they resemble a bucket handle. So that's a bucket handle motion.

25:27

Coordinated with this is the breastbone. Breastbone has to go up and down but on a different axis and that goes up and down like a pump handle.

25:36

and you coordinate these two motions and you're able to accommodate inspiration and expiration. We have the next slide.

25:46

So here we are, the chest cage in deep expiration, the chest cage in deep inspiration, and you can see the change in the axis of the ribs and the breastbone. And this is all dependent, normally, on the motion of the major muscle for respiration, the diaphragm. Here you see this dome-like structure, which goes up and down like a piston, and in so doing permits the entrance of air into the pulmonary alveoli and the exit of air during expiration. and that is the major muscle of respiration and ordinarily the only thing that comes into play with normal respiration. However, if any stress is placed on this system, there are methods of protection

26:48

And these are the accessory muscles of respiration. The intercostals, for example, are one of the serratus muscles. The one that maybe will draw most of our attention for today. Let us keep our eye on the rectus abdominis muscles as a proportion. And the next slide, please.

27:13

Here is the pectoralis major muscle, which is part of the brachial plexus.

27:21

Not the brachial plexus, the shoulder girdle. You notice it has nothing to do with respiration, but it has a very deep, extensive and rounded insertion on the ribcage. It is this broad expanse of insertion on the ribcage which permits the shoulder girdle to do many of the sophisticated maneuvers, and it does.

27:52

I guess that's what Todd McGraw does when he strikes people out. And the next slide, please.

28:00

We did all kinds of maneuvers and trials trying to see what happened when someone suspended. We had the next slide.

28:14

We tried swings, we tried a number of other Maneuvers. Have the next slide.

28:21

And then you begin to see here some of the accessory muscles of respiration coming into play as he's hanging in there. Have the next slide. Next slide, please.

28:37

Let me sharpen that up a little bit. Here we see he's on the ground. He has his arms extended.

28:48

I'll just draw your attention, since time is of the essence, to the area just below the rib cage here. He's suspended now, and notice how the rectus abdominal muscle begins to contract itself. And the next slide.

29:09

What's actually happening then is a tremendous pull of the shoulder girdle muscles with the forces of gravity pulling the body down, there's this push forward and you can begin to appreciate the pull and the forces that come to exert themselves on a chest cage. The chest cage becomes

29:35

impaired and embarrassed and have tremendous difficulty in expelling the air and you get contraction of the abdominal rectus muscle. Next slide please.

29:49

Here we see again a series of respiratory cycles and again keeping you high here. You can see the change as respiration is attempted. You can see the change and the increased contraction of the rectus abdominal muscles as the person lies suspended from the cross beam there. Now the next slide.

30:14

Here we see a frontal area. Notice the tremendously scaphoid abdomen. that we're encountering here as this rectus accessory muscle comes into play. We have the next slide.

30:31

And of course the Romans learnt since the lower portion of the body is transfixed, the only way for an individual to ease the pressure on the

30:47

from the shoulder girdle muscles would be to raise himself up in some fashion. And the Romans appreciated that if you could break the lower limbs, the person couldn't do that at all.

00:02

And cause this difference in appearance of this area here, which is Dr. Buckland mentioned is in keeping with the flow of blood from an area that opened here.

00:20

the difference in this collection of blood from another blood flow. May I have the next slide, please? This is the flow across the back where you can immediately see here and here the difference in density of the flow. And if you look a little more carefully, you can see there seems to be this fluid in between. Now this is certainly of lighter density than that on the side that we just demonstrated.

00:57

How can we reconcile this difference in blood flow since there seemed to be a connection between the two? Purely from an anatomical standpoint, if there was a flow of blood from the side and the person was tilted,

01:17

It would follow the normal blood contours and come right across the loins, as we see here, across the smaller back. But how could we explain the difference in the density?

01:32

We can postulate one of several possibilities. Next slide, please.

01:46

Close it a little bit. One of the things that we... Is that a carousel? Take a quarter out of your pocket.

02:03

Put it into the screw in the middle. Turn it counterclockwise. Lift the slide tray off. Straight up. And you'll be able to take the slide out and put it back in place. pays to teach for a living while we're waiting for that i'm sure you'll all be happy to hear that larry schwalbe is resting well and the latest report we have is it's merely indigestion john howard will tell you that's because larry heard i was going to take his place

02:43

While we're waiting, I can tell you about, since we're talking about the image here and getting philosophical, perhaps, and maybe biblical, there was this Bible class.

03:05

And they were given the lesson of drawing a scene from the life of Christ. So little Maria picked the flight into Egypt. And as she showed her picture to her class, she showed Jesus, Mary, and Joseph in an airplane.

03:24

Well, I thought that was pretty good, pretty natural flight into Egypt. But one observant said,

03:32

Classmates say, well, who's the fourth person? She says, oh, that's Pontius the pilot.

03:46

Well, what I had hoped to show you is this.

03:50

This is blood. This was blood recently drawn. Can we sharpen it up a little bit?

03:56

Blood recently drawn just a few minutes before I took the slide. took the picture, and these two units were drawn about 30 minutes previously.

04:07

In this unit, you can see what has happened. There's been a sedimentation of the red cell mass by gravity to the bottom of the container, so there's a rather clear separation of the red cells on the clearer supernatant opalescent fluid, which before the plasma.

04:30

Now this unit was exactly like this one, except what I did was stir it up a little bit, and you can see the rather prompt dispersion of the red salt mares throughout the unit. But you will notice that the density here is somewhat less than it is here. So we have a difference in density, clearer fluid,

04:55

Red cells in its greatest density here, dispersion here, the normal situation. Here, have the next slide, please.

05:05

This is a chest x-ray. Heart, lungs, inspiration, expiration. There is a potential space here called the pleural space.

05:17

And we know that in certain types of trauma, that fluid can be accumulated there. And I'm not going to go into whether this is heart failure. We will take as a given that there's fluid in the chest.

05:33

And one of the possible explanations then could be, have the next slide please, if blood was there,

05:41

And assuming that death has arrived, there would be a separation of red cells and a clear supernatant fluid, somewhat in this fashion. And the next slide, please.

05:57

A instrument would pierce the chest wall just at the level of the lower portion of the pleural space. We have the next slide.

06:11

And we can postulate then that as we move, this is backwards, there would be a flow of blood. Now this would be the agglomerated red cells. that we see, and as Dr. Buckland demonstrated, rather high concentration of red cells.

06:33

Now the next slide, please. There would be an opening, what we call an open pneumothorax, where the person is taken down from the cross.

06:42

Now the next slide, please. Crucified person, then the material in the pleural space, would be mixed with the clearer supernatant fluid, and you would get a less dense type of material. And as the position would change, the person is taken down from the cross.

07:05

This person with the side lance would get a flow of blood, that would be a character demonstrating less density and more watery, and certainly this has that characteristic. And that's one possible explanation of the difference in the bloodstains there. One of the things I would like perhaps that Don Lynn can do would be to measure the densities of this fluid, fluid on the side and the wounds in the feet, the hands, and compare those densities, and perhaps demonstrate a difference between clotted blood, agglomerated red cells, and then fluid, diluted red cells, and perhaps we can get some information there. And the next slide.

08:00

Thank you very much. Thank you.

08:14

The next series of talks are going to be on photography and spectroscopy. The first speaker will be Dr. Joe Aceta from Martin Marietta. He's going to talk about IR reflectance spectroscopy and thermography. Joe? Thank you.

08:43

Thank you very much. I notice some of you are still taking photographs of the screen, and I might remind you, you're probably wasting film. It's almost impossible to get a good shot. If you're going to take photographs of what is appearing on the screen before you, turn your flash off. I'm going to address...

09:13

It's been defined this morning that there are two categories of people in this auditorium. One of them was called normal, and I want to talk to you for a few minutes. I thought it would be fruitful to talk about spectroscopy, because in the ensuing series of talks, you're going to hear a lot about spectra and frequency, and I want to talk to you about what that stuff means and how it is we come to the conclusions that we do.

09:41

The space around you is full of radiation.

09:44

You see it coming from the lamps above you. You've probably held your hand in front of a hot iron and felt radiation, although you couldn't see it. Well, that's all the same kind of radiation. Another example is when you dial through your AM radio band or your FM band.

10:02

As you dial through, you pick up different frequencies, and that is kind of like spectrum if I were to go say in New London here and dial through the AM radio band and Record those frequencies which I heard a station And also perhaps recorded the kind of music that was on that station And I did the same kind of procedure for every city in the United States Then I could go back and almost tell where I was by looking at the by dialing through the radio band and finding out where the frequencies were and

10:37

noting what kind of music occurred, and going back to my original reference, I could tell pretty closely where I was in the United States. And that's kind of the same procedure that takes place when we deal with things called spectroscopy. Now, spectroscopy is done in many regions of the spectrum, most of which are inaccessible to the senses. We know about the visible region of the spectrum because we can see it.

11:05

We can see the white lights.

11:07

In fact, you've probably seen the experiment where you take sunlight and you use a prism and you split the sunlight up into its component colors and you see all these beautiful colors come out at you. Now there's a much more sophisticated version of that, say, that the astronomers use when they look at stars. Now if you look up in the evening sky, you see pretty much the same colors of stars. however if you use the very sophisticated techniques that the astronomers use you can split the starlight up into many many different frequencies and from those frequencies you can pretty well determine what elements

11:43

the stars made up of, and that's what we're going to talk about here today. I'm going to talk about a region of the spectrum called the infrared region, and it's kind of like the same region that one deals with when you sort of feel the heat coming from an iron. It's a heat picture.

11:58

It's kind of like a heat picture. John Jackson talked about that this morning.

12:03

So without further ado, let me give you an example of a spectrum, and we'll go through some operational definitions. Can I have a first view there?

12:19

Now the first item on there I want to draw your attention to is just the upper left hand corner. This is a spectrum of something you're familiar with called Saran Wrap.

12:32

And we did this as a test. You can see that these little jiggles here are very characteristic of that particular plastic and where they occur down here.

12:41

So that by taking a scan of that spectrum, we can match the spectrum up against say a common laboratory reference of that and say well that that must be saran wrap there's another concept that that i'm talking about here and that is resolution there is a difference you see there are two graphs in this in this particular chart one of them is much cruder than the other you see the laboratory instrument gives us very fine resolution you can see these these lines are very sharp

13:11

The actual instrumentation that we use to do a similar experiment in Turin does not give us quite a sharp definition of those lines. You can see some of the peaks have filled in, but it is nevertheless definition. So, we are going to apply this technique to

13:31

the observation of infrared radiation coming off the Shroud of Turin to see if we could say anything about the chemical constituency of the surface. And that's very important, as you've probably heard already.

13:43

We are very interested in the chemical composition of the image area, for example, or the chemical composition of the blood area. And one of the ways to find that out is by doing things similar to this.

13:56

The problem with doing this kind of spectroscopy is that there is no established database because it's not conventionally done. We had a very unique object here and so this kind of spectroscopy is called reflectance spectroscopy and you're going to hear a lot about this in the next few talks. It will be discussed in the visible region and in this particular one we're talking about it in the infrared.

14:21

We made some laboratory measurements of

14:25

materials similar to what we would find in Turin. Of course cotton and well cotton was done for a specific purpose I won't get into that but we did look at linen for example here and cotton and the differences and you can see I hope you can see in the back that there is very little spectral difference between the two. However I point out that

14:45

sometimes the instrumentation is not sufficiently sensitive to be able to see the very small fluctuations. So you really don't know, in some instances, whether there really is no difference between two curves or your instrumentation is not sensitive enough.

15:04

It turned out that in the series of tests that were done in Turin, I suspect that our instrumentation was not sensitive enough but that was the first time around it's not uncommon to determine that sort of thing so the question is open as to whether or not there really are differences in some of the things that i'm going to show you because of insufficient sensitivity this is linen versus cotton in one particular wavelength band that's the three to five micron we call we reference our frequencies in terms of wavelengths three to five micron band we also looked at a linen versus cotton comparison in the 8 to 14 band you can see this they're quite similar i hope you can see that you can see this these two curves we also looked at scorches and what does the scorch

15:52

is there any difference when you scorch linen? And you can see in the bottom graph here that except for a slight shift in amplitude of the spectra, we see that there really isn't any big change or characteristic change in the shape. And similarly in the linen versus scorched linen in the 8 to 14 micron band. Now, again, I point out that maybe the instrumentation is not sufficiently sensitive to be able to see these very small changes.

16:24

Let's go on to the next view graph, please.

16:31

What I'm showing you are view graphs taken right from the paper that was published on this particular topic. I point to the upper right-hand corner where I'm checking cotton, looking at the characteristic spectrum of cotton versus blood on cotton.

16:48

And you can see in this particular instance that, indeed, a change occurs in that characteristic spectrum. It smears it out quite a bit.

16:57

Those are laboratory things, laboratory measurements, because we had to, in the brief time that we had, try to establish some sort of database so that when we did go to Turin, we could have something to compare our results with. Let's go to the final chart.

17:15

And we have some more of similar kinds. I can barely read those myself. On the left-hand corner, I think I have scorched linen.

17:38

A shroud scorch versus a regular scorch here.

17:43

And you can see that

17:45

there are some differences between these two. And if you observe this in both wavelength bands, you come to the conclusion that, and I think I'll just give you the bottom line without going through all the discussions on both of these, that the image area in the shroud, at least in this wavelength band, these regions of frequencies that we're looking at, looks very similar to a scorch.

18:12

The question is, is it identical? And I don't know the answer to that at the present time. I think perhaps future work might be able to make a more definitive statement. It's possible that we are dealing with one and the same thing here. The subtleties may be below the resolution and

sensitivity capabilities of the instrumentation we use. That is similarly true in the other region of the spectrum that we looked at.

18:40

With regard to the blood, we also did the same and similar test in both regions of the spectrum. And you can see that the Shroud blood here versus a laboratory spectra of blood in this band is not too dissimilar. There is some differences. And in this band, there is a large difference. Now that led me to speculate that perhaps what we observe on the Shroud is not

19:08

totally blood but perhaps a composite of blood in some other substance because there is such a radical difference between the two curves that I speculated that there may be in fact a chemical difference. It certainly doesn't resemble whole blood on cloth. And what I mean by whole blood on cloth is I'm sure everybody in this auditorium at one time in their lives has cut themselves and grabbed a hanky and put the hanky over the wound and a little while later look at that and you see a very dark brown stain.

19:39

OK, visually.

19:41

In the infrared, we see the differences that I have already pointed out. But there is a spectral difference between whole blood on cotton and what was observed from the bloodstains on the shroud.

19:55

So that's the two real conclusions, if you can call them conclusions, out of the infrared spectroscopy study. I'm going to discuss now

20:07

Another aspect of this, and still in the infrared region, and John Jackson talked about it this morning, is called infrared heat pictures. We call this sometimes thermography. It's another way to describe it. And thermography basically is creating, the creation of an image in a region of the electromagnetic spectrum that is not accessible to your eye. It's kind of like a heat picture.

20:32

Can I have the first slide? The only slide.

20:37

This is a thermogram of the shroud facial region in the 8 to 14 micron band, which is the first of its kind. You can see, firstly, that the resolution, in other words, the quality of the image is rather poor with respect to a visual or to a regular photograph. And this is normal. Instruments of that kind just do not have the very nice resolution that you might get out of a camera. what we observed is a image in the infrared very similar to the image in the visible region of the spectrum what we were looking for was the possibility that we might see two different images and what two different images might have told us was that there might have been a difference in chemistry

21:29

we might have seen detail in this region of the spectrum that was not accessible to us and invisible. And it turns out that that is not true. So there's no other detail, at least in terms of the infrared experiment, that can be seen.

21:42

There's a property of materials called emissivity, which has very much to do with how well or how effectively certain compounds or surfaces radiate energy. And what you're observing here is the differences in emissivity, this property, on the Shroud of Turin. Now, in order to get a temperature difference, we had to artificially induce that with lamps that are very similar to sun lamps, so that we heated very slightly the surface of the shroud. And because of these differences in emissivity, we created this image that you can see. Now, you can go through the theoretical arguments about this and describe it mathematically, and we'll turn out that under the conditions under which the experiment was done, that this is what you would expect to see barring any anomalies, and that is indeed what we did see.

22:32

So, with the exception of a few minor details, for example, in the eye region, which has been pointed out to me, and I withdraw from any interpretation.

22:45

What you can see here is a slight convexity here, whereas this eye socket seems to be much darker. I cannot explain that. I'm not sure it's really a significant difference.

22:56

Also, what you see is that there's an absence of perhaps image here. Now this is, in my comparison of this imagery with what I see in the high quality visible photographs, I see that the image there is kind of lacking too. The image in the shroud is sort of lacking on the right side a

bit. So that this image in the infrared is quite consistent with the image in the visible region and no apparent anomalies are observed.

23:31

We attempted this same experiment in another region of the spectrum. We did not observe any imagery there. The reason for that I attributed to the basic lack of instrument sensitivity in that region. I think there would have been an image there in the three to five band if we had an instrument that had a much bigger aperture on it and consequently much more sensitive. So I think that

23:55

That's pretty well the bottom line with respect to this series of instruments, or this experiment. I never thought I would say it at this point in time, but perhaps it might be feasible at a point in the future to attempt a much more sophisticated version of this should other attempts at defining the surface chemistry fail.

24:15

And I'll conclude at that point. Thank you very much. Thank you.

24:26

We can also thank Joe because he finished about five minutes early, which gives you time for one of John Heller's famous stretch breaks. So everybody stand up, stretch, take a five minute break, and come back here in five minutes.

24:42

Thank you. I'm the normal Gilbert.

24:46

Our job in Turin was to make spectral reflectance and fluorescence measurements. These are two techniques which will help us in studying the substances which lie on the surface of the cloth, especially those which make up the various stains. This afternoon we're going to describe what we mean by spectral reflectance and fluorescence, discuss briefly how we did the work, and show what results we obtained.

25:18

Our background, or I should say rather Raj's background, is basically in optical instrumentation, not in chemistry or biology. So we will leave the interpretation of these results to the scientists who are going to talk later.

25:35

Let's talk first about what we mean by spectral reflectance. Joe talked a little bit about this. Normally when we see an object, What we're really seeing is light reflected from a source reflected by that object. For instance, right now you're seeing light from the overhead lights reflecting on my clothes into your eyes. Reflectance is a measurement of the fraction of light hitting the surface that is reflected.

26:07

A perfect white source reflects 100%. We have the first slide, please.

26:16

To make a measurement of reflectance, light from a source is reflected from the surface we're measuring into a light detector. The amount of light reaching the detector is then read out on a light meter.

26:37

We start by measuring light reflected from a reference surface, an almost perfect white reflector, and then we substitute an unknown surface for the reference and divide one reading by the other. For instance, let's say that with the white reference surface we get a reading of 60 on the meter,

27:00

And with our unknown surface it reads 30. By dividing 30 by 60 we get 0.5. We can then say that the unknown surface has a reflectance of 0.5.

27:11

What happens to the light that hits the surface and is not reflected?

27:16

It's absorbed by the surface material. It's just swallowed up.

27:22

What we're interested in here is spectral reflectance, how reflectance changes across the color spectrum.

27:31

Light can be thought of as traveling in waves, waves of different lengths. Next slide, please. Wavelength of light determines its color. Let's look at the spectrum which shows the wavelengths associated with the various colors.

27:49

Wavelength is measured in nanometers.

27:54

We can see the spectrum of visible light from violet through deep red. This corresponds with the wavelengths of 400 to 700 nanometers. White light is generally a mixture of all these colors. Below the violet, that is below 400 nanometers,

28:15

lies the ultraviolet, and above the red, above 700 nanometers, is the infrared, which Joe was just speaking about, the IR abbreviated here.

28:27

A monochromator is an instrument which takes in white light, light from all wavelengths, and allows through it only light of one color.

28:37

Actually, it passes a narrow band of wavelengths, somewhat like a filter. By using a monochromator, we can vary the wavelengths and scan across the spectrum.

28:53

By inserting a monochromator in the light path, we can now take a measurement at a single wavelength.

29:02

Then, by changing the wavelength, we take reflectance readings at various wavelengths across the spectrum.

29:09

If we plot these on a graph, we have a reflectance spectrum. Next slide.

29:16

Here are some reflectance spectra of typical colors.

29:21

A red surface looks red to us because it reflects a much higher fraction of the red portion of the spectrum than elsewhere. A blue surface looks more blue. Next slide.

29:35

We said white is a mixture of all the colors, so a white surface is neutral. It reflects approximately evenly across the spectrum.

29:44

Gray surfaces are also neutral. The darker the gray, the lower the reflectance is, all the way from white to black. The reflectance curve of a yellowish surface is similar to that of light gray, but it comes out slightly tilted.

30:05

As I mentioned, what isn't reflected is absorbed by the surface. A yellowish surface therefore absorbs more in the blue than in the red. This is important to us because the absorbance characteristics of the surface can tell us something about the materials that make up the surface.

30:28

Another technique for studying the surface materials is to study their spectral fluorescence. In fluorescence, light of one wavelength is absorbed by the surface, and the surface is then caused to fluoresce or emit light of longer wavelengths.

30:47

Those of us who are discotheque freaks understand that pretty well.

30:51

Discotheques have a habit of installing so-called black lights, which emit ultraviolet, which we can't see. However, it causes our shirts and dresses and even teeth to glow up.

00:01

Why do we want to make spectral reflectance and fluorescence measurement on the shroud? And here we basically have two analytical questions that we asked ourselves in Turin. Next slide.

00:14

The first is what substances make up the body image stain?

00:19

Is it a paint or a pigment or a dye perhaps? Or is it some natural degradation of the cellulose in the cloth itself and the blood stains? Are they really blood, or are they perhaps some other substance?

00:35

We had hoped that the reflectance and fluorescent spectra that we took on these various stains on the shroud might be able to be matched with that of some known surfaces to throw a little more light on the subject.

00:48

We also had thought that perhaps spectra taken on the clear area of the cloth might help us or someone in getting a little more information on the cloth, perhaps learning something about its method of manufacture, et cetera. A quick look at the equipment that we use to make the spectral reflectance and fluorescence measurements. This spectral reflectometer fluorimeter was designed and built for the shroud work by the Oriel Corporation in Stanford, Connecticut.

01:28

It is shown here in action.

01:33

Next slide.

01:36

Looking at a schematic of the instrument for reflectance measurements, the light from a xenon lamp is passed through a monochromator which takes in white light

01:50

and selects out a narrow wavelength band. This light is then transferred by a series of mirrors to a small three by six millimeter spot on the shroud. The light reflected by the shroud is brought through a second monochromator to a photomultiplier light detector.

02:13

For reflectance measurements, the monochromators were scanned in unison across the spectrum.

02:19

The wavelength is read electrically and sent to a horizontal axis of an XY recorder, while the electrical signal from the light detector is fed to the vertical axis. In this way, we were able to obtain reflectance spectral scans. Next slide. Spectral scans were run of a number of different points on the shroud on several different body image points. on points scorched by the 1532 fire, and on mud-stained points.

02:58

For reference, we also ran several points in the clear, unstained areas of the cloth, and we ran a spectrum of a white surface, magnesium oxide.

03:10

To obtain an absolute reflectance of the clear cloth itself, we divided point by point the reflectance scan readings from the various clear areas by the magnesium oxide readings and replotted the results.

03:29

Here we have the absolute reflectance spectrum of five average different clear points plotted with two individual points.

03:39

We can see the higher reflectance at longer wavelengths which corresponds to the yellowish look of the cloth, we can also see a variance from point to point.

03:53

To answer the two major questions about the body image and the blood stains, our interest was not so much in the absolute reflectance of these stains as in the effect of these stains, which these stains have on the reflectance of the cloth.

04:08

Because of this, we used as a reference surface not the white magnesium oxide, but the average clear area of the cloth itself. We call these relative reflectance spectra, relative that is to the underlying cloth.

04:26

A word on the errors and variances in the reflectance measurement. The maximum probable instrument error due to noise or due to errors in reading curves is plus or minus 3%, as determined by multiple scans on the same point.

04:45

In addition, we have the non-uniformity of the cloth itself, which we mentioned earlier. The effect of this noise has been reduced by averaging data from several similar points.

05:00

For fluorescence measurements, the source monochromator was set at 365 nanometers in the ultraviolet. The lamp was switched to a mercury lamp for more output. The detector monochromator scanned the emission from the cloth across the visible region from 400 to 700 nanometers. the raw fluorescence scans from the recorder were corrected for the sensitivity curve of the measuring system and replotted as corrected fluorescence spectrum.

05:38

Well, what do we learn from all this?

05:41

Before we went to Turin, can we have the next slide please?

05:45

We ran some relative reflectance spectra on some typical pigments that we could obtain, quite a number of them. Here's two shown here. This was a yellow ochre and burnt sienna. In each case we saw in these spectra substantial changes in slope as we go across the spectrum.

06:05

When we look at the photograph of the, look at the shroud itself, next slide please, we see by eye that the coloring of the image and that of the lightest of the scorches in this 1532 fire appears to be similar.

06:25

But it's a little hard to tell by eye, and our eye can't see in the ultraviolet. So we were curious as to how the instruments would see this difference in spectral reflectance. We took a number of different body image points and scorch points of approximately similar reflectance and averaged them and plotted the average body image versus the average scorch. Next slide, please.

06:51

And this is what we saw. Considering the errors in the instrumentation that we mentioned earlier, we believe these curves to be essentially identical.

07:04

with an almost constant slope throughout most of the spectrum. And also these curves, either one of them look quite different to us than the spectra of any of the pigments run previously.

07:18

Then when we looked at the cloth, and we then looked at the cloth in fluorescence. Next slide, please.

07:26

When irradiated with invisible ultraviolet at 365 nanometers, the cloth fluoresces a faint bluish color, and the intensity is quite low, really less than 1 100th that of the fluorescence of my white shirt.

07:43

The spectra, the next slide shows, next slide please.

07:51

shows a spectrum of the fluorescence of one clear area, shown here at the dashed line for reference, and a number of the body image areas, shown down here.

08:03

Here we see that the darker the image, in other words, the lower the image is in fluorescence, in reflectance, the lower it also is in fluorescence. And we also see that these curves tend to have a very similar shape. and similar shape to the fluorescence of the cloth underneath, which gives us the, leads us to the conclusion that primarily what the image is doing is just reducing the fluorescence of the cloth underneath, reducing it, or as people say, quenching it. It's more or less as though the image is acting as a filter.

08:40

Next slide.

08:41

Shows us a similar family of curves compared with a clear area, but these are the scorched points on the cloth. Again, from a light scorch all the way to a rather dark scorch.

08:53

And here we see a similar situation. We see the quenching of the fluorescence from the cloth underneath. But in the case of the scorch, we also see, particularly at longer wavelengths, a little bit higher reflectance. In fact, this one went up even over that of the clear area.

09:09

And then when we get to the dark scorch, we see that the peak wavelength has shifted to longer wavelengths. Here the peak wavelength of the clear area is down around 440. And then gradually, as you get to darker scorch, it shifts to longer wavelengths until this curve, when the peak is around 500 or even more.

09:35

To look at this more carefully, we went back to the averaging technique, and the next slide shows... Focus it once more, if you could. Thank you. The next slide shows an average of clear area again in the dashed line. The next one is the average scorch and the average body image.

10:01

And what we see here, and after doing a bit of calculation,

10:04

we see that we not only have the reduction of the fluorescence from the cloth underneath in both cases, but we also have what we call some self-fluorescence, that the stain seems to be

fluorescing itself. Now, the scorch stain fluoresces substantially greater amount than does the body image stain, but we believe that we see some self-fluorescence in the body image as well. Making the assumption that these stains do act as a filter, we calculated

10:35

the amount of this self-fluorescence and plotted it down here.

10:39

This is the self-fluorescence from a scorch and from the equivalent images, and you can see that the image self-fluorescence is quite a bit lower, but it is there. These curves, by the way, have a somewhat similar shape to that curve on the very dark scorch you saw in the previous slide. A possible explanation for this difference in self-fluorescence

11:04

As we will see later when we look at microscopic photographs, the scorch appears around all of the fibers.

11:14

It's sort of scorched all the way through. However, the image appears only on the very front surface of the fibers, and we think that this difference might have something to do with this difference in the measurement of cell fluorescence.

11:27

Now let's look at the bloodstains. Next slide. Or I should say apparent bloodstains.

11:34

This is a curve of the average of five apparent bloodstains. We see here a flat region from 350 to about 500 nanometers, and then a sharp rise at 550 with a small dip at 630, and then a rise again in the ultraviolet below about 330 nanometers.

11:54

For comparison, we ran curves on a three-month-old bloodstain that was given to us by Diane Soren, She didn't say whose blood it was.

12:06

And also a sample of iron oxide on linen. Next slide shows that result. And here we see now again the blood stain on the shroud.

12:19

We see a blood stain, the three-month-old blood stain here. And the three-month-old blood stain has some absorption peaks in it here and here and here and even there. And these are at the various wavelengths that the blood chemist would expect from blood on a piece of cloth that's that old.

12:41

The blood stain on the shroud, however, doesn't show any of this. In fact, to our eye, which is untrained in this, it appears to take some resemblance to that of the iron oxide.

12:58

sample. I will say that we have this dip here at 630 appearing in both of these and I should caution people not to put too much significance into that dip because that's in a region of substantially greater instrument error and we're pretty sure for instance that in the iron oxide that that dip is not real.

13:22

The statistics show that it is marginally real in the

13:26

on the cloth, but we're not sure of that either. So I wouldn't put too much significance in that, but even so, to our eye, the curve does look more like the iron oxide than it does on the fairly recent blood-stained linen. Now, what this means is very difficult for us to tell. As I said, we're not chemists, but whether this means that there's blood and another material, as Joe Assetto was suggesting, or we never did get any hold of 2,000-year-old bloodstains to compare it with.

14:02

Very hard to tell. This is at variance, by the way, with some spectra, microscopic spectra that were run by Dr. Heller and Adler, and they're going to be talking about it later, and we're puzzled by that.

14:21

So going back to the original questions, next slide, please.

14:29

Number one, what was the body image stain? It doesn't look to us, it does look, excuse me, the body image stain, it does not look to us like it's a paint or a pigment or a dye.

14:41

In reflectance it looks identical to a scorch which in fact is a degradation of the cellulose of the cloth. In fluorescence, it looks similar to a scorch, but with significantly lower self-fluorescence that we mentioned earlier.

14:55

Finally, what is the blood stains? We see indications that it's similar to iron oxide. We don't know what that means, and we'll leave that question up to the blood chemists, who will be talking later on or tomorrow.

15:10

We had a really wonderful time doing this project, working around the clock in the magnificent surroundings of the Royal Palace. It was a great week, beginning with the initial setup of our instruments.

15:25

Next slide, please. Slide. Slide. Here was our setup laboratory, which was assigned to us. And the Oriel labs have never looked quite like this. Going all the way from this to the final ceremony.

15:46

This is the weighing in of the shroud, and here we see two members of the Italian scientific community, Professor Ginella reading the scale and Professor Regi taking the data. Looking on is Monsignor Cattino, senior representative of the church.

16:05

These three men and others there definitely made us feel very welcome in Turin and we certainly thank them. We also thank the many employees of Oriel Corporation who worked very hard to put that instrument together and to ship it out. Thanks also to John Jackson and Eric Jumper and Dee German for asking us to join the effort. And to the many members of this research team who supported us and helped us and loved us all the way along. Finally, in this sleepy part of the afternoon, we thank all of you today for sitting through all this.

16:43

Thank you. Next man up is Sam Pellicori, sometimes better known as Agent X. You've got 10 minutes.

17:01

We never were told the fate of the poor boy that Dr. Gambiska was trying to crucify in the name of science, but I think I can explain one of the miracles he was talking about, namely how

17:23

some of our equipment was released from customs. The actual truth was that 300 million lira, a bond of 300 million lira was put up to release that material. I realize that's only about $10, but small miracles we're grateful for also. Let me have this slide up there, please. One of the pieces of equipment that

17:47

was rescued from customs. It was a little spectrophotometer that I put together just a couple months before going. It is portable, self-contained, and has digital readout. This does a similar thing to what the Gilberts does, but it's much more simple and gave us a quick look. Next slide. A quick look at the reflectance information. Next, please.

18:15

And next. And this is some of the data.

18:23

The Gilbert's data was taken at a higher spectral resolution and over a wider range of spectral wavelengths. but anyhow we got a quick look from this these are a couple body image areas and blood and an intense scorch area once again what you see is relative reflectance what these curves mean when they're sloped this way is that the stains absorb more highly in the blue region than they do in the red region and that's very significant we'll get to that later in the program

19:04

Okay, we've got all this data. What do we do with it?

19:09

We could publish it in our professional magazines and let go of that, or you can let it bother you and say, what does it mean? Well, you go to the laboratory and you attempt to reproduce the

information and thereby gain a handle on deducing what possibly might be causing the spectral behavior that we see. Well, one of the first things to attack was

19:39

Where do you get old linen? Even if it's only 600 years old, where do you get some old linen to play with?

19:47

Well, one thing I did was to take some modern linen and to artificially age it, and then take spectral data on it. To start with, however, we have some data on scorched linen.

20:07

the data was obtained as follows. We took the reflectance value at this blue wavelength, 666 nanometers, divided it by, I'm sorry, that's red, divided it by a near ultraviolet point, 387 nanometers, and plotted it then versus green light. We get curves for scorches that go like this. So this would be a very red scorch,

20:37

And this would be a very, this would be an unscorched area. So you have this gradation in scorches. Next.

20:51

Okay, now here is how to make linen that is very old. You bake it in an oven, in air, at a high temperature. You can choose your temperature such that you don't create pyrolysis products. I use in this instance 165 degrees C and it'll happen in about an hour or a half an hour at this temperature or you can go to 130 degrees C and it takes a couple hours you can work down the scale and this then is a plot at one temperature of the relative color versus the green color where your eye is most sensitive for various times of baking

21:37

It turns out that the shroud color is in this area.

21:42

Next slide. That's the shroud background.

21:45

The next thing to approach was then the body image. Now of course the body image is our most important goal. The goal of the program was to explain what the body image is. Well some experiments I did used olive oil.

22:05

uh baked for various times at 140 degrees c and they plotted then the relative reflectance versus can you get that on the lower raise it versus versus wavelength so this tells me the color that the olive oil stain approached or obtained

22:31

with various times of baking after one and a half hours it is here's the unbaked slightly yellowish it absorbs a little more blue light than red one and a half hours significantly yellow and as you continue you reach a point at say three and a half hours where further baking does not cause more yellowing this is an expanded scale

22:56

Okay, we will then compare these sorts of stains with the measured body image that the Gilberts obtained. The Gilberts have much more data than I was able to obtain in my little spectrophotometer, so that is the data to compare with.

23:23

I'll talk just briefly about blood. I did some comparisons now. All this data incident was taken in the laboratory with a professional spectrophotometer using spherical integrators, which capture all the light that is scattered by the piece of linen.

23:46

Okay, again, Mr. and Mrs. Gilbert's child blood curve versus wavelength. Once again, here is red light. That would be your laser light. Deep blue light. Reflectance value.

24:05

I put some fresh blood onto linen and did its reflectance curve and got these absorption bands.

24:15

This is a very significant one for the porphyrin component of blood. These are also indicative of hemoglobin. I then soaked the linen in water and did the curve again and we got essentially the same curve except with a slight change in the far red reflectance.

24:36

Dr. Heller supplied a sample of blood which was denatured acid methemoglobin.

24:45

At this point it was 18 months old and it was on old linen. I did a reflectance curve of it. That's the dash line.

24:53

All the curves in the laboratory have these absorption features.

24:58

As Roger mentioned, The shroud measurements do not have these features. This is something we are working on explaining.

25:06

Possibly it's due to the fact that the shroud blood is more denatured because of its age.

25:15

Or perhaps the chemistry of the linen affected the actual absorption properties of the shroud linen. What? Okay. Thanks.

25:35

Okay, this is that curve in more detail. I think we can go on.

25:48

This is a curve right off of the spectrophotometer showing on the vertical scale the wavelength in nanometers and this scale is the reflectance.

26:02

We always have a baseline, which is, in this case, a perfect white reflector, correct for the instrumental function. This curve, which you can barely see, is for linen, which has no material on it. It's as received.

26:22

And then, in this experiment, I applied, I soaked pieces of linen in potassium hydroxide, just a material to use, and it succeeded in yellowing the linen. So this was another way to yellow linen. And I varied the concentration then of the potassium hydroxide solution. so i'm only demonstrating to you the tools that we use in the laboratory to obtain comparison data from with which we can perhaps deduce the nature of the body image we'll go into more detail on the chemistry in the chemistry session thank you thank you sam

27:10

Moving right along, our next speaker is going to talk about the visible ultraviolet photographs, and it will be Vern Miller from the Brooks Institute. Vern, can you find your way to the podium?

27:47

thank you i apologize for taking so long to get up to the podium well my responsibility in turin was to i might add that my highly enviable responsibility was to provide the photography the scientific photography and i shared that with several members of the team barry schwartz who is here

28:10

my employer, Ernest Brooks, one of my graduate students, Mark Evans, and several other people on the team, Sam Pellicori, Don Lin, and Don Devan. So I hope I haven't oversighted anybody.

28:26

Now, I might add also that every time I explain my responsibility to any audience, almost everyone in the audience wonders why I was chosen, and they all feel that they would be perfectly adequate photographers to do that, and we all make pictures.

28:44

And it is kind of hard to respond to that, and I'll try to justify that a little bit. I work awful hard for this, but I do feel a strong defense mechanism, and so I'm going to extend these pictures a little bit to make it look like I did an awful lot of work.

29:04

If we can start with the slides now, I'll maybe mention how I got into this. Don Devan first talked to me about it in the summer of 1977, and I would like to say that at that time I had never heard of the Turin Shroud, or any other shroud for that matter. So at least I entered into this without any bias and with quite a lot of objectivity.

29:31

As Don explained,

29:33

the objectives to me. Photographically, he made a point of telling me that the artistic and creative photography had no part of this, and that I should try to make as dull of photographs as possible. And the most elegant thing that I might be photographing would be a piece of paper called a step wedge that he mentioned this morning, and that I probably wouldn't see anything that would attract my attention. And I can say that he was quite wrong in all of that, that I have been moved by this experience more than anything that's ever happened to me, and I've seen elegance beyond compare, and that I wished that I had taken the time to be a little bit more artistic.

30:17

In the summer of 1977, after meeting with some of the people, we started the due test to decide on the type of equipment, the type of film that would do the best job for this. And I obtained a replica shroud from David Rolfe in England, and we practiced on that.

30:38

And one of the motivations was to provide the highest resolution. The shroud had been photographed at least three other times in history, and there were some very good photographs made in 1933.

30:49

I realized that our photographs would be compared to those and that we should try to do something different. And the approach that we did was to divide this 14-foot piece of cloth into several sections, and we could get...

00:02

So we had a lot of things to decide on, what type of film, what type of instrumentation.

00:09

I won't, oh, I was pushing the button to change the slides. Would you change the next slide, please?

00:17

And focus.

00:20

We built some apparatus to hold the camera so that we wouldn't provide any distortion into it to keep it geometrically correct. And that took us quite some time. We made this out of angle iron, Tom. It didn't cost very much. I heard Father Ottobine tell me one time that this cost like $30,000 or $40,000. And it was more like $15.95, I think.

00:46

But it had some kind of interesting things. We've built some levelers here. When they told me that this investigation would take place in a 15th century palace, I thought of dungeons, you know, in movies and the things you'd read, and I thought of cobblestone floors and so forth. So we put about a two-foot leveling screw on all four points here to compensate for that adjustment. and there was an upright that held the camera and it was divided off into increments here and then this horizontal piece would allow us to move along the rail to two predetermined positions enabling us to divide the 14 foot section of cloth into 60 equal sized 30 centimeter sections we positioned lighting here across the way and we tested several types of light

01:39

trying to get the ideal spectrum that would respond to the cameras and that light that would stay the same throughout the experiment and that we could duplicate and verify in the laboratory.

01:52

Another piece of elegance that I like is this little projection, telescoping projection here. Again, in order to square off to the flat frame, we could take measurements and move this back and forth, but we built this extension and we would go to the extreme four corners and just extend that out and get to the same location and that way square up to the frame.

02:17

If any of you ever have an occasion to photograph a shroud, I can highly recommend that method. Could you change the slide now, please?

02:28

And focus.

02:30

Now this is the plan again and shows these 60 centimeter sections and they had overlapping areas so that none of the shroud would be missed or at least we had planned that not to be missed. And this is the replica slide, a photograph of the replica shroud. None of us had seen a

shroud at that time and I thought that it might look something similar to this and I was pleasantly surprised that it didn't. but it shows the the various areas and how these were divided up and they we divided them in the spectra in red green and blue and we would travel through kind of fly by that in a photogrammetric fashion and photograph each one of those and then later combined it through via the computer into a mosaic image slide please i knew that was going to happen

03:26

I'm using the slides to remind me what to talk about next. So I have to be quiet at this point. Oh, Al says that if you take a quarter out of your pocket.

03:48

Another professional teacher. Alan, I teach that system. That same trick.

03:57

You know that's how it always happens with the material about one day before you give an exam that you want to cover for them because you want to ask a question on it? I know this too.

04:11

I'm making kind of light of this now, and I don't think I could at this particular time. There's a lot of my friends out here that I don't want to embarrass.

04:23

And Barry says he's taping me.

04:29

Well, I might have to say something if this doesn't go on. I think the last slide was that mosaic that we practiced on, and I would say that then we started to select the films and we went through available films. Wow, that is not me.

04:44

Is there anything about that? Well, I know now that I'm going to talk about that.

04:53

There were available films, of course, from the manufacturer that were over-the-counter types of film, and what we had heard from the various requesters and investigators that a film with high

resolution and one that was responsive to all wavelengths of light would be what we wanted, and that the image on the shroud was very subtle and subtle tones all in about one color, so we wanted a film that would give a little bit of

05:22

contrast to that, a little higher slope. So I first approached the Polaroid Corporation, and they gave me an awful lot of film to practice with, Polaroid films that had this ideal slope in it, and that allowed us to pick the best contrast range of film that we could use. I was gonna talk about that picture, there we go.

05:45

Okay, this is the rail in place, and it shows the lighting. The lighting had to be portable, and we could move it along and carry it over to Europe as well. Down the slide, please.

05:56

We finally decided on a film of 70 millimeter capacity because we had to make a lot of pictures and again portability and Eastman Kodak had a new special order film called SO 115 at that time and had a resolution of about 300 line pairs per inch and it seemed to fit all of the requirements we needed so we started practicing with that film. This is a digitized print from the Jet Propulsion Laboratory of the of the replica image and it shows a histogram of tones below it there. There's no routines played on this at all, no enhancement, but it shows the type of imagery that you can get through digitized photography, computer photography, as opposed to normal silver photography. And one of the great advantages is that through this method we can measure over 200 different shades of gray.

06:49

And in photography, it's only slightly, at best, over 15.

06:54

So there should be more information in a digitized photograph than in a normal silver photograph. Okay, next slide.

07:05

Well, this is at the Royal Palace, and we're assembling all of the equipment here. Sam and Don and I leveling with those two-foot leveling screws. And lo and behold, we had very nice parquet floors that were extremely level, and none of that was really needed. Slide, please.

07:28

And this is the camera all in position and the lighting equipment.

07:35

I think I can afford to tell you this story now about that lighting. Is it all right now, Tom, to tell that? I've held this for so long. And I don't want you to know that everything went absolutely so well.

07:50

Not only was the equipment held up in customs in Milan, but one of the crates never arrived. And that one crate I had a premonition wouldn't have come because I know that it was shipped a little bit out of sequence with the rest. And that crate was the one that contained the lighting for this whole thing.

08:12

part of the investigation.

08:15

And so for three days, I chased all over this strange city to me and turned 700,000 people that all spoke Italian, trying to locate a replacement for this lighting so that the experiment could go on. And I tried to tell everybody, you know, my predicament on the team, but they all had their own problems. Didn't want to listen to mine.

08:43

Eric Jumper told me to go on without it. Said, well, what difference do the lights make?

08:49

It was a little comical to go into a camera store and tell them, you know, what I wanted in English. And these lights, and they were flashlights. They're seen on tube lights, and I would go, flash, flash, or something. And they brought out a variety of little things to try to sell me.

09:08

Well, there's got to be an end to this. It didn't seem like it at that time. But the National Geographic was there to cover the event. And a person that has become a great friend to me, at least I kneel down to him now for providing that equipment, was Ken Weaver and Mickey Sweeney and Vic Boswell were in Turin. And they lent me their equipment that they had brought over to photograph the Shroud. And we were able to go on. On Wednesday the third day of the investigation the crate finally did arrive after about seven trips to Milan Several speeding tickets

and I don't know how much money to the various palms Okay, so I couldn't help but tell you that when I looked at those two packets of lights I know that this was Wednesday because we have the lighting next slide And

10:03

This shows the sandbags we brought over, bags to hold in case there were any earthquakes, to hold that equipment steady. We only brought the bags. We used Italian sand, and it seemed to work okay. Okay, and the next slide.

10:22

Now, this is Don's famous step wedge and John Lohr holding it for us, and he says that that will become the most famous photograph in the world.

10:34

All humor aside, I know the impact of these photographs, and if you stop to think of it, Barry, I think that more people have gazed on these pictures than almost any other pictures that have been produced in history. Next slide, please.

10:54

And the final one.

10:57

Next, please. This is the special filters, the dichroic filters that allowed only 100 angstrom band, white band of light to pass through.

11:10

We positioned those on carefully so that they didn't angle and change the response. Next slide.

11:22

Now, another responsibility beyond that of spectral photography was to make photomicrographs. And this was for the first time in history that we knew of that photomicrographs had been made. And there was no instrumentation that is off the shelf for that type of job.

11:40

Now, one of the restrictions that had been explained to me very carefully is that we would not be permitted to touch the cloth or do any harm, of course. And all the microscopes that I had seen and worked with were vertical microscopes where you would place an object and a specimen on the stage. Not being able to do that with the shroud, there was no way that I knew that we could do photomicrography. And we devised some other simple methods that we could do photomicrography without the two-lens system, but nothing to get the high magnification needed to study particles there.

12:18

And about a week before we left for the dry run here in Amston, I ran across the manufacturer of this instrument, which is called a Wild Microscope. And he felt sorry for us and gave us an instrument to disassemble and to reassemble in a horizontal mode. And that's the instrument that we use to make these wonderful photographs.

12:44

Next slide, please.

12:45

Sam Pellicori will be talking about those and showing some of them tomorrow.

12:49

We also made pictures with transmitted light where the panels were removed and the light was beamed through. And this provided a different kind of data. It showed how the bloodstains stood out from the body image differed so that the surface qualities could be studied. We made photographs of that. If you can make the next change, please.

13:15

We could see styrations in the weave, a difference in the weave that gave us some clues to how the cloth itself was made, and these are horizontal and vertical styrations, as well as the various stain reflectivity. Slide, please.

13:37

Now, I guess we could call these artistic pictures. We made these with National Geographic equipment, able to photograph the shroud with the 8x10 cameras, large format cameras, and these are the ones that were printed in the National Geographic slide books.

13:57

The film was processed at the Jet Propulsion Laboratory with their equipment. We didn't want to risk doing it

14:06

with small film processors. There was seven rolls of 75-foot, 70-millimeter film exposed, and it all had to be done very carefully and in the same manner, so we went to the laboratories there that was processing the Voyager films and processed all the film. And I could tell you some of the problems, but I'm not going to bore you with that, so I'll go to the next slide.

14:32

These are some examples. of the most boring of the pictures, I'm saving the best ones for last, that this shows the differences of the image, the appearance of the image through the various colors. And what we discovered, but knew really before we did this, that low frequencies increase the contrast. The shorter the frequency,

14:56

higher the contrast, and as we approached the same color as the stain, as you got into the reds, the contrast started to deteriorate and the image would not separate as well. Slide. You can run through these very fast because they're, it would be ventral and dorsal images. This is with the blue. The blue, the red-green-blue was the highest contrast and showed the greatest differences. The UV, of course, would show even more so.

15:26

and the red the less contrast from body image, but of course the red would penetrate the bloodstains better and into the red areas and we could see details there. Keep going.

15:43

These were the UV reflective pictures.

15:49

This is John Lohr at the image processing lab at Jet Propulsion, and he's digitized some of the pictures, as Don Lynn had said today, and I have some examples of those digitized photographs.

16:06

Try to focus that, please.

16:10

Now, these are very difficult to tell these from a normal silver photograph.

16:16

There has been no routines played on them, but it shows the the recorded imagery.

16:22

This now can be sent to various labs and several different routines can be played. You can go through these too.

16:38

Okay, this is where I'd like to stop and this shows a mechanical enhancement that

16:46

increases the detail, shows the detail above the background level. It coincides with the dimensionality that John was talking about today, that you can almost see that in a two-dimensional form, that three-dimension, the cylindrical lighting on the body. All of the photographs, I've been trained by eye to see that by themselves.

17:12

And I have these photographs on display at the exhibit, and I certainly invite everyone here to come by and look at them, and I'd like to talk about them with you. So thank you very much.

17:36

Thank you, Kern.

17:38

We'd like to continue at this point with a discussion with photomicrography. Sam, are you going first or is Mark Evans going first?

17:49

No. Well, then Agent X is back on the platform.

17:56

Let's just make the house very dim.

18:03

Difficult to see these. Could I have all the lights down?

18:11

You're going to have to skip until we get to the right slides. Keep going.

18:23

Yeah. Okay, go back three now.

18:28

Yeah, that's where we're going to start.

18:30

Okay, Mark Evans, who is not here, is actually responsible for the photomicroscopy. Vern already showed you the instrument.

18:41

I would like to turn this light off. The problem is the photomicroscopy images are quite faint and

19:10

I'm going to break this light in order to maximally appreciate it. Okay.

19:17

Focus, please.

19:19

These are photo documentation exposures made by Barry to keep track of where we were taking exposures. You see the tip of the nose is one area that's being studied. The blood stain there and off-image area. Next.

19:40

There'll be a photo of this very dense blood stain at the small of the back and some other areas. Next.

19:52

And on the blood on the foot. Okay, let's go to the next one.

20:02

Okay, go on. Now this is the blood at the small of the back.

20:10

I'm sorry, at the lance wound. What you can see are clumps of reddish material.

20:23

And you also see that the shroud itself is a very tight weave.

20:30

The reddish material is caught in the fibroids. It is caught in the the bends and turns of the weave. Next. This is another bloodstain area.

20:59

You can see that the tops or the crowns of the threads have very little material. Apparently this material was braided off

21:08

during the repeated foldings and during the ages.

21:13

Focus again. A lot of reddish material caught in the fibrils.

21:26

This area is in the small of the back. Next. at lesser magnification this is approximately 2x on the original slide also in the small of the back notice the rather reddish color we've been showing so

far and also the blotchiness there's much a much denser concentration there than here next On the dorsal foot area, this is blood again.

22:17

I'm gonna let you study these for a few seconds. Okay, next.

22:39

You can see the weave very clearly. Also notice it is quite a tight weave. The threads are somewhat flattened as opposed to modern rims which would have the threads more for the circular cross section. Next.

23:13

We had some difficulty with the photomicroscopy because although Vern was very pleased to have a parquet floor, turns out it was a very flexible floor, so whenever anybody moved in the room, the image in the microscope danced, and we had to tell everybody to freeze while we were taking an exposure.

23:33

The exposures were made with xenon lamps to provide a white light, and as you see, color

23:43

slide film was used.

23:45

And the film was processed at the Brooks Institute in Santa Barbara. Many copies were made. The originals are being retained by Mark Evans.

23:56

And an article was published with this information, with photos, in Archaeology Magazine, the January-February 1981 issue. It has the full-color photos that I'm showing you now. i think all of us would admit to wanting more data we've we've done i think a good job but it's always the case in an investigation that you just don't have enough data so if we went back i certainly would want more photo micrographs of different areas this is the first body image this is the tip of the nose you can see quite a different character

24:44

There is a brownish or dark yellowish plus also some red specks and even some darker specks in this area. This is one of the densest image areas on the body.

25:04

This is at 64x magnification on the original slide. That is as high as we could go.

25:14

Next.

25:17

This is another image area. It is the right eye. Focus please.

25:27

You can see how under dense, how very faint the image coloration is.

25:33

And in fact the image coloration

25:36

resides only in the upper fibrils, the upper three or four fibrils, approximately five thousandths of an inch in total depth. It does not go around the bends in almost every case. It is only on the topmost fibrils.

25:56

Also, you'll begin to see more clearly that it occurs in clumps of colored yellow fibrils. There are areas adjacent to these colored areas that are not colored for example here's a colored area and there's not there'll be better examples to be seen this is what the body image looks like there are no essentially no particulate materials that can be seen okay next yep

26:35

I should say that the threads are composed of microfibrils, which are about 10 to 15 micrometers in diameter. That's about a half a thousandth of an inch in diameter. And a bunch of these go up to make a thread.

26:53

Ah, looks like a major problem. They've taken the whole cassette out and they're turning it upside down. Okay.

27:05

olive oil on the slide that should help that's when you scorch them that they deform get stuck in there so that's a very important characteristic we are seeing on the body image namely that it is only in the upper fibrils it is an under dense coloration or discoloration essentially no particulates are caught in the fibrils and the discoloration does not go around the bends. This area is what I call the dirty heel area. Indeed in this case you have some particulates caught in the fibrils. These may be either dirt or indeed blood particles. This is a very dense image.

28:03

Under very high magnification such as this, on a flexible object, it's difficult to have everything in focus at once. So you're just sort of going to focus on the areas that are in the focal plane of the microscope. That explains why some of the threads are not sharp.

28:37

Okay, next.

28:44

This is also a foot area and illustrates concentration of coloration adjacent to essentially uncolored. So you have a striped effect in the body image.

29:06

Next. I think this is another eye image.

29:16

This is the right eye again. Focus. You see the banding or the striped effect.

29:39

So we have a very tenuous image.

29:43

One very unlike what you would expect if somebody had used a paintbrush to apply a pigment. Next.

29:55

Okay, we also took photographs of water stains for comparison.

30:01

And in contrast to the body image, the water stain coloration focused

30:10

does penetrate. It goes around the bends.

30:14

And in fact, we were able to look at the backside of the cloth and verify that both the blood stains and the water stains do penetrate to the backside. The body image does not. The body image, as I mentioned, is only essentially five thousandths of an inch deep.

30:31

The water stain is quite unlike the body stain. It is also browner. Next.

30:43

this is another well this is the water stain showing that the water came from your left to right and as the water evaporated just simply dropped the particulates it was carrying so you have an increase in density here the water stains have density to x-rays as Bill Modern showed us earlier and this is the cloth with no stain Doctors Adler and Heller will tell us what some of the material...

00:02

into the crevices around the bends, a darker brownish coloration. Try to focus that a little bit.

00:33

Okay, next.

00:41

The more slides you have, the more probable it is that this is going to happen to you.

00:47

Some of the other areas that we photographed were scorch areas because we wanted to compare body image with that. One of the suggestions made at the very planning stages of the experimentation was

01:02

was the body image a scorch? So naturally we had to take some data on scorches for comparison. The scorches run in all densities from very faint, resembling the density of the body image as the Gilberts demonstrated, to carbonized linen, a very black material.

01:34

And after we show the scorched areas, we'll be looking at areas of the linen which have no stain, which are control or background areas. This is a scorched area, very brownish.

01:56

And let's go to the next one.

01:59

Another scorched area. There's no limitation to

02:04

scorch. It goes around the corners.

02:12

Next.

02:15

And the very, very extremes.

02:17

I think Mark was the first to point out that heat traveled in a heat pipe fashion along the thread. That's why you had this happening. Heat was traveling from the burned area along the thread

and succeeded in scorching until the temperature got below the scorching temperature of the linen.

02:42

Okay, next.

02:46

Another scorched area, lighter scorch. Next.

02:56

This is an area that has no discernible stain. It's far from

03:01

It is far from image and also far from water and bloodstains. So that's the background area of the shroud, is the background. You find particles of green and yellow, which are some of the wrapping cloths that have been used through the ages on the shroud. and you'll find also areas that are more tangled or more disturbed than other areas let's probably do the handling next and a close-up of an unstained or a background area which has no image features or blood or water or scorch

03:56

of course linen is cellulose and modern linen looks the same way in terms of looking at a fiber it's translucent the threads the weave and the threads may indeed be different between modern linen and the shroud linen but essentially the composition we're talking about is almost 95 percent cellulose that makes up the linen i think that's my last

04:28

Okay. Thank you. That concludes this afternoon's presentations, but we're actually about 15 minutes early. Tom, do you want to make any announcements about tomorrow or

04:59

What time we start tomorrow? 9 o'clock? 845.

05:05

Otherwise, Tom says, have a good day. Thank you.

00:04

I mean in the next slide we have okay next slide we have some typical data now the if anybody out there is in the x-ray fluorescence biz he'll probably say man those are the worst spectra I've ever seen but the work was done under rather severe constraints

00:32

the most serious of which was the time constraint. And the counting time was limited to 30 minutes, about 2,000 seconds, 33 minutes.

00:41

And there isn't much of anything there is the problem. So you have a very low signal with the normal amount of noise and therefore you have a fairly low signal to noise ratio, but it's still not so bad that you can't drag anything out. The top spectrum is

00:59

a typical spectrum from a non-blood area, and they all looked almost the same, although they weren't quite. The bottom one is a spectrum from the side-wound area, and it's typical of the blood, and you'll say, hey, there's a big difference here, and he's gonna tell me that's another artifact, but that turns out to be the iron peak. The peak at 6.4 kilovolts is characteristic of iron, and it was at this point, that it was realized that there is something really different between the image in the background and it looks like iron.

01:42

The other peaks in here, why don't we have the next slide because what I want to do is explain a little bit about what these different peaks mean. This is an average, it's a composite spectrum. if you if you take a bunch of data and average a bunch of data that look nominally the same you know or are supposed to be the same average them you can uh you can increase the signal the noise ratio you can smooth things out and see uh features a little bit better and that's what we've done here just to illustrate what these different peaks are this is a composite average of the scan of the face we have here is one one is just a is just a low energy background

02:27

background peak and It is the same in this spectrum and I forgot to tell you what the bottom one is because that's very important That is a spectrum that was taken from Watman number 42 filter paper that has nothing in it So that any of the artifacts that arise from from the x-ray tube impurities in the secondary target Whatever

02:54

should show up on this and not on this. The bottom line is that if we identify all of these peaks, if we identify which peaks here are artifacts from this, then we know which peaks are real and represent the actual elements on the shroud.

03:15

Number two,

03:16

i think is let's see i can't see number two is is uh is a calcium peak and it's not down here in this uh this control spectrum number three is an iron number four uh it turns out see you can see them here here's those line up it turns out that uh number four is some uh multiply reflected uh fluorescent radiation from the from the tube target uh number five i believe uh our lead peaks you know we had this all surrounded by lead there are a lot of x-rays scattering around here so there was some uh contribution to the spectrum from the lead from the left target and number

04:14

whoops okay number seven uh is also a real peak but because it's not seen here so the real peaks that we have left are two three and seven calcium iron and strontium uh if i could

04:46

Could I have the next slide, please?

04:49

Okay. We'll get to that in just a minute.

04:54

You're saying, so where did calcium and strontium and iron come from? And at the time you wrote the paper two years ago, it looked at, we suspected that probably the calcium and the strontium just came from dust deposits in the air because the shroud has been in Turin, Italy for, for hundreds of years up in a marble producing region and there's a lot of calcium carbonate floating around and I had suspected that where you see calcium you will see strontium and as a general rule I thought that that was true although in the last few days we're beginning to rethink that position. Since then there has been more work on with the tape studies that you'll be listening to next was found that there really isn't all that much that much dust nothing that could amount for account for the amount of calcium for something like 200 micrograms of calcium per square centimeter and that that accounts for about one weight percent of the of the cloth itself it's really a terribly large amount it was later suggested in the absence of of the evidence for

06:09

You believe that.

06:30

Since there was no dust on the tape, someone came up with another hypothesis, and that someone will be speaking next, that this calcium and strontium and perhaps also the iron, which is also fairly uniform in the non-bloodstains, actually became attached to the cellulose molecule through an ion exchange

06:56

process while the linen was being read. That's a part of the manufacturing process of linen back in the olden days.

07:07

And there's also further evidence. I think I'll have a few words more to say about that in a few minutes. The...

07:21

in the blood areas you noted if you remember from the from the earlier slide we saw a significant difference in the iron concentration I mean there's there's a real difference you can you can really see it and if you do some sort of quantitative analysis you can calculate that this difference represents about 30 to 40 micrograms per square centimeter above measured or inferred backgrounds in those regions and you say big deal so what

07:50

It doesn't imply anything by itself, but we measured whole blood iron. We found there were about 0.5 micrograms per cubic millimeter and that about 25 cubic millimeters saturated at one square centimeter area of Watman 42. And if you do your arithmetic right, you can estimate from those measurements just how much iron you might expect from a blood stain

08:19

from a blood stain on cloth. And it turns out that the difference in the iron concentration that we see in the blood areas is roughly what you might expect if the shroud areas were indeed blood. So you say, hey, great. That's neat.

08:39

But it doesn't prove anything. Because if you remember from right in the beginning of the talk,

08:45

we said that you only see atoms, and what's important for blood is how the atoms are attached. This technique couldn't tell the difference between blood and an iron paint, for instance, but it's still very strong corroborating evidence, and the first evidence that we had, I might add, that the stains were blood. There's one more thing I'd like to say, and that is that, no, actually there were two more things I wanted to say.

09:14

First of all, in the blood areas, if you do x-ray fluorescence on blood, you'll also see potassium. And there were no potassium peaks seen in the spectra. But there were also quite a lot of difficulties involved. The potassium peak is about an order of magnitude, about 1 tenth of the iron peak. And there was an awful lot of noise down there. And there is also the added complication that the potassium compounds in blood are soluble.

09:44

And there are medical people felt that there was really no good reason for potassium to be there. And if it had been there, we probably would have been able to see it anyway. So the absence of potassium does not disprove that blood is there. The last thing I want to talk about was this slide.

10:07

I was actually supposed to point to this about a minute ago because this is a plot of iron concentration in micrograms per square centimeter going up this axis right here. And this is distance in centimeter along the scan line. Now, you remember along the foot scan that first slide I showed you where we started on the...

10:31

on the bloody spot and just kind of marched off into the background region. Well, this is right on the blood stain, right here. And here we're marching off into the background region. These squares are the data for the foot scan iron concentrations. And on the next slide after that, I pointed out that face scan where you started at the nose and marched across the face

11:00

wound up on the little blood trickle over on the side.

11:04

Well, you'll notice here that the iron concentrations on the nose and also on the blood stain on the side are slightly above the measured quantities in between. Now, we've since learned that the blood is

11:27

indeed blood, and so a slightly elevated iron concentration here is reasonable.

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Over here on the nose, it turns out that if you look at the tip of the nose very carefully, there's some particulate matter there, so that the very tip of the nose isn't all image, there's some other crud there. And it just warns us that

11:52

that a simple explanation for the presence of iron or any other element may not be sufficient.

11:59

Some of this iron, you know, may just be particulate material in the cloth and whatnot. And that certainly is a contributing factor here at the tip of the nose. But right now I think we have the x-ray fluorescence results nailed down pretty well.

12:17

And we'd like to do it again for longer counting periods because uh from this study we've uh we've learned the right questions to ask so uh thank you for your attention thank you daryl get some lights please can we have the house lights a little bit please the next speaker on the question of blood on the shroud would be john heller new england institute richfield so

13:19

This is going to be a joint presentation by myself and Dr. Alan Adler.

13:25

We've changed our mind three times who's going to present what, the last change being about five minutes before we arrived here. So basically it was decided that I would stand here and wave my arms around a lot and that he would show you slides and pictures and some spectra. I kind of have the feeling that you've been spectered to death a little bit by seeing all these spectra, but this is one of the ways that we work and get our answers. It was about three years ago, a little more, and I was a new boy on the team, and I sat down and had a talk with Dr. Ray Rogers.

14:05

who was telling me what he thought from the evidence then available, photographic and otherwise, what the shroud might probably be and might not be.

14:19

And I wish I had a record of that conversation because he was prescient.

14:26

He predicted almost everything that we wound up finding. Might as well have stayed home for a certain amount of the degree because he was so on target with so much of his thinking because he is a brilliant and insightful man and derived a huge amount from very little evidence that had gone before. The initial problem that was we were going to have to solve was a little one, we thought. It was, is the blood blood?

15:03

And as you notice on these pictures of the shroud that you've seen, the shroud itself looks like a photographic negative, light and dark are reversed, left and right are reversed. But the blood isn't. So...

15:18

Is it blood, or is it red paint, or what indeed is it? And we rather fancied, and I found out later that I wound up being called a blood specialist, which is the last thing in the world that I am.

15:32

But we have some methods for measuring very minute amounts of things, and blood is one of them. And we figured if there was any blood on there, why, we could probably get it pretty solidly.

15:47

There is a structure in nature which is an organic chemical structure called a porphyrin. And in the middle of these porphyrins, there are single atoms of metal.

16:01

In chlorophyll, it's magnesium. In blood, it's iron. There's one atom in the middle, and it's surrounded by the rest of the porphyrin molecule.

16:12

And Ray Rogers was interested in porphyrins, and I said, Ray, if there's a heme porphyrin, which is the one that's a blood there, don't worry, we'll nail it.

16:23

And I was to swallow my words with great indigestion subsequently, because when I received the first slide back from Turin, I saw some stuff which I thought was blood, and I didn't know how to nail it.

16:41

What Ray Rogers had done over there was to take sticky tape samples that were specially made up of tape and adhesive and a nifty gadget which put so many grams of pressure against the shroud so that when the tape was pulled off there wouldn't be any damage done to it.

17:03

And these tape samples were the specimens that were brought back. And if you want to know what it looks like, Take a piece of scotch tape, put it on your shirt or dress, push lightly, pull it off, and hold it sideways up to a light pole. You'll see a little fuzz on there. Well, that's what we had to work with, fuzz.

17:23

It had gone through other hands before we'd gotten it, and it was stuck sticky side down to a glass slide.

17:33

And you have to realize that that shroud is old.

17:38

Very old. How old, we don't know. But it has the debris of centuries on it.

17:45

In addition to little microfibrils, and I'll keep calling them microfibrils because that's all you get with a piece of sticky tape.

17:54

These are the tiny microfibrils of linen which, twisted together in many, many of them, make, finally make up a thread.

18:03

On this, there was all kinds of debris. There were animal hairs. There was wool. There was silk. There was cotton. There was green polyester. We even found some pink elastic nylon, like in pantyhose. How that ever got on, I'll never know. We found spattered wax. We found fly ash. We found all kinds of insect parts and so on.

18:31

And you have to work through all that nonsense and try to figure out what's down there. Well, the amount of blood that we saw on the initial slide, which was just a tiny portion of a few microfibrils, we figured out, we didn't know how thick the layer was of blood on the microfibril. We didn't know whether it was blood, but it looked like old blood. And we'd never seen 630-year-old blood before or 2,000-year-old blood before through a microscope.

19:00

But we figured that that is what it ought to look like. But we figured also that, given certain assumptions, that we had about 500 picograms, more or less. Now, a picogram is a millionth of a millionth of a gram.

19:18

No, it isn't. Yeah, it's a millionth of a millionth of a gram. And that was out of our league or anybody else's league.

19:27

100 nanograms, which is the thousandth of a million, that's no problem. But as you get down to less and less, you begin to have problems.

19:37

And you finally get down to the point where there is no instrument which can measure it. And we were doing a chemical technique which was taking the iron atom out of the porphyrin ring, hitting it with long ultraviolet, which you've heard about before,

19:55

and causing it to fluoresce red.

19:58

There was no instrument in existence, nor is there today, that can measure the minute amount of red fluorescence that would have occurred. However, there is one instrument which is a lot more sensitive than anything that's made by man, and it's called the human retina. If you sit in a pitch dark room and you let your eyes dark adapt,

20:21

for about 30 minutes, you can see an incredibly few number of quanta of green light. Green because that's where the eye is more sensitive. I had no idea of how many red quanta you could see.

20:36

And we decided we'd better start making up some controls.

20:44

And I have a very unusual wife. She does all kinds of crafts, but she has a very unusual attic. And whenever you have something which is totally bizarre that somebody wants, you ask Maria, would you happen to have? And she gets a kind of unfocused look in her eyes and says, I'll look. And she always comes down with it. So I asked her something really bizarre. I said, do you have any... hand-spun, hand-woven, unbleached linen that's a few centuries old that I could have.

21:19

And her eyes unfocused, she said, oh, look.

21:24

And she came down five minutes later and said, here, it's Spanish, it's 300 years old. So every member of the team, I think, has wound up with a piece of Maria's linen and using it for control.

21:36

So I went and I bled on it and we studied this blood and we got down to measurements smaller and smaller and finally got down to a level where we knew we couldn't go and yet it was nowhere near the amount that we were seeing on this slide. So we decided, well, we're going to have to give up chemistry here, we're going to have to move to physics. Now you've heard quite a few people talking about taking a spectrum.

22:05

What they mean, they have already explained to you, and I'll be darned if I'm going to push you through another spectrum analysis.

22:12

In any event, there is one band in the spectrum. It's called the Sorey band, and it's unique to porphyrins. I won't try to tell you why at all. But on a spectrum, it looks like Mount Everest.

22:27

And we figured that maybe we could get a spectrum, if we could find a microspectral photometer.

22:34

Now, a microspectrophotometer is just like any other spectrophotometer, except it's hooked up to a microscope, and it permits you to go down to one micron, which is down around a millionth of a meter. You can't see much below one micron in an optical microscope.

22:54

So you can make a very small, you can focus a very small hole, a very small beam of light on a very particular particle,

23:04

And if you have the right instrumentation, you're going to get a spectrum.

23:07

Unfortunately, in this case, this piece of tape, which was made of mylar and stickum, had been put face down on the slide. So the beam of light had to go through the slide, the stickum, whatever the debris of ages had fallen on there, the red stuff, whatever it was, the fiber, more stickum, the mylar tape on top.

23:33

That's going to give you such garbage that you're not going to see much fine structure However, you should see Mount Everest Mount Everest unfortunately was way down in toward the ultraviolet and

23:47

and it was dubious whether or not you would see Mount Everest peak because if you run out of light down there because ultraviolet can't go through all that mess that I described you start to climb up a peak you say hey great Mount Everest and then if you can't really get enough light through Mount Everest just keeps going and you're you know you don't know whether you climb something you just run out of light So unless you can go up like this, plateau, and come down the other side, you won't know whether or not you have the soiree van. Well, hallelujah, we found the soiree van, so we knew we had blood.

24:25

And that's really what we had been kind of supposed to do. But some problems arose because there were others which had suggested that the Shroud was a painting and had suggested that there were reasons for this. And among the reasons, it was suggested that the painting was due to an iron oxide earth pigment, like red ochre or Venetian red, which has been used by man since Paleolithic days, in a gelatin binder, and that the image was made by a paint of gelatin plus red iron oxide.

25:09

We didn't think that this made an awful lot of sense because of the X-ray fluorescence data that you've just seen, which did not show an increased concentration of iron in the image, and from a whole variety of other spectral work that the other investigators did. So the problem was, well, was there any possibility at all that this might have been a pain?

25:35

And so we began to take a look at that and then we figured we ought to worry about the calcium and the strontium and the iron that Larry Schwalbe was just talking about. At that point we didn't know very much about linen and at this point we know more about linen than we ever wanted to know.

25:54

But what we found out was that up to the 19th century, and still today if some people make it in the old manner, they take the flax and they put it in a natural body of water for weeks.

26:06

And a good part of the plant falls off, and you wind up with the flax, which you will then spin into thread. However, while it resides in the water, it acts as an ion exchange resin, like what the Culligan man does in your basement.

26:24

And it selectively takes up calcium, iron, and strontium. And that's how the iron got in the shroud, and the calcium, and the strontium. So that made us feel better. We at least had a reasonable reason for explaining why all this was there. An increased amount of iron in the blood area certainly jived with the fact that we found blood there.

26:46

There wasn't an increased amount of iron as seen by the X-ray fluorescence people in the image. And indeed, when we went down, we looked very carefully at the image of microscopy. We couldn't find any iron oxide there. And we couldn't find any protein there. And we used the most sensitive protein detectors that exist.

27:08

many a thousand to ten thousand times more sensitive than those that have been used before to try to prove that this was a pain and there was no protein. Then we use some enzymes which are a mixture of them which specifically eat up protein like gelatin and it did not change the yellow of the image in the shroud and then we used acids and bases and when we used all kinds of solvents and we went through the spectrum of every conceivable paint pigment dye or stain that could have been on the body and there was no paint pigment dye or stain so the image had to be something else

27:55

The image actually is due to a change in the cellulose itself. I'll let Dr. Adler speak more about the kind of the change and why it gives us such fits when we try to put all the physics and the chemistry together. We look for every other conceivable kind of element and we found only two others which are not of great interest but

28:22

we did, we found tiny little black spots. All this work, incidentally, all the chemistry was done under the microscope, which is a giant pain and takes a terribly long time. So it took us a long time to do all these experiments and get the paper written. Not because it was so hard, but because it was just such a pain and such a painstaking kind of an experiment to do.

28:47

We found, around the charred marks in particular, tiny little black spots which turned out to be silver. And in terms of the fact that there was molten silver that fell in during the 1532 fire, that's not surprising. And then on one slide,

29:03

we found a particle which looked optically like cinnabar, which is an ore containing mercury sulfide, which when ground up is the painter's inorganic vermilion. And we found this one particle, which had been broken off and dragged across one slide.

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There is a doctrine in science called necessary and sufficient.

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And you can bring it to bear here. You say, well, if you want to show that this is a painting, you have to show that they're pigments. That's necessary. But it's not sufficient. You have to show that they are there in adequate amounts in order to prove that that particular pigment made the image. But we found later all kinds of blood in the blood areas and blood breakdown products and albumin.

29:58

But we found only one piece of mercury sulfide, and we consider that an accidental. This shroud was painted

30:09

in person by over 60 artists, among whom were Rubens and Van Dyck, and we think a few flecks of artist's paint got on the shroud. It is not enough to explain the red of the blood color, and the blood is adequate in amount to explain the red.

30:32

There's another point about the red iron oxide not being and red iron earth pigment because virtually all red iron earth pigments have contaminants of manganese nickel and cobalt and There was none in the iron on the shroud The iron and the shroud are two kinds in one

30:58

picked up by the renting process of making women, and that is pure iron. And the other is biological from hemoglobin.

00:02

I'll finish up with the details of how and why. Thank you. Thank you, John. The next speaker is Dr. Alan Adler of Western Connecticut College in Danbury. Thank you. Do people hear me without the microphone? Anybody back here? Can you hear me now?

00:54

All right, the first thing I ought to tell you is how I got into this. I was minding my business, my office one day. I was not a part of the original team. When this character called and said, I'd like a little help identifying blood on a piece of cloth.

01:10

Now the last time I agreed to do that with him, I found I was involved in a murder case. So I took a little time before I answered.

01:21

And he said, if we take this along, it should be real easy. You're a quirk for an expert. You can do this thing quick. So I figured, all right, what is it? He says, the Shroud of Turin. I said, what's the Shroud of Turin? How's a nice little Jewish boy supposed to know what the Shroud of Turin is?

01:40

So I took one afternoon and went down. I figured I'd take an afternoon to do this. It's a technique I've worked out quite a while ago. It's very simple to do. We use it almost every day in blood testing on iron porpoise. And I walked and I said, where's the sample? He says, it's under there under the microscope. And I see this piece of glass slide that he'd gotten from Ray Rogers with seven allegedly blood-stained fibers, one piece of this red-brown material.

02:06

And I said, you expect us to test this for blood? You're out of your mind.

02:10

Well, as he said, we took six months to finally work out the controls and things. So in fact, we could perform that test and do the other tests we wanted.

02:18

Then I made a further mistake of letting him convince me to go to a conference in Colorado at the Air Force Academy about two Easter's ago. I had to go out there for other reasons with respect to the research I was really supposed to be doing.

02:33

And he said, you know, we'll pay for your way. You know, how can you lose? Well, that's always a good invitation for someone who teaches for a living. They don't pay us any more now than they used to in the past.

02:44

And I made a mistake coming into this conference, walking in, and somebody was arguing about how to test for protein. I opened my mouth.

02:52

And the next thing I knew, two guys in Air Force Blue, one of them was here, Bill Erkeline, sort of picked me up, moved me down to a laboratory. Next thing I know, I spent four days testing things. I had the flu. Adam Otterbein kept bringing me hot tea, medicines that he would send over, offering me extreme unction if I passed away.

03:14

And next thing I knew, I was in the chemical testing business on this. Now, I think that it's important to understand a few things I have not really clearly expressed so far that people have asked me about. I think people should understand right from the very outset

03:33

just exactly what this team is doing. There is no possible way science can tell us who is on that piece of cloth. That is not a scientific question. There is no test for Jesus Christ.

03:48

A single scientific test could tell us this thing's a forgery. If in the middle of the testing I detected thalosinin, which was a pigment which was first discovered by Lindstedt in the 1920s, and it was all over the cloth, we'd certainly know there was something phony. We could prove it's a forgery.

04:06

So the best we can do is to find out what is on there, and then attempt to explain how it got on there. But we cannot tell you who is on there. Now actually, a lot of people are asking us, why haven't we proven this is authentic?

04:20

Well, the opposite is to prove it's a forgery. We have not been able to do that, but we have been able to completely describe the chemistry and a great deal of the physics, and there still is a

problem. I'd like to show you now what we've really been able to do with the chemistry and put together some of the pieces you've seen. Can I have the lights out, please?

04:43

Can I have the lights out?

04:46

All the way out. Completely.

04:50

Thank you.

04:52

Now, this is a typical image you've seen before, the shroud, positive and negative. And the first thing to note that in the negative, which shows a positive image, as John pointed out, the blood and the scorches show up. Well, they don't always wander around like that. But they show up quite differently from the image. Now, part of this is perceptual. But it should be noted that, in fact, what we think of as image shows up with the opposite color tones and does not behave the way you would think an ordinary photograph should show an image.

05:27

On the other hand, the blood spots and the scorch marks do show up the way you would have expected if you took an ordinary photograph. And this has immediately suggested that a different process was employed in putting them on the cloth from the image and, in fact, a different sort of chemistry.

05:44

maybe not in its exact structure, but certainly in its details. So this is the first evidence that's indicative to us that there are things that have to be explained. What we really want to do is to explain the chemistry of this image to establish whether or not the blood is blood, to talk about the comparisons of the chemistry we see on the cloth itself,

06:04

on the body image only parts of the cloth, those parts that are adjacent to water stain areas, the water stain margins you see also show up quite differently. And in respect to the chemistry of the scorches and anything else we can find, plus any particles that we can find on there that are

there in sufficient concentrations to be evident to the eye as something that's part of the image that's actually seen by the eye. All right, may I have the next slide, please?

06:35

The spectroscopy was done in place, but the chemical samples that were taken for analysis were taken by what's known as the sticky tape sampling technique. This shows you the captain of our American chemistry team, Ray Rogers, Looking on while Max Frye, one of the other people who was engaged in the investigation, is taking an ordinary scotch tape sample. You notice they're using white glove technique and applying it. How many of you own dogs and cats? You all know just before you go out somewhere in your best dark suit, the cat jumps up and puts white fur all over the floor. You can pull it off with a piece of tape. And of course, you end up, as John said, with fuzz.

07:14

He's taking a sample for his analysis with ordinary sticky tape. Next slide please.

07:20

Ray and Bob Dinniger used a very special color and a special tape that was provided for us by 3M. It's Mylar. It's a polyethylene terephthalate, which comes out as a linear polymer, which I'll show you later gives us some problems, with a proprietary adhesive on it that we identified by low angle internal reflection IR spectroscopy. as in fact a polyethylene polystyrene block of graph polymer we later found we had some traces of oxidants in it which produced problems in some of the testing it was mounted on a special type of mounting tray as john said it didn't want to the hands of the people involved in the chemistry an investigator previous to us applied it to cover glasses we had to work through this next slide please

08:10

There were 35 such samples tanked in approximately five centimeters square each tape sample. We received 22 of these. Six of them were pure blood areas.

08:21

About another three or four were blood associated with water stains. We had several water stain tapes, three pure body image tapes, and then a number of tapes of scorches and various control tapes for patches and for non-image areas.

08:37

Unfortunately, predominantly, most of the slides we obtained were actually blood slides.

08:42

As it turned out later in the test, it would have been nicer if we'd actually have more of the pure body image area slides. However, we did have some that were pure image, not associated with water stain or blood. And this shows you where their locations were on the shroud and what their designations were. Next slide, please.

09:01

One of the things that we first noticed when we examined these microscopically was that we saw traces of red fibrils, which are obviously silk, and blue fibrils that at first we couldn't identify on several of the tapes.

09:14

And in fact, as John said, when we looked, there was debris of ages of all sorts on there. We found insect parts and, as he said, pieces of wool and things that obviously had fallen from the air, ecclesiastical robes. Larry told you the possibility of people worrying about marble dust. There's a lot of strange stuff on there. Furthermore, John Jackson had pointed out that folding of the shroud over a period of years would have displaced particles from mechanical abrasion from one part of the shroud to another. We found that was true after we finally learned to identify what we're identifying. We could find samples of blood materials all over each of the various tapes. So after examining them microscopically in several ways, under the polarizing microscope, top lid, bottom lid transmission, and also in a phase contrast microscope, we made an arbitrary limit. We would require at least 15 of a particular class of specimen to be found on a particular tape sample before we designated as typical of the sample.

10:18

Now, we have no statistical validation of this. This is just simply an operational number we've set, which we found is useful, and the only thing we can say is the type of testing we've done, it seems to have been warranted.

10:30

Next slide, please. On this basis, we're able to divide the types of classes of materials we had to identify into something that you order about, I don't remember how many I've got on the next slide, but about 10 different types of samples. first we saw a number of very pale yellow fibers the predominant places they were found in fact from our control locations when they're looked at under the phase contrast microscope they appeared very smooth surface then we found actually uh more

11:03

yellow fibrils. They're slightly more yellow. They were found in the non-image area of the cloth rather than on the control things like the Holland patches and things. And under the phase

contrast microscope, the surface of these fibrils started to look as if it were etched, slightly corroded.

11:20

then we looked in the body image ones non-blood and the virals are quite distinctly yellow and the surfaces here appear corroded under phase contrast you look at them as somebody taking a smooth pipe and etching it with an acid

11:34

Then from the scorch areas we could find very dark fibrils. They appeared anywhere from a light to a dark brown.

11:42

There are some that you saw the other day were carbonized. We saw carbonized materials but not carbonized fibrils in our samples. And here the surfaces under phase contrast appear very corroded. And this is actually part of the process of the oxidation of the surface.

11:57

Then we found there were red-coated fibrils in the blood areas.

12:02

Here, the coating acknowledge one from very smooth, we had some to look like a piece of red spaghetti over the top of a solid core, to fractured, to particulate appearing. Near them, there were other sorts of fractured materials. The colors varied anywhere from a deep red, through to an orange, down to, as you see down here in some of the scorchers, to quite dark.

12:28

Now, the important thing is that after we removed these particles from the tape and looked in the polarizing microscope, none of these red-coated materials were birefringent or pleochroic. Birefringent means when you look at it across polarizers, it should light up because they're optically active. It changes the plane of the polarized light so that it's not occluded, which would be if you normally had a pair across polarizers. Pleochroic means that the color changes as you rotate the polarizer.

12:58

And I'll show you physically what that looks like in some later slides. Now, we also found in blood-adjacent areas that we could find some fibers that were also coated, except instead of

being this red color, they're a golden yellow or a honey, it's been described by people, but they're definitely coated. Except for the color, they had the same general appearance as those we found in the blood areas.

13:22

In the water stain margins, in the areas where blood would near were scorched, we found that there were birefringent red particulate-coated fibers. Now, these look quite distinctly different from these we found on the blood areas. It varied from a deep red to a dark brown. They were birefringent pleochroic. And furthermore, in the phase contrast study, we could see that some of these particles were actually inside the medulla of the linen fiber. Linen looks like bamboo.

13:53

it has joints and there's a hollow space in the middle and some of these vitals were seen inside that core between intact joints next slide please then we found things that looked like shards like roof tiles that were broken off from ceramic roof tiles these are the blood areas and what they were a replica coatings from the coated fibres that had fractured off. Instead of fracturing off the small parts, they fractured off as tablet-shaped materials. These again were birefringent, or not birefringent, or pleochroic. And in fact, some of these were quite interesting, because near the discorcheries, they were distinctly an olive brown colour, rather than a red or an orangey colour.

14:38

Then we found these orange gloves, which just looked like the fractured material from the more orange, butt-coated areas.

14:44

and had the same properties, not birefringent or pleochroic. And then near the real scorch margins, we could find sort of orange globs, brown globs, which are similar to previous except they're darker in color. And finally, we found some dark particulates near the scorch areas that were irregular and opaque. Now, the first thing we did was take this precious 300-year-old linen John talked about, and we made up a number of controls. We found out if we didn't treat the linen in any way at all, the pins start scorching it. It began to look as if it went under the phase contrast microscope. The surface got more and more corroded, and it had the same properties as going from non-image to image to scorch.

15:25

When we coated it with protein, it resembled the yellow coated ones. When we coated it with protein and iron oxide, it did not look like any of the materials we look like. It had quite a distinctly different appearance.

15:40

We did some other types of things. There was a suggestion that perhaps the linen had at some point been treated with saponaria.

15:48

I also have a wife who puts up with a strange husband, just like John does. On the way to work one morning, I asked her to stop the car right near the tracks at the respirator station, went down the station, picked up some fresh saponaria, threw it in the back of the car, brought it into the lab, amazed all the organic chemists in our department because I started extracting it, and made a saponary extract that we could treat linen with. And we made up some saponary treated samples so we could develop some controls to compare with this possibility.

16:19

Uh, saponaria, the egg-like chrome part of it, is a triterpenoid. It's similar to the structure of steroids. The structure's similar to cholesterol. You know, everybody tells you you're not supposed to eat, but they don't tell you you make almost as much of your body per day as you do eat. Uh,

16:35

But we tried some tests similar to that, and one of those was just treatment with acid. And we found out that treatment with strong oxidizing acid, like sulfuric acid, immediately turned these saponaria-treated materials into bright, dark brown red. So, in fact, we developed a very simple test for it we could then apply. There was one other possibility, and that's where this iron was coming from. As you heard from both Larry and John, we had some suspicions the iron was not added to the cloth by man, but in fact by the natural process by which linen is actually, flax is converted into linen.

17:08

we discovered in hunting around through these textile books that one of the older way people used to make khaki they made what was called a mineral cat was to take cellulose materials like cotton and lemon immerse them in iron salt solutions take that out and soak it and lie that as a base uh precipitate iron hydroxide on the surface of the fireball and in fact it's you'll soon as you'll see in some of the later ones within the core

17:36

And then under dehydrating conditions, you don't need any oxidation at all. You remove water from ferric hydroxide, you end up with iron oxide. And this would give us an iron oxide that could be precipitated within these hollow pores. So we tried this, and in fact, this worked. We found it gave us an appearance very similar to the materials we found on the water stain margins. Okay, next slide, please.

18:01

Now, what do these things look like?

18:03

This is actually what you see on one of these slides in the microscope. You can imagine the horror of a chemist when somebody tells him, this is the stuff you're going to analyze.

18:12

Now, this is not an ordinary light microscope picture. This is under parallel polarized light, parallel polarizers. We've got plane polarized light, where the light, if you can think of it, is coming through, so it only absorbs in one direction.

18:27

And the polarizers are set so that if it's in that same direction, and nothing in the material will change that direction, it'll come through one color. And you'll notice that the fibers show up different colors, and there's particles all over the place. But you'll also notice that the background is not clear. It's a sort of a pinkish-yellow color. And the reason is, is because the tape itself is optically active, as shown by the next slide.

18:55

under cloth polarizers, instead of getting a black field with only the birefringent material showing, it turns a deeper pink.

19:02

So we discovered with one technique we'd use for studying these things was via polarization analysis study, we would not be able to do this on a tape. We would have to remove the materials.

19:14

And as John said, what we had to do was to excise material from the tape. I let the surgeon do that, you know, a chance for him to play doctor.

19:23

He would cut out these pieces. We would then take the tape, tweezers held, hold it over our testing apparatus, our spot plates, wash it off with toluene, and then remove all the stickum that's on there because that would interfere with the testing.

19:38

And that had to be taken away by holding the specimen down with a glass needle under the microscope and absorbing it. with a micropipette or a small piece of pointed filter paper. Then you could begin to test it. And this is a laborious process. It's anywhere from 10 to 20 minutes just to prepare a specimen. Of course, usually what would happen, the chemist would be sitting there laboring away while the doctor's loafering and hollering.

20:01

Finally, you get up and say, will you shut up? And of course, when you talk that loud, you blow the specimen away and you start all over again. The way you correct this is to take the mouth of your surgeon, and then you can proceed with the chemistry.

20:16

You tell them when to cut, otherwise to shut up.

20:19

And we did over 1,000 of these tests, including all the controls. So we really did a lot of chemical testing. Next slide, please.

20:31

Now, this shows you a pair of crossed fibrils as seen by ordinary transmission microscopy.

20:39

While they're embedded in the stick and underneath the cover glass, you can't see much. They stick them itself in the air pockets and it cover up all the detail and you don't really see anything. However, next slide please.

20:54

Under phase contrast, you can see clearly that this hasn't etched in a corroded surface. I must warn you under phase contrast, while you can see detail clearly, it distorts colors. So you cannot tell by the color. How we found by playing a bit, if we look at some of the controls, we can see some color differences.

21:12

And it became apparent to us that things like this, for example, that you see up here, this sort of a blue color, that's really protein. Iron oxide does not show up that way. It shows up a very deep purple under this type of microscopy. So we were able to actually put the fibers into a progression on this degree of corrosion we could see from non-image to image to scorch. Next, please.

21:41

This is to show you the problem that we saw with the birefringent stuff. It turns out here is a fiber under parallel polarizers with red-coated material all over it. Next slide, please.

21:55

And you notice the reason I want it to light out is because the only thing that shows up birefringent here is the cellulose fiber, which is known to be birefringent. You notice the particles do not light up.

22:07

This is absolute proof that, in fact, these particles are not iron oxide.

22:12

Iron oxide is birefringent pleochroic. Furthermore, we did other tests in the index refraction. We found these red particles we could find somewhere above 1.5, some below.

22:24

Below, obviously, is a proteanaceous-type material. Above is iron oxide-type material. When we do this same kind of trick in the water stain margins, they do light up.

22:34

There is iron oxide in water stain margins and in scorched blood incineration areas. There is not in the blood image areas or in the image areas. Next slide please.

22:46

One of the problems that I first had when I looked at these shard-like materials That actually is the shape and the form and the right characteristics for what Perutz and Kendrew reported as, in fact, the crystal form from hemoglobin, the oxidized form of hemoglobin. And your blood hemoglobin is normally there in a reduced form. I thought, great. This stuff's really the crystals. And here's one of these black spot things we found, as John said, is really debris from the silver debris from the fire. Next slide, please.

23:19

Under the polarized light, it's quite clear they're not birefringent. In fact, they were not crystalline material. They are, in fact, just replicate casting material coated on there. Next slide, please.

23:31

Here's one of these orange blobs, again from near the blood-adjacent areas. And see, it sort of looks as if it might be a piece of fractured blood.

23:42

Now, one of the things I think I should speak about a bit is what blood is. I'm afraid there are too many people labor on a delusion. You can go take a bottle of something labeled blood, and it's one compound, and there's a simple test for what it is.

23:55

Blood, as you're well aware, is a mixture.

23:58

It's a mixture of several types of serum proteins. There are formed elements in it, the blood cells. The erythrocytes have actually contained the heme protein. There are white cells. There are platelets. There's all kinds of material in blood. Joe Gambisha showed you yesterday, you just let it sit and it starts to actually sediment. The formed element parts tend to agglomerate. Furthermore, clotted blood, the serum separates. There's a process called senoresis from the protein portion of the blood. There are lysed cells where some of the hemoglobin will mix with the serum. It's not only a mixture of materials, but in fact, as the blood begins to coagulate by different processes, you'll get physically separated materials, as these materials will differentially separate. That means the color will vary all over the place. Furthermore, the heme protein is a very complex material. It contains a porphyrin ring, one of the real big secrets in understanding life, I want you all to know, but we don't have time to talk about that.

25:03

This porphyry material is very unique. It's a very intensely absorbing compound. Unlike most molecular species, it doesn't have one broad band in its absorption of the visible chromophores. It has four in the visible, an immense peak in the ultraviolet, and if it has a metal container, it readily will chelate metals.

25:22

You often see minor peaks in the near-infrared.

25:25

So you actually get a number of spectral indicators. Metals are bound. They will pick up different ligands, go to different oxidation states. Every single one of these will change all seven or eight of these peaks. It's very sensitive.

25:38

That's if the porphyrin ring is intact. Porphyrin rings, in the process of time, either bacterially or by natural enzymes in your body, or by, in fact, environmental treatment. We'll break down the formula. They're called bile pigments. This is the stuff that gives your aunt trouble when she goes for a gallbladder problem sometimes.

25:58

You know, when people have these stained gallstones. It's because they contain bile pigments. Vile pigments are the natural breakdown products of porphyrin rings, and so they also are highly colored.

26:11

One of them tends to be green colored, one tends to be an olive green color, and one tends to be an orange color. So these are again things that we want to look for and can in fact show up in some of these materials. If someone had been beaten, excoriated, and scorched, you'd expect to find some of these blood breakdown products within some of the blood sample. Next slide, please.

26:35

All right, now this is a repeat of one of Sam's slides.

26:38

This is a micro photograph of a blood area. I think you should notice the fact that there's several things here that are distinctly different from the image areas. Here you do see cementation, evidence of capillarity, and you'll notice that the color of this image is not uniform. You see dark red particles, you see clumps, you see things that look like intubated virals, you see things that look more orange.

27:02

Clearly this blood is in fact blood which has gone through some type of physical process where some of the elements have separated. And when you put a tape on this, you should expect to

find a variety of things. Fractured things, orangey things, red things, tubulated things, replicate casts, just the sorts of things that in fact we do see on the tape.

27:23

So one of the first things you should note is that, in fact, the macro photographs, in fact, give you evidence of the sort of things that we should have seen and we're identifying with blood on the microscopic ones. Next slide, please. This is one of these shard things we saw.

27:39

And you can see it really does look like something had been fractured off a cellulose fiber. The fact that it's non-birefringent shows you that it's off the cellulose and it's not crystalline.

27:50

These were some of the things that we did the microspectrophotometry on over at Yale, John was talking about, and were some of the easiest for us to do some of our initial testing on to, in fact, establish the fact that the presence of blood-like materials were present. Next slide, please.

28:09

This shows you what some of the red-coated particulate materials were like. And you can see that, in fact, the stuff that's on the fireballs looks like some of the junks and globs that are off on the side. And there is quite a range of color and variation in shape and size from being something that looks mechanically abraded to smooth. Next slide, please.

28:29

Now, what this is is a comparison of the transmission spectrum of a blood material. This is one of the shards.

28:38

with, in fact, the reflection spectra, which is provided for us by sand from the whole shroud. I should point out, when you have a material like a heme porphyrin, which has very high extinction coefficients, these things are intensely absorbent. In fact, one of the things people don't realize, the color of blood is not due to the iron.

29:01

In fact, when you put an iron in a porphyrin, you actually lower the overall extinction. The dye itself is a very intensely absorbing material, one of the most intensely absorbing materials, in fact, known to man.

29:17

With respect to the contrast in the background, different things will happen. Without going into all the physics, it turns out the reflection spectrum for porphyrin-like materials should reveal to us their structure best in the red portion of the spectrum, red colors.

29:33

while the transmission spectra should give us better contrast and better identification of the peak-like features that we could see here in the blue and the ultraviolet. Let me first talk about what we did with the transmission spectra on a microcrystal with microspectrophotometry. There's Mount Heller that he was talking about, and it is here at somewhere about 420, which is the expected soiree peak for an iron port. This is an absolutely characteristic feature of these materials. No other compound known to man will give you that intense absorption in that region.

30:11

Furthermore, there's a bump in here which at first we didn't believe. It turns out that this bump that's seen here and seen up there at 450 are in fact indicative of

30:22

bile pigments, biligynes in particular, such as bilirubin, one of the breakdown products of blood. We later had a chemical identification of bilirubin in these samples, and it is showing up In fact, the blood spectra are both in reflection, in transmission, and it's part of the reason for the confusion you've seen on some of the identified bloods that you've seen, like in Joe Aceta's stuff with the infrared. He pointed out yesterday there's probably some other material there. There is other material there. There are blood breakdown products there.

00:02

The interesting thing happens physically.

00:04

These two peaks undergo a process known as charge transfer and intensity stealing, and they merge to one peak at 525, which is what you should expect to see in old blood that, in fact, had coagulated. There it is.

00:18

This peak here at 630 that you heard the Gilberts talk about the other day is another very characteristic peak.

00:26

One of the few compounds that shows this double peak like this is what's known as a high spin ironene. It's a very characteristic indicator for ferric perfumes in an ionic link with some type of a material like a chloride. So in fact, both these spectra, the reflection spectra and the transmission spectra, are indicative of heme-containing materials. Absolutely. And one is from the whole cloth, one is from one of these microcrystals.

00:56

This slide has been seen by several other heme protein experts and myself. There's no doubt in any of their minds that, in fact, these aren't fact specters or characteristic of blood-derived materials. In fact, I showed it to a pair of my colleagues a week ago, two weeks ago, down in New York, waiting to see whether they'd pick on me for this. They only pointed out I missed a peak. that one peak that's off there to the back they tell me is characteristic in fact a billy bird one of the ones i missed that i was sure was noise next slide please all right so we've got a lot of tests to confirm the presence of whole blood on the shrimp first one is that indication i showed you just from the difference in a characteristic photographic impression. We find that the reflection spectra carry indicative peaks of the presence of heme proteins. The microspectra transmission also contain characteristics indicative of heme proteins.

01:54

Then we did this trick of generating the porphyrin fluorescence that John talked to you about. After we spent the six months going through our controls, we treated these materials with hydrazine. which will in fact dissolve H-denatured protein, reduce the iron, pride it out with formic acid, which is a strong enough acid to do that, and then we're able to generate the characteristic red fluorescence that we could see by eye. Because we did this on a whole tape and it did not disperse, we could see this by eye.

02:23

The quantum efficiency is very high. The characteristic fluorescence is very characteristic. This is a legally acceptable test for the presence of blood in a court of law. The next test that follows it is also a legally acceptable test for the presence of blood in a court of law.

02:44

If you treat an iron porphyr material with a reducing nitrogenous agent, you get what's called a characteristic hemochromatic color. When we coated these things, just micro-spotted them with hydrazine, we got this characteristic pink color. We also then did the standard clinical test for the measurement of blood. We treated them with alkaline cyanide and were able to get the characteristic cyan methemoglobin color test.

03:14

We were able to detect bile pigments in these blood materials, particularly the larger orange blobs, by treating them with diacetized sulfonylic acid in the standard Ehrlich reaction test developed by Gendrassik and Groff. John Jackson always boggles when I do this, but I teach it to my med techs once a year. We use the standard kit for this, the Billy Rubin 525 kit by American Monitor. And we're able to show that, in fact, not only did we get a positive test for the presence of bilidines, but, in fact, the test had its proper characteristics. The color was discharged by ultraviolet light in 15 minutes.

03:52

We have a very sensitive test for the presence of protein, fluorescimine, which is good to nanograms of protein. There was protein in all these blood areas.

04:03

one of the tests for protein is using bromcresyl green. This is a specific indicator for albumin.

04:09

It's the same one that's in the albumin sticks your doctor uses to tell you whether you have albumin in your urine. We got positive tests for this, which indicated that we not only have protein there, but the type of proteins that are associated with human serum. We then treat it with proteases, enzymes, dissolved proteins. They dissolve these materials completely, leaving no particular residues.

04:31

Finally, the microscopic appearance is comparable to controls, agree to what we've seen with our blood-prepared controls. And then there's the fact that you've heard the forensic judgment of, in fact, people who are medical examiners and physicians, that, in fact, these wound and blood marks appear like blood. They have the right appearance.

04:49

They're rounded on the edges, depressed in the centers, and they look like free-flow blood or clotted blood, whatever they're supposed to be in the appropriate places, with, in fact, cirrus-type additions. So, in fact, we have 12 separate tests of blood as blood, two of which are accepted in a court of law.

05:11

Now, somebody could ask me, is there some other way this could be faked? The answer is yes. I could take a synthetic iron porphyrin, put it in with a protein-like material, and make it today. But the question is, nobody knew any of this chemistry from the 14th century back. The

evidence that this blood is his blood is as good as the evidence that the blood in your veins is blood. The stuff that's on that cloth is blood. B-L-U-D, blood.

05:39

Without any doubt. Next slide, please.

05:44

All right. Now, there were these problems, as John has suggested. Someone suggested this color was from aged yellow protein, and we needed a test to prove the blood was broad.

05:55

There are several tests for establishing the presence of proteins. We try to number them. The standard ones are converted to the amino acids proteins are made from, ninhydrin. We found out that under our conditions, the metals that were present, calcium and iron, would interfere with the test. Amidoblack and Kumasi brilliant blue are standard histological stains, one of which was used by a previous investigator. But we found from controls that these materials would also stain highly oxidized cellulose. One of the tests for a so-called carboxylic acid cellulose is in fact the fact that it accepts what are called basic dyes. Both these are basic dyes, and therefore they're not specific. Under our test conditions, they don't distinguish between oxidized cellulose and protein. Therefore, they're not going to do you any good. They won't tell you whether you're seeing protein or oxidized cellulose.

06:47

Bromthymol blue is nice. It is metachromatic. It changes color. These two don't change color. They just absorb.

06:55

But we found out it wasn't sensitive enough. There's a standard test called a Biorep Lowry test, which is more specific. It tests for peptide linkages directly.

07:05

But it wasn't, again, very sensitive. It was good only to about a tenth of a microgram. Brompresol green wasn't much better than bromthymol blue, but where we had large concentrations of protein, it was indicative for us for albumin.

07:20

Then we discovered fluorescence. Now, this stuff is a gangbuster reagent, specific for primary amino groups.

07:28

It fluoresces a bright green with shortwave UV, so it can't be confused with any other conflicting fluorescent materials that are there. And it's good for nanograms of protein, which we confirmed in our controls. This is the most sensitive protein reagent that's been used in any of the Shroud studies. And finally, we had another very specific test, which is something to see if this material we thought was a protein will dissolve with a protease. Proteases are specific for proteins. If it dissolves and leaves no residue, it's a pure protein.

08:00

Well, we found that when we ran these tests, anywhere we had blood or blood-associated materials, we got evidence for proteins. In the pure body image areas, there is no evidence for protein, nor is there in the water-stained margin areas where we did find real iron oxide.

08:16

So the iron oxide that's there in the water stain margins is not held with a protein binder. There is no aged yellow protein in any of the body image. There is protein in the blood area. This is proof of several things. That there's not a protein binder holding an iron oxide pigment anywhere on the shrapnel.

08:35

that, in fact, again, if the blood is blocked. Now, there are a number of interesting things about the protein things we saw. One of the interesting things that we saw is the thing that you just saw Sam and Vernal move to. We found those halo areas that they're talking about, which are adjacent to blood areas. We could find fibroids that, in fact, were yellow-coated and, in fact, gave a bromocresol green test as well as boresomate.

09:02

So there's protein there. Protein is typical, in fact, of a known serum protein, albumin.

09:09

And it has the physical appearance of a blood clot, of senoresis. So, in fact, this does confirm the forensic judgment that those are, in fact, real wounds.

09:21

It also confirms, again, the fact that, in fact, someone isn't painting it. For the simple reason for someone to paint it, you'd have to paint in the ultraviolet. You don't see in the ultraviolet, and therefore you couldn't see what you were painting.

09:38

So these are quite nice. We've managed to show there is no protein binder, and in fact the blood judgment And the forensic judgments, the wounds are, in fact, real wounds that represent real wound images, are, in fact, confirmed by this chemistry. Next slide, please.

09:57

All right, the question then became, what is, in fact, the image color due to? If it's not aged yellow protein, what could it be made of? Well, it has to be made out of one of the known elements of structures known to man. Otherwise, again, it's beyond scientific testing.

10:14

We went through the standard periodic table and picked out every single metal that could give rise to some sort of yellow, orange, or reddish or brownish color.

10:25

That is a metal pigments, known ones plus unknown ones. And we set up the test for them, ran all the controls, and ran them off on this. Now, it's important to say a very important thing here about these chemical tests for metal ions and for functional groups. One of the things John pointed out is it is necessary to show a pigment is present if you want to say it's a painting, but it's not sufficient.

10:51

You have to show it there and sufficient concentration will account for color. And also what you see has to be in agreement with other people's measurements and not capable of explanation by other means.

11:03

That's a very important point because while some of these tests are not very brisk, we're seeing a color. We worked under concentrated conditions and add reagents that are used as tests for these because they increase the intensity of the color you see by a factor of 10 to the third to 10 to the fourth.

11:21

So if our tests fail, maybe the concentration we can detect is pretty low, but it means something that's very obvious. It means the stuff is not there in sufficient concentration to have been seen by the eye.

11:34

So we've got a built-in quantitative detector. When one of these tests fail, it means this stuff cannot be present as an image-forming material on the surface of a cloth. It may be there, but it doesn't matter where it's there. It's not there in sufficient concentration to give you an image you can see by eye.

11:53

Well, this is nice. because when we went through all this we found that this whole slew of metals we could detect only four we could find iron we could find calcium we did not test for the strontium unfortunately we could find silver and we could find mercury The silver, we only found on those little particles that were near the scorch areas, and there are obviously debris from the known fire when it was known that molten silver droplets fell on the cloth. There's nothing particularly exciting in finding and explaining that.

12:30

The mercury, as John said, we found one piece of it along a clear track. We've since found by electron microprobe, both by us and the Air Force Academy team, that in fact there is mercury along that track, but particles away from that track do not show it. And although the painting of the shroud is a severely historically contested fact, it is an incontestable fact, as John said, the shroud has been painted by innumerable artists.

12:58

So, in fact, there certainly is evidence, historical evidence, that the shroud has been in the presence of artist palettes, where, in fact, pigments could have accumulated in the accidental debris. We found one piece.

13:11

I understand Dr. Rigi has found one piece somewhere else. Dr. McCrone has reported mercury in one other sample. It is not pervasive. It does not show up in the X-ray fluorescence. It does not show up in the journal testing. We conclude it is an accidental.

13:28

All right.

13:29

Now, how about the iron and the calcium?

13:32

Well, when you rag linen, you begin to oxidize the surface. That's why it gets corroded.

13:40

When you oxidize the surface, you produce carboxyl groups. This is a very nice ion exchange agent. That's why we use paper for an ion exchange support in laboratory demonstrations.

13:51

Two of the elements that we're buying quite strongly, common elements found at work, calcium and iron. In fact, we found all the old linens we had as controls showed strong calcium and iron. Professor Ritchie provided us with some Coptic and Pharaonic cloths. They showed calcium and iron. Maria's 300-year-old Spanish linen showed it. Any piece we had showed it.

14:12

But the thing that we found was interesting. We found there were three types of iron actually on the cloth.

14:20

This test up here, 3, 4-phenyl, 2-pyridyl, 5-phenyl, triazine, sulfonic acid, disodium salt, PPTS, is good to nanogram quantities of ferrous iron.

14:32

So, in fact, to do the iron test, you first have to dissolve with your suspected sample, then reduce it, and then run the test. Now, when you do this, you have ways of discriminating about different forms of iron present.

14:44

We found out that in the blood areas, where we have pure blood and no fibrils, we had to digest with a strong oxidant before we could get a positive iron test and this makes sense because the iron that's bound in the heme is very strongly bound and you have to destroy the hemorrhage before you can read it with this test so that's nice it indicates to us that in fact that iron is heme iron when we look at the iron oxide particles we saw in the water stain margins That stuff dissolves with a weak acid. It requires an acid to dissolve iron oxide. It will dissolve with concentrated cold HCl slowly over a period of time, and it then gives us a positive test.

However, the iron that's found pervasively over the whole shroud that Larry talked about will give the test directly with no digestion of pH 4.5.

15:33

This is not iron oxide. It is obviously an iron that's held by some type of covalent linkage. The easiest one to envisage is to the aldehydes and carboxyl groups of the partially oxidized cellulosic structure. And so, in fact, that is a covalently bound iron, a coordinately covalently bound iron, chelated iron. And, in fact, this is about 85% of the iron that's on the shroud, just like it is in all these other linens we've looked at. So the iron oxide that's on the shroud is only a few percent, and it's found mainly in the water-stained margins. How do we explain that? We go back to this packing process.

16:10

It went through a fire. If it went through a fire, you've seen the things migrate at the edge of those water stains. If you had calcium and iron migrating in water on heated cloth, they would carry ferric iron and calcium to the edges where it would deposit. Since you carried the calcium, it would be basic. It would form iron hydroxide, and over a period of time, it would form calcium. just like our candy. And in fact, the proof of the matter is that we find the two within the internal of the fibers. They could only get there by a precipitation process. Otherwise, the guy who painted this would need a tenth micron hair that he could insert these little particles through the intact joints with. This would be a real feat of magic. All right, so we've been able to explain what we see and we can easily account for the metal pigments We we do see and there's no evidence that there's an applied pigment There is no metal ion on here that we cannot account for by natural processes that are indicative of a non-painting process next slide

17:19

We then did the same thing with all possible types of chromochores that have been suggested sometime that could have resided on this cloth that would have produced color.

17:28

Vegetable dyes have known types of groups on them that you can test for. It's been suggested that from the excoriation and the high increase of nitrogenous waste and the perspiration, some of those materials could have been on there and produced color in time, like creatinine and uric acid and urea.

17:48

We tested for everything you could think of that would give a yellow color, the type of characteristic group. Phenols, steroids, riboflavin, indoles, lignin, starch, porphyrins, pyrroles, creatinine, uric acid, urea, amines, nitro groups, aldehydes, carboxylic acid, cellulose, and saponaria.

18:05

We can find porphyrin across the blood areas, but that's all, not in the image areas. And in fact, we only find in the image areas two chemical tests that are positive.

18:18

We can get a chemical test for aldehyde, but a standard shift glucofusion reaction and this carboxylic acid cellulosic test where it accepts basic bonds. The other standard test for carboxylic acid groups put sodium carbonate on there and look at the bubbles.

18:38

I couldn't believe it when I read that. I talked to our organicers. That is the way it's tested for. I said there has to be some other way and found this one in the textile order.

18:47

Now, the interesting thing is we can put the fireballs we see in a series. If we start out with non-image, image, and scorch, we find out that the non-image ones are weak in these two tests, the image ones are stronger, and the scorch ones are the strongest. It's exactly the same progression as we saw in the corrosion of the surfaces.

19:09

How could these things be formed from cellulose? It's very simple. by dehydrated oxidation.

19:19

Now, it turns out there's two ways you can oxidize a cellulose structure. Cellulose is the beta-acetal polymerized form of glucose. It's just made out of one of the elements you have in ordinary sugar, just polymerized into a long polymer.

19:38

If you oxidize this under alkaline conditions or with ionizing radiation, It will give you carboxyl groups only where it oxidizes, no aldehydes. And in fact, if you oxidize linen this way, it stays white.

19:53

On the other hand, if you oxidize it under acidic conditions or pyrolytic conditions, like scorch conditions, then you dehydrate before you oxidize and you get aldehyde groups formed. The chromophore is in fact a conjugated carbonyl group.

20:10

The ultraviolet absorption peak for conjugated carbonyls, of course, depends on the degree of conjugation, but the peaks are characteristically found between 315 and 350 nanometers. You may remember the peaks you saw yesterday in the Gilbert spectrum and the SAM spectrum in the ultraviolet aren't back in the region of 315 to 350.

20:32

In fact, the evidence on the spectroscopy supports the notion that we find in the chemistry that, in fact, the image is due to nothing except dehydratably oxidized cellulose.

20:44

All right, now we wanted to do further tests. Next slide.

20:48

So we gilded the lily.

20:50

There is an archeological chemist by the name of Saltzman who's worked up a solvent series that is known to dissolve every single known dye, synthetic or naturally occurring, from dye textiles that is used by the archeological chemists.

21:06

We tried all of those. The yellow color does not dissolve in any of them. If, in fact, were oxidized cellulose, it shouldn't. It didn't.

21:15

Furthermore, if there are plant pigments on here, all known plant pigments are either redox indicators or acid base indicators.

21:23

Eight normal KOH and concentrated HCL do not change the color. There's no simple dye indicators.

21:32

Weak oxidants and weak reductants do not change it, but strong oxidants and strong reductants do. Hydrazine will bleach it slowly, dye in it very rapidly.

21:43

Neutral peroxide won't touch it, even if it's 30%. Superoxal alkaline peroxide will, in fact, discharge the color. Again, those are typical of the chromophores expected from a carbonyl group conjugated in some way to another carbonyl group.

21:57

One of the interesting things we found, in fact, when you treat the non-image fibrils or the control fibrils with sulfuric acid, about half an hour they turn yellow and are absolutely microscopically and chemically identical with shroud fibers.

22:14

So, in fact, we have got the chemistry of what's on there. We know the chemistry of the image.

22:20

One of the other things I should point out that's interesting, when we put proteases on the protein-coated materials, take the protein off, and then go back and look in phase contracts, they most closely resemble the non-image fibers.

22:36

So, in fact, this is sort of suggested that, in fact, the blood materials went on before the image-forming process, which is one of the conclusions that could have been drawn, in fact, from the sort of stuff that Sam and Werner are saying. So, we've again come to the conclusion that, in fact, this stuff is, in fact, the color of conjugated carbonyl as the chromophore formed by a well-known natural process

23:03

dehydrated oxidation of the cellulose structure of the lumen itself. Next slide.

23:09

Well, this presents us a problem. This is a painting. It's a painting by Maurice Escher. And you see, you start out thinking you know something. You go along and you fall off a waterfall and find out you're back where you started. This is our problem presently with the shrimp.

23:26

Our problem is we know the chemistry of the image. We know the physics of the image.

23:31

We don't know how to put the two simply together. The types of things John Jackson talked about would suggest the image was made by some type of projective radiation process. I've just told you that would give us the wrong chemistry.

23:46

That would give us carboxyl groups only, no alveoli. On the other hand, we've told you that chemistry is suggestive of something like a scorching process.

23:56

We've absolutely proven, I hope to your satisfaction, it could have been painted. Some nut could not have painted this with sulfuric acid. You need a three-foot brush with a 10 micron hair. You'd have to paint things inside the joints, show no capillarity, touch the individual tops of the fireballs. It's just clearly impossible, mechanically, physically, or chemically, to conclude that this is a painting. Absolutely not a painting.

24:22

But the trouble is, if we use the scorching process, You'd have all those problems John talked about in the image formation. You would not get the resolution. You would get severe distortion. You'd get things which we see are not characteristic of the image. So we do not have a simple explanation of how that image was formed. We've actually answered one of the questions we set out to answer. We can tell you what it is, but we can't tell you at this point how it got that way. Now, a little bit later, Sam's going to tell you some ideas he has had on some non-simple mechanisms that, in fact, might give us a way of putting these two pieces together. Next slide.

25:00

So this leaves you with the present status of chemistry, with the mystery of the man on the shroud. We know what, but we do not know how. Thank you.

25:10

Thank you, Al. Can I have the lights, please?

25:21

We have the lights.

25:23

I think we take a 10-minute break now. There are restrooms upstairs in the back. There's a tent across the street that I believe has depression. We'll see you back here in 10 minutes.

25:49

Blood acting, naturally. Blood acting, naturally. Yes.

26:12

is that in order to, when the blood began to coagulate and the rigor mortis is setting into the body, if you had a large, massive wound in the wrist area, and I put a cloth on it, let's assume a linen or whatever, and I took that off, it would tear and I would have a complete smearing of the image. No, it's like somebody pricked the body like a balloon.

26:43

And it wasn't there yet, because you could not have removed it or puffed it off or something. It fits in and becomes that.

27:02

That's why they're so reluctant to ascribe. They're not going to, obviously, but it's supernatural in conjunction with a natural event.

27:23

Oh, uh, well, there are other ones. There are other vampires, and, uh, there was, you know, a court of law against, against Christ, you know, against the circumcision of Christ, and, uh, that we don't know. So, I think that's a fact, but I don't know if Christ is out there. I don't know if he's in the room. I don't think he's in the room. I mean, there are very few instances, if I'm gonna shoot you, that I have a photograph. It's made up of

28:04

Opportunity, motive, circumstances, and all those things are put together to create a change. In fact, he said the last time he was involved in this, it was a murder case. Although he spoke very well, but I lost a lot of his technical stuff. I won't describe his plight right now.

28:25

What do we have next? I want to hear Wilson. I don't know.

28:31

I'm leaving soon. Well, you're not going to hear. Well, Wilson is speaking before. Yeah. When are you going to write up your tomorrow?

28:50

working on it last night. I put them out to a bar. Yeah. Yeah, well, I met a lot of folks at a bar about 2 o'clock in the morning. I don't get a conceded this morning. Yeah. Oh, is he going to be on the ground?

29:35

No, I haven't, but they should be waiting right on the desk, though. Yeah, I think they should.

29:44

The man on the shroud in yellow seconds, describing the light of the mission, x-ray ranges. He has a tendency to reboot himself. Well, that's all we can do about it. Oh, I know. I'm not performing. All you can do is... But it's the first time. really taken so-called rough, put it through precise scientific examination.

00:10

He was very nice. He said that the conclusions in the book

00:24

where even their own conclusions were at the end, said that in the end, all this may prove to be unfortunate. But they're saying that the things that we're hearing today, they're putting two and two and two together, coming up with eight, and drawing conclusions, resurrections, something happening beyond what would normally happen in the thing. And he says they don't think they've done anything wrong. They happen if they were expelled, or Stevenson's jail. It's terrible. They've heard the room is settled out of court. They've taken away all the accounts. I guess the argument of the book is that the verdict of Lestrade speaks to that argument. That formation of the images will never be really identified.

01:18

and that therefore it lends itself more to the supernatural than it occurred.

01:26

My answer to that, I've learned a lot about that. If it was a highly pronounced image, that being so pronounced, it would have been immediately recognized as a miraculous type of thing.

01:51

They suspect that the image may be fading, but that the image may also be getting stronger. When they wrap it, they recognize

02:21

Send me a copy of your article when you're done. I don't have a card.

02:48

Thank you. Thank you.

03:03

Well, they printed Springfield Union, and I'll be guest speaker on three radio stations. Good idea. I'll be speaking on the radio myself on Sunday. I'll be speaking on Radio Sunday. Excellent. Thank you.

03:30

Oh, you're with the, you know, it's funny that I, I didn't call to have the service. No, I thought it was what I did for you. And then John Heller will read the paper that Giovanni has

04:17

prepared okay welcome professor regie please foreign

04:40

I think I have been committed for a long time to this role. Professor Heller has had the great privilege of being able to read my work. And I think he will be able to give you all the credit for what we have done together and looked at all the time. Thank you, Professor Heller. I hope you will be happy.

05:14

Giovanni expressed appreciation for what he perceived here. He said that he had worked on the powder, or dust, which he obtained both by vacuuming parts of the shroud, the micro-vacuum container which he designed, and also from the container in which the shroud rested.

05:40

So he is one who does the microanalysis by taking a look at very tiny bits and pieces of the thing, the debris, if you will, the powder. He's a meticulous worker and he's worked long and hard on this problem and the team is very proud to have him a member.

06:09

I am going to read his paper.

06:14

I'm sure he will correct me if I do anything wrong. On October 9, 1978 night, I drew by hand, by forced suction, that's vacuuming, particles and dust from the front, which he's going to call the recto, and the back, the verso side of the shroud, and all the samples from the back were obtained by suction after separating to some extent the shroud from the supporting cloth by clipping some of the threads which attached the former to the latter and inserting this device which he had designed and built the

07:01

He also used fiber optics, which he designed in order to take pictures of the backside of the shroud.

07:09

Such operations were done under sterile conditions for the conservation of the dust obtained.

07:15

The tested areas were in the first slide. First slide, please. The lights down, please. Don't take them all the way down.

07:30

A is the surface of the recto or front. B is the verso area of the hands. C, the verso area of the face. D, verso of the feet. And E, verso area of the buttocks.

07:49

Okay, whites please. Small pieces of wax. were drawn from the recto side and approximately two milligram of dust and particles from each area of the verso side were subjected to suction

about 80 pictures were taken of the four areas of the verso by using fiber optics and about a thousand pictures for recording of the operations were taken next slide please

08:22

This is the operation process. The shrine where the shroud had been kept was examined in advance.

08:52

and dust particles and samples were drawn from its interior and the items were used and the items that were used to roll up the shroud and protect it were not exhibited which refers to the backing cloths and the protecting red silk the trend of the research the original research program handed over to the surveillance committee that was established by the tyrannies religious authorities the guideline of the work which is still in progress The large amount of material obtained from the sampling and the subsequent vast amount of observations made has made a very limited part of what has been done be able to be presented here.

09:39

Further lines of research of substantial interest are still to be done ahead.

09:45

The very wide span of the current research and of its newly emerging lines of lines was constrained by the extensive use of time of investigation and by the large expenditures involved even today he cannot state that that the analysis of the dust drawn from the shroud may still not be done for a matter of several years perhaps decades before obtaining a definitive and complete research on the subject in any case the lines of research

10:20

that have been pursued to date are one direct optical examination of the Verso, photographic examination of areas on the Verso, microbiological research on the dust, scanning electron microscope microscopy of dust, qualitative and semi-quantitative microanalyses of dust, examination of comparative dust using the same research methods employed in the shroud dust,

10:47

examination of the pollutants and foreign matter found during the tests, a study of a proposal for suitable preservation of the shroud in the future. It should be mentioned here that absolutely nothing has been done to conserve or preserve the shroud according to modern museum practices. It's just kept rolled up in a box and a box and a box.

11:12

Now the results and methods. the direct optical examination of the verso.

11:19

The verso of the shroud shows several stains, but not the image of the recto. You'll recall that the image is on the crowns of the threads of the microfibers in the slides which Sam Pellicori showed.

11:37

The fiber optics which was used in the back demonstrated this and it was confirmed by the exposure of the area of the verso corresponding to the feet that was done during the last days of the work by further cutting more threads around the perimeter of the shroud and allowing direct observation of a wider area.

12:00

Next photographic examination of the areas in the verso. Unfortunately this kind of work did not give the results we hoped for owing to extremely difficult focusing problems on the subject. Nevertheless, some stains remained impressed on the film, and they allow us to state that in some places the recto, the reddish stains commonly indicated as blood, show a perfect correspondence with similar stains on the bursa, thus indicating that in some places the blood has filtered through the cloth to the limits imposed by the opposite surface. Next slide.

12:36

All right, let me slow down a minute on the slides, and I think I can fill you in. The previous one is the container that the shroud is normally kept in. Go back. Go back. Go back. No, the other way. Wrong way.

12:52

The other way. Other way.

12:55

No, not forward, backward.

12:58

It's going one way.

13:01

You're doing fine. Keep it up. If you go long enough, you'll meet yourself coming back.

13:07

Did you take it back to the box? Just do it at high speed.

13:12

All right, we'll get back to it. You know... Yep. Okay, that's... They're extracting the... Okay, keep going. Next.

13:21

Okay. That's the box. Next.

13:27

Okay. Basically, he's saying that the blood has gone through

13:35

And on Maria's Spanish cloth, when I bled on it, the same thing happened. The blood flows like a type of red, viscous molasses. And it will go through, but it will not penetrate into the empty portion of the microfibers that have been described like bamboo. The blood is too thick to get into the interior.

14:00

Next, microbiological research on dusts. The vacuum-suck dust from the back of the shroud and the wax fragments drawn from the recto were tested by many methods in order to arrive at some kind of a biological picture of the cloth. Such tests have provided some important elements for the future preservation of the shroud, and they can be summarized as follows.

14:26

The shroud, the presence of very common bacilli and abundant fungi, such as Diplococcus constellatus, Diplococcus magnus, Cetha polypela pneumoniae, and others, such as Mucor, Genus rhizopus, and more,

14:42

were seen. From the wax was extracted the presence of common bacteria and others which are infrequent, such as streptococcus aureus, sarsenii, and most unusual, Fusobotorium necroforum seethemortotherum, dangerous to man. The same tests were carried out on the samples from the box and gave evidence of abundant fungi and bacilli of many kind. Of course, all of those posed a threat to the integrity of the linen through time.

15:13

scanning electron microscopy of dust. This type of research has provided the greatest number of observations and data on this very research, and I concentrated most of my energy and time and personal expenditures. Owing to the large quantity of samples obtained, a non-systematic research was developed at random for every group of dust that were drawn. The items of major interest are pollens. They are frequent and abundant. Some are recent, others ancient.

15:42

and there's a note here i gotta go to another page for the note ah newer recent pollen is clean pollen which he placed in turinese tap water for one week is covered by a layer primarily of calcium as determined by electron micro probe

16:05

This last, the last historical use of water on the Shroud was 1532 at the time of the fire. Presumably the first use was during the redding process at the time the linen was fabricated. And virtually all the poems that he has found have been covered by a calcium deposit.

16:27

Let's see where I am. There we are. A note, yeah, figure five. A notable exception among many I examined was a fossil poem of the genus Lycopodium, which most likely can be traced to the Cretaceous period. Next, please.

16:48

No, that's not it. All right, there's no photo for that. But, you know, with the way people look at evidence, somebody's going to run around and say, ah, this is proof that it goes back to the Cretaceous period.

16:59

Please don't do that. Only the translator.

17:06

To avoid irretrievable damage to other items, I've never tried to clean the oldest pollen. Special attention was paid to the possible finding of pollen from saponaria officinalis, but until now, no trace of such pollen, even blurred by coating or anything similar by shape or dimension, has been detected.

17:27

Insects. From the beginning of the research, it appeared rather surprisingly that a large number of tiny insects exist on the back surface of the shroud. the technical preparation of the samples do not permit us to say that such insects are still still exist today but we can certainly maintain that in the past they have invaded the surface and may and may be since the manufacture of the cloth comparative research on dust drawn from egyptian mummies of an earlier period than that of jesus of nazareth have provided us with very similar

18:05

insects at the scanning electron microscopic level, and in some cases they are superimposable. Their classification is very difficult.

18:15

Such, they are unquestionably mites, and according to the Institute of Systematic Zoology of the University of Turin, are at least ten times smaller, next photograph, than the mites which are known today.

18:33

That's not a mite. No, the last one was.

18:36

Pardon? The previous one was the mite.

18:39

The previous one, yeah. Shrouds and Egyptian dust seem even more difficult to classify. Minerals in general. Mineral dust represent the bulk of the materials drawn. In some instances, their crystal aspect identifies them, but in most cases, their uneven shape does not permit any assumption. That's the might, and the next one should be a crystal. Next slide, please.

19:06

The most interesting findings are related to the areas of the hand and the face. In these areas, but not only there, many particles, mostly made of light elements, are observed.

19:17

The prevailing chemical elements were silicon, sodium, aluminum, phosphorus, sulfur, chlorine, potassium, and calcium, which is the most abundant of all. Iron, copper, silver, lead, and gold, this last one for technical reasons. No, can you raise the slide a little bit, the last slide a little bit, show the spectrum at the bottom. Can you raise it up? A little more, whoa, there you go. Thank you. That's it. There you go.

19:47

The gold is an artifact and he's found a couple of lead and that's interesting because they appear to come from the heel area where there's presumably dirt.

20:03

In the above connection, we can say that the light elements are often linked together in a complex and numerous combination that can suggest the abundance of various acid carbohydrates, carbonates.

20:15

Among the heavy elements, iron is prevalent in the samples examined. It shows to be two possible kinds of combinations, suggesting in the qualitative analysis the presence of organic and inorganic iron. There are particles of iron oxide on the cloth, which are pure iron oxide.

20:38

There is iron linked to elements such as potassium, calcium, sodium, and others, which seems to be of organic origin, probably blood or its derivatives. Next slide, please.

20:54

That one is presumably blood.

20:59

Examination of comparative dusts using the same research methods employed on the shroud

21:06

After some unsuccessful attempts on dust from fabrics of difficult comparison, the analysis of dust from Egyptian mummies of a period around 1100 BC has provided the best and perhaps the most surprising results.

21:21

In fact, the dust drawn from the skin of mummies beneath the innermost layer of the bandages show a considerable similarity in our microanalysis with most of the microanalysis made on shroud dusts.

21:33

Moreover, important biological similarities were also noticed, such as, for instance, pollen incrustations and the similar aspect of bits of tiny insects found in both cases. Next.

21:52

Next one. Okay.

22:03

This is his reference iron oxide dust that he has used. Are there any more? Okay.

22:20

Let's go through the next two. Yeah. Okay.

22:26

All right, these are more examples of the insects

22:31

are in parts of insects which are mites unequivocally and are part of his comparison with the Egyptian mummy clothes. The shroud is on top and below are those from the Egyptian mummies and their similarities I think are quite obvious even to a non-entomologist or aqueirologist as mite experts are called.

22:56

Incidentally, you'll find that there is no, I found there was no such thing as a mite expert. It either has to be a predatory mite or a storage mite. I mean, it's like having, you don't have a nose and throat anymore, it's a left nostril expert. Okay, now we are...

23:21

Several items whose shape and analysis are not well defined have led to the investigation of substances related to current and ever-increasing atmospheric pollution. Frequently, some particles have been recognized as hydrocarbon combustion derivatives originating to a large extent from central heating in the Turin area.

23:41

Next slide, please. Okay.

23:48

Other pollutants are related to the presence in the atmosphere of commercial detergents. It's also been found that articles which came in contact with the shroud, such as ex-voto, sacred vestments, and painted copies of the shroud, have transferred traces of their constituents to it. These are the contaminants pointed out to before from artists painting it. In fact, extremely small particles of gold, silver, bronze, candle wax, and shreds of different fabrics and so forth have also been detected.

24:19

Study for the proposal of suitable preservation methods for the shroud in the future. The information gained from the very aspects of the research made is such to provide useful indications for a suitable preservation method of this important document of Christendom, the property of all of mankind and silent witness of an immense suffering.

24:42

The study of the proposal is underway in collaboration with James Druzek of Los Angeles, California. The present idea is based on the realization that an airtight container filled with inert gas is at least mandatory. Conclusion. The result of this research described opens a new hypothesis on the events related by the gospels. The man in the shroud was prepared for burial along the Jewish tradition, probably strongly influenced by the Egyptian civilization of that time.

25:13

Once dead, prominent people of the Western Mediterranean, as for instance the Egyptians and the Copts,

25:20

were subjected to an embalming process consisting of a dehydrating treatment by coating the corpse with natron, a substance brought from Egyptian mines from Ostrakhina, whose chemical composition seems to be very close to much of the shroud dust particles examined by the scanning electron micrograph. A significant confirmation of this hypothesis may consist in the

presence of insects of a very similar nature that are present both on the shroud and Egyptian mummies, as well as the likeness of respective pollens found on them.

25:56

Along this hypothesis, the gospel narratives whereby pious men carry to the grave about 30 kilos of materials for treatment of the corpse seems possible and even acceptable. If aloes and myrrh and other spices were employed, they must have been so in a limited way and certainly not in such a large quantity. that could not have been economically justified. It seems reasonable to think instead that such substances may have been mixed in the wet or dry dehydrating powder and represented the burden carried by the pious man. Lastly, a modest quantity of spices may explain the fact that to date no particles of such a kind have been identified in the dust examined. I believe the above hypothesis may also support the formulation

26:45

of a new theory on the formation of the image of Nishra on which we are presently working. Thank you. Thank you very much for your patience and I hope you enjoyed it. Greetings from Italy.

27:15

If I may make one comment, Professor Rigi has been working, doing all of this work essentially by himself alone in Torino. And he has put a tremendous amount of time and effort in and deserves, has really done some superb work. We hope to publish that here in the United States somehow, soon. Thank you.

27:46

The next and last paper in the chemistry aspect of the symposium are chemical considerations presented by Sam Calicori.

27:56

Excuse me, Sam, before we start, how much time do you want? How much time do you want? Half an hour. OK.

28:10

You've seen a lot of presentations of data

28:13

And you've probably come to the same conclusion that I often come to, that data by itself is awfully boring.

28:20

But when you have such a difficult subject as this, we quickly learn that in our process of checking ourselves and self-criticism, that any one piece of data alone is insufficient from which to advance. You've really got to put things together and try to make a coherent picture.

28:41

When you do that, then hypotheses begin to be generated. And when you have a hypothesis, now you've got something you can sink your teeth into. You can test it. You can try to see whether the next idea that comes into your mind fits the hypothesis.

28:57

Now, hypothesis generation is fun, but it's also vulnerable. You're also vulnerable when you generate a hypothesis. You're vulnerable to being accused of...

29:10

being a nut, you know, at times. Well, you put up with that. You learn to live with these guys and tolerate all their funny ideas that depart from your own.

29:25

Well, let's assemble some of the evidence and see where it leads us, particularly in the attempt to explain how the image got onto the Shroud. Let me have the first slide.

29:45

and the lights. First let's review the image characteristics.

29:58

You've seen that the image consists entirely of straw-colored fibrils, which penetrate to a depth of only about five thousandths of an inch. That's about two to four

30:13

fibrils in depth. It does not penetrate to the backside of the shroud.

30:20

It is not water soluble. There's no evidence of paint or protein. Finally broke it. Colored particulates. It contains contour information suggestive of a human form.

30:41

It appears as a reversed image that is a light on dark background. Incidentally, a lot has been made of that and I hope by now people don't consider that a mystery. Okay, and it's not fluorescent to ultraviolet light.

00:02

In other words, the shroud itself is yellowish. Well, this talk might easily have been titled Laboratory Simulations of the Shroud Data in an Attempt to Reproduce It and Thereby Explain It.

00:29

I'm sometimes known as a kitchen chemist, and one of my favorite dishes is baked linen with olive oil garnished with lemon. And those of you who don't understand that, we'll get to that later. Anyhow, I took a piece of modern linen again, baked it, and got a curve that reproduces the reflection characteristics of the shroud. So I succeeded in making...

00:55

a piece of linen that looks like the shroud background.

01:01

For the moment, ignore this. This is iron oxide.

01:04

We'll come back to that. Next slide.

01:09

Okay, again, in my baking experiments, using these particular temperatures and these times, we're able to get the color. This is the color index of the shroud.

01:24

and looking just at the reflectance of cloth versus time, it rapidly decreases, we're using this scale, rapidly decreases if baked at that temperature.

01:37

Within an hour, it's definitely yellow, and if you continue baking for these number of hours, it becomes yellower and yellower, but not as rapidly as it did at first. The shroud itself is this yellow.

01:51

Okay, so we haven't gotten quite there,

01:54

I don't know how long I'd be allowed to bake to get to that point, but that is quite important. This is the main point here. Next slide.

02:06

Okay, now let's try to replicate the body image spectral characteristics.

02:12

Again, the Gilbert's data for the shroud body image versus wavelength. Again, deep blue light and red light. This is the reflectance.

02:24

I applied various materials to linen and put these, put the linen then in an oven under controlled temperature time conditions and then removed it and did spectral reflectance measurements again.

02:41

Some of the materials I used were perspiration and body oils. That's these two curves. This is a very dense perspiration stain. This is a lighter one. I also used the spice myrrh.

02:56

Later on, these experiments were done in approximately two years ago.

03:01

Since then, I've found that a lot of materials will give me curves like this. There's nothing magic about the spice of myrrh or perspiration. A lot of materials stimulate the reaction that Dr. Adams explained to you, namely the chemistry is an oxidation and a dehydration and a conjugation of the cellulose molecule to form a different molecular structure which absorbs blue light. Next.

03:36

Okay, iron oxide. Let's just quickly look at what iron oxide, how iron oxide reflects. Here's red light and blue light. This is right off the laboratory spectrophotometer.

03:51

A concentration of only four micrograms per square centimeter. this is just barely visible to the eye to the spectrophotometer we see high reflectance in the red and it begins then to absorb or reflect less as we go to green and by the time we're in the blue this very iron oxide is fairly dark so it's got a distinctive curve which distinguishes it and is

04:20

a confirmatory piece of evidence to the chemistry which says that yes, there's iron there, there's even some iron oxide, but to a very low level. In fact, the amount of iron or iron oxide is so minute that it's not visible to the eye. Therefore, it doesn't contribute to the visibility of the shroud image.

04:41

Next. That was iron oxide in the previous slide. This is, these are hydrated iron oxides, most commonly known as rust.

04:54

Larry Schwalbe kindly measured the concentrations on the linen that I prepared for him.

05:00

This number really is five micrograms per square centimeter. It has this sort of reflectance curve. See, it's still quite reddish. This number is really 18.

05:13

Redder yet, and by the time you get to, that should be 30.

05:17

It's very red. So these, again, have distinctive curves and are quite distinct from the body image. Next.

05:30

If you can lower the lights a little more. These are pieces of linen to which I've added various concentrations. And Dr. Schwalbe measured the concentrations, again, using the X-ray fluorescence method.

05:46

and then did spectrophotometry on them and the point is that here we've got 25 micrograms per square centimeter and there we have eight here we have uh four or no 2.8 three micrograms Now there's 2.8. Okay, you can just barely see the color when you're down to approximately three micrograms per square centimeter. So that is sort of the detection limit of both the spectrophotometer and the eye. And the color is still distinctively red, quite different from the shroud body image. So previous descriptions of the color of the shroud body image, which were made essentially from colored slides, it's very difficult to get the right color on a color slide for such a low contrast image those previous descriptions describe the shroud body image as cpf we know today those of us that have seen it in person those of us have done experiments that yellow strong yellow is more appropriate and certainly this is can by any stretch of the imagination be described as yellow next

07:05

Okay, some of the materials that I applied to linen to simulate the body image characteristics were done on one piece of old linen, 30-year-old linen, and they consisted of applications of myrrh and aloes, which were provided by Dr. Ray Rogers, blood, iron oxide, and perspiration and skin oil.

07:33

and there was a background area used as control. This was put into the oven, baked at a high temperature for several hours, and then they did reflectance curves, some of which you've already seen.

07:45

Thanks to Dr. Adler, my beautiful piece of cloth has been disfigured. You see these patches. He applied some very nasty chemicals to rehydrogenate the reaction that occurred here, restore the linen to its original color thus proving the chemistry the name of the oxidative dehydrated conjugation chemistry that explains the what the body image is next

08:27

So again, we have the mer-reflectance curve, the shroud body image.

08:31

This is a quite expanded scale, and this agreement is considered quite good. When you get too much dirt from your skin, then you have quite a bit of absorption in the ultraviolet, so it departs. But this is fairly good agreement. And of course, iron oxide.

08:52

doesn't have anything to do with the shroud body image visibility next just a close-up of one of the areas that were developed by this process now the accelerated aging technique which is what i did amounts to baking the material at high temperature for a short period of time and what i've done there is simply accelerated the natural process that occurs

09:23

at normal temperatures for longer periods of time. We cannot specify how long it would take at normal temperatures and humidity to achieve the reflectance characteristics that the shroud body image has.

09:40

because there are many other factors that are involved. The actual acidic condition of the cloth, the presence of all this calcium, and several other factors, the amount of humidity, the amount of exposure to solar ultraviolet energy, all affect the rate of this reaction. But basically, this is what's going on. Later, Adler and Heller confirmed by the microchemical tests on the fibrils, without a doubt,

10:10

And you heard this just a few minutes ago, that this is indeed the chemistry of the shroud body image. Next. Now let's go on, this is getting boring.

10:23

Okay, some of the laboratory, kitchen laboratory experiments used olive oil, and we got a stain that was measurable. This had had some previous exposure to sunlight.

10:42

The slide isn't as clear as the live picture would be, but exposure to sunlight does some degree of pre-sensitization. Next.

10:59

Okay, so these are things you can go home and do yourself. You could use olive oil or lemon juice.

11:08

I will now explain the title that my friend Adler hung on me, Agent X. I don't know, it's a combination of these or any one particular one to make images.

11:22

Okay, I applied some lemon juice to my fingers and got, after baking, a visible image that looked like this.

11:29

Okay, these are all self-explanatory. Lemon juice is not a new idea. Those of you who have children have used

11:36

lemon juice as an invisible ink. Next.

11:42

This demonstrates that with an aqueous solution of one of these stimulating materials, you can get an image on only one side of the cloth. It doesn't need to penetrate on the other side. So I've used oily materials like olive oil, also aqueous materials, and both produce the accelerated degradation of the cellulose.

12:07

The amount of penetration differs, of course, between an oily material and an aqueous material. Next.

12:17

This is a variety of things, and the point I'm trying to make is just because a spice or an oil or perspiration stimulates this reaction to occur doesn't mean it was used

12:32

at the time. Some of the Italian scientists, or one in particular, is saying that, yeah, the chemistry is such and such because there is now myrrh and aloes, et cetera. Well, Adler and Heller have already shown that these materials do not exist today. Where did they go if they were there to start with? They probably were either consumed in the reaction or have evaporated over the years. But I have a variety of things. Just quickly go through them.

13:03

This is tea, orange juice, lemon, urine, perspiration of various degrees in a blank. This was baked at 130 degrees C for a couple hours, and the images showed up. Next.

13:20

Well, briefly, the chemistry. This is a part of the cellulose molecule. When you dehydrate, you... end up changing the molecule such as you create a conjugated bond and that bond has the property of absorbing blue light if you went further and did a lot of heating you can create other more complex groups which have different properties some of which fluoresce next okay here is probably very barely visible to you an olive oil stain done on my fingers

13:58

Now we're attempting to reproduce some of the properties that we see on the shroud. Next.

14:06

We had that process on the VP8 analyzer and you can see that we have reproduced cylinder-like objects resembling the original fingers. Now the way I did this follows

14:26

a suggestion put forth by John German who's a team member that if you apply a stimulating material to say your fingers and put the cloth on top of the fingers and then lightly apply pressure and on the very tops and slightly begin to form around the finger to pick up the curves

14:54

you can reproduce the contour. The idea that Mr. and Mrs. German have is that a cloth placed on a body and, say, put in a tomb or somewhere in a cave would absorb moisture, become more flexible such that it begins to contact around the curve. It spent most of its time at the crown of the curve and less time going around the curve.

15:22

The fact that it spent most time on the crown means it picked up more of the stimulating material than it does on the side, and therefore the image is darker. This might give contour information. Next.

15:41

Okay, this is Larry Schwalbe's work.

15:45

I'm gonna talk a little bit about, a little bit more about iron. These are the concentrations he found. Very little in the face compared with the blood areas.

16:06

We're looking at iron.

16:11

The blood areas are a large amount of iron in the blood areas. very little in the image.

16:23

And what was called the background, this is already been mentioned, has more indeed than the face. And since then, looking carefully, next.

16:35

Well, Larry's already presented this. I've indicated here the minimum visible detectable amount of iron oxide. Next.

16:49

Again, Larry took his trace through here. And this area turned out to have, to be a water stained area. And Dr. Adler indicated that some of the blood particles were transported by the water and deposited. This probably concentrated the amount of iron. Next.

17:14

Just a liberal summary of Dr. Adler's results of the iron on the shroud.

17:24

This iron was deposited by the ion exchange mechanism. It accounts for most of it. There is some bound as blood particles.

17:37

It accounts for that much. But the real iron oxide is very low. This is what would be detectable by the spectrophotometric and visual

17:51

All three types are seen by x-ray as iron. Chemistry distinguishes each type for what they are. These are direct quotes from Adler.

17:58

And spectrometry and the eye are sensitive to as low as three micrograms per square centimeter of types two and three. I'm just driving home the point that if you had that much iron, you would see it as contributing to the visibility of the image. You just don't. Next.

18:18

okay once again characteristics of the body image next and the photo micrograph of the tip of the nose showing the discolored fibrils with some reddish material next

18:47

Another body image area where we have some clumping of colored groups of yellow fibrils adjacent to fibrils that have no color. Next.

19:06

Again, the dirty heel area, which is an intense body image area. Next.

19:12

This is done in the laboratory.

19:15

We have the striped effect. We have clumps of colored fibrils adjacent to uncolored fibrils. We have coloration only on the topmost fibrils. It doesn't penetrate.

19:30

So we have succeeded in reproducing several of the image characteristics. We have reproduced the color We've reproduced the physical location of some of the stains.

19:46

We have also reproduced, to a certain extent, contour information on fingers. Next.

20:08

Again, the fluorescence Photography tells us something.

20:14

This is the visual photograph, and this is the fluorescent return.

20:22

Look at the scorches, very faint scorches, emit reddish-brown coloration. The scourges and body image have low contrast in the visible, much higher contrast in the ultraviolet emission, you can begin to see more detail in the scourge marks. Next.

20:48

This is the chest area, the white light photograph, and the UV fluorescent photograph.

21:00

I urge you to do this at the exhibit. I can't show it here. The slides don't have quite the fidelity of color as the prints do. In the exhibit, there are UV fluorescent photographs.

21:13

If you were to compare a body image area with a scorched area that has the same density, and it's cut off of the screen here, do that in the visible, and look in the ultraviolet. at the fluorescent return.

21:32

These scorches have a color. They have a reddish-brown fluorescence. The body image has essentially no color. The blood, the same way, has no color. These speak against the hypothesis that the body image resulted from a scorch.

21:52

Adler presented confirming and supporting information And Dr. Jackson also proved to us that a scorch or radiation or diffusion could not give us the properties that the body image has. Next.

22:16

That's the back of the head and the back of the shoulders.

22:22

We're looking at the skin wounds now. Next.

22:30

Well, this was meant to show again the, where you have very faint, scorched areas, you have coloration. You don't have that on the body image. Next.

22:45

Pay attention to the skin wounds on the chest. Next. That's the white light.

22:56

And that is the ultraviolet. You begin to see scratches. that the UV has shown us that there is detail in the skin wounds that is really scratch-like to the millimeter scale.

23:13

This tells us something.

23:16

And what it tells me in particular is that the cloth had to be in direct intimate contact in order to transfer such detail.

23:26

from the skin to the cloth. And certainly that was true of the blood, the blood transferred by direct contact.

23:34

So the next logical step to take is that the foreign material that was on the skin, whether it be the natural perspiration and skin oils or burial ointment, also transferred from the skin to the cloth by direct contact. This then was the catalyst or stimulant for the chemistry, the darkening of the cellulose in those local areas that accounts for the body image.

24:05

We did an experiment in the laboratory. This is Vern Miller's students actually did this. Took some linen and folded it, and this indicates a series of folds where that's the top, these are intermediate, and that's the bottom. They scorched

24:20

using a soldering iron scorch such that you had a gradation in the density of the scorch.

24:27

Then looked in the ultraviolet. Now, this is a stainless steel ball bearing. Its purpose is if you get a lot of return from there, then you have a leak. You aren't really looking at pure ultraviolet. Your camera isn't purely blocked from ultraviolet.

24:44

Okay, this is the way it looks in fluorescence. This is a deep scorch.

24:50

And there's very little fluorescence until you get to the light scourge. You have a rim of fluorescing material. When you get very light, that's quite bright.

24:59

The next thing is the students took that cloth and washed it. And they were clever enough to hang it sideways. And what you see is that the pyrolysis products caused by the scourge were transported by the water and went off to the side here. okay and we have that on the shroud also the flaring that you see in the scorch in in white light you can see as a gradation in color reddish to brown to more dense brown near the scorched areas but what's remaining is cellulose washed clean of the fluorescing of at least the volatile or mobile complex florescing compound, leaving florescing cellulose.

25:50

And it floresces this color.

25:54

Okay, after a second washing, more of the material is removed and you still have remaining, you know, just cellulose that itself floresces. And again, this is evidence that weighs against a scorch hypothesis. because if the image were scorched you would have an image that just lighted up as this does and this going back to the natural white light just to compare what's actually happened visually is not it's almost indetectable but by ultraviolet fluorescence you you see a lot more next

26:40

Okay now we're able to summarize what we learned in the laboratory when we attempt to reproduce what using cellulose some body image characteristics.

26:54

We can produce identical spectral reflectance curves to match the shroud background linen when we add sensitizing foreign materials unspecified agents x

27:10

whatever, we get identical spectral reflectance characteristics to the body image. The surface, we get surface fiber discoloration for aqueous materials, but for oily materials we get penetration.

27:29

The color is insoluble and is invariant as we approach scorches.

27:35

No particulates are required to give us this discoloration. We get a dark on light image. In other words, a reversed image. Perfectly natural, just what you would expect. No mystery there.

27:46

Finger shapes have been reconstructed. Only one experiment was done, and it was encouraging. Certainly we're going to pursue this. The image is non-fluorescent.

27:59

And I just have a note that

28:01

This is the degree of degradation or darkening of the cellulose is subject to external presensitization or external treatment of the cloth. Next.

28:20

Just quickly, that experiment done by Vern's students. This is the white light, faint scorch. Next.

28:26

The UV, quite bright. Next.

28:32

washed, and you can see the plume of fluorescent material going off to the side. Next.

28:39

Washed again, you still have fluorescent cellulose. Notice the color is kind of getting close to what we saw in the shrub. Next.

28:50

Okay, this is the... I hope it doesn't bother you that it's upside down.

28:58

Of course the face is here, and that's the chest. Try to focus that a little bit. Again, we're talking about the detail seen in the scourge marks on the chest.

29:11

Scratch-like detail. Next.

29:16

On the back, this is white light. Look at the scourge marks. Next. Look at the detail you've got there.

29:29

You see the too diffuse sort of the dumbbell shape, but also you can see scratch-like detail.

29:40

I think that's pretty convincing that the cloth was in direct contact with the skin. Next.

29:48

So we can sort of summarize. Remember our original question was, what is the image and that question consists really of two parts what is the image actually what is the chemistry of the image and how did it get there i think we have answered without a doubt and adler is adler and heller are the people responsible for nailing this down such that there is no question remaining what is the image of the chemistry it's the advanced degradation of cellulose

30:26

And that's it in more detail.

30:29

And how did it get there? Okay. I've proposed a hypothesis that it has got there by direct contact between the skin and the linen.

30:42

That we had a latent image that namely developed over time at normal temperatures over tens, hundreds of years. I don't know. I can't tell you. Nobody can tell you. and it's latent in which was catalyzed locally by

00:01

information using the time contact dependent model developed by the Germans.

00:09

Now the objections, and this is the major one, we've been able to do limbs and fingers, but we have not to date, using simple direct contact, been able to reproduce the face in an undistorted manner. The face is certainly most difficult because of the very that happens spatially over a very short area.

00:35

You get distortion if you apply a foreign substance to your face, touch a linen to it, such that every point on your face makes contact. Take that off, then you will obviously have distortion. So something beyond that very simple-minded hypothesis is needed.

00:58

The other objection is there's apparent pressure independence for this phenomenon. Well, I don't know how strong the question that is.

01:06

We've shown that the detail on the front is just about as dense or as complete as the detail on the backside of the image. So I don't know how strong that question is. The objection raised is that, well, with all that weight on there, with the weight of the body, the back image should be much denser. than the top side and it's not okay so that's something that needs to be explained well I should have had a chemist do this no none of the materials like the spices have been found on the shrouds we've only found linen which is a polysaccharide cellulose which is a polysaccharide

01:53

These, as I mentioned, these foreign substances may have indeed been consumed in the reaction or evaporated or whatever. We just don't know. So we have explained a lot of things. We know what the image is, but just how it got there still remains unexplained. I don't say it's unexplainable, but by as far as we've gone today,

02:17

We cannot fully explain it. We have a hypothesis. The hypothesis needs more checking. We have to be more clever in designing some experiments to check this hypothesis. We have to also be more clever in preparing our test samples. Indeed, the presence of so much calcium, it's been suggested, may act as a buffering medium to prevent penetration of of the reaction so that it stays at the surface may have something to do with very limited diffusion which could give contour that's diffusion surface diffusion which could give contour information so the model is certainly incomplete is there a final slide that's it okay well that's all i have thank you thank you sam give the lights please

03:14

we please have the lights house lights house lights please okay before we conclude the morning session i'd like to make a couple of announcements final announcements number one uh to reiterate the members of the stirp team are requested to meet at lunch there will be a short meeting okay number two uh the college Reminds you that there's lunch available in the tent across the street you are Requested to feel free to wander around the campus picnic on the green. Enjoy the facilities that are here, please At the where are we going to eat lunch is where the meeting will be Okay for more

04:09

We will try to have a question and answer period this afternoon.

04:13

It's going to depend on time. I can't guarantee it, but we will try to do it.

04:17

And just as a passing comment, remember that all of us up here are expressing our, in many cases, either outside or inside, or expressing individual opinions about various things. They may or may not represent the opinions of the other members of the team, OK?

04:40

1.30, please. What time is it now? 1.30, please.

04:46

If we can start promptly at 1.30, we've got a good chance of getting Q&A. Thank you.

05:10

A pilot session of the Shroud of Turin Research Project Symposium.

05:17

We're starting here just a little bit late, but we'll do everything we can to make it up. The first speaker today is a man who really needs very little introduction, I think, because he wrote a book called The Shroud of Turin.

05:40

which is about three, I believe about three years ago. He comes to us from England, and he has put together a theory of his own dealing with the possible history of the Shroud.

06:02

Now, his work is, as is well known, Anything that just about anybody does has some controversy about it. Some people agree, some people do not, but he wanted to discuss some objections as part of his talk to his thesis that have been raised.

06:27

But I think you'll find Ian Wilson to be a very delightful person to listen to.

06:36

And this falls in the category of an invited paper. It's not really part of the Shroud of Turin Research Project, but we asked him to come because we thought it would be something that you would enjoy hearing. So without further ado, I'd like to introduce Ian Wilson.

07:00

Thank you very much indeed, John. When I was invited to come over here about a month ago, just after I got back from the States, I wasn't expecting to get back for another couple of months. Sorry.

07:12

Right. Can you hear me now? Thank you.

07:16

Right. When...

07:30

Now, is that all right? Yes, good.

07:33

Right. Well, one of the things that Step said in their letter inviting me to come over here was this would just be a kind of informal family gathering.

07:44

And so I thought it would just be a handful of people and didn't prepare that much. And then I see there's all of you. So anyway, I'm very pleased to be here. I suppose I must come into the category of what were called, I think, yesterday, the normal people.

08:00

So far as historians can be normal. And essentially my area is very different from the scientific area, although I hope that one can apply certain scientific principles to the study of the historical questions relating to the Shroud.

08:18

The problem with history so far as the Shroud is concerned is that while scientifically there seems so much evidence to support the Shroud's authenticity, historically it's been a dead duck for many years amongst the general run of historians because it has seemed you couldn't trace it back before the 14th century. And so everything that I'm going to put to you now

08:44

is to show that there is a case for the cloth being in existence earlier but what we cannot expect in the earlier centuries is that we're necessarily going to find references to a shroud and a shroud bearing a image of the full body of jesus christ this has been the difficulty that a shroud identifiable with the turin shroud does not seem to be recorded before one of the earliest and most mysterious references, which was in 1204, and that was to a cloth in Constantinople.

09:19

You do not have, you have references to shrouds in the earlier centuries, but there's no reference to these bearing images, and in most cases you can trace them to other cloths that are distinctly different from this one. So this is where you have a historical problem of some complexity and what I'll try and do is show you very briefly how I've approached this because the two arguments that one really needs to look at are the question of was this cloth we know today in history? And if it was, what was it? If we can have a look at the first slide please. Don't need to dim the lights too much because

10:03

They should be just a bit more, I think, dimming. Now this is a slide which simply goes back to the earliest representation we have of the Shroud as we know it today, which is a pilgrim's amulet of the 14th century, the 1350s, when we know the Shroud to have been in the possession of the Deshani family.

10:25

And we have literary references which in fact say there was a lot of contention at the time that this cloth was a forgery.

10:33

That is the earliest picture that we have of the cloth that we can say is definitely the Shroud of Turin. Before then, we go into a distinctly murky area. But let's start thinking about this cloth from the point of view of an image of Jesus. If we look at the next slide, please.

10:54

we can see what I call the conventional likeness of Jesus that in fact was done in the 15th century by van Eyck and it's the type of likeness of Jesus that we instinctively look at and say that's Jesus.

11:10

Well the question we need to ask is why do we say of that particular likeness that is Jesus? What tradition is there for that likeness? Were artists working from the Shroud?

11:24

van Eyck could have been working from the Shroud because the Shroud was certainly around in his time, but we do know that, in fact, he was working from a much earlier tradition. But just to show you that this is a portrait of Jesus very compatible with the Shroud, let's look at the next slide, and what we can see is the negative that we're also familiar with on the right-hand side,

11:52

But of course, anybody back in the early centuries, before the age of photography, would not have been able to see that. All they would have been able to see was this likeness on the left here. Now the question is, was this likeness done by somebody working in the 14th century copying the conventional likeness of Jesus, or was it the origin of the likenesses of Jesus that we have today. It is of the same type as we saw in that van Eyck picture, the long hair, forked beard, long nose. How far can we then trace this likeness back? Let's go to the next slide, please. Now this is some Byzantine portraits of the 11th century or thereabouts, and we see that the same likeness is around.

12:42

And we can in fact go right back, and if we go back onto the next slide now, we're just going back into time, trying to put every picture of Jesus through history into a kind of time machine. And we get back to this point, the 6th century, a silver vase, a likeness of Jesus, one found in Syria.

13:03

And we can see that the artist who did this was

13:08

portraying Jesus in virtually the identical manner that we see on the Shroud. Let's try and go back though, just a bit further back into time. Next slide please.

13:21

We're now in 5th, 4th centuries and what we're seeing is something different. We are seeing portraits of Jesus.

13:32

The one, the earliest one is the one from England which is on the right.

13:36

and it's definitely Jesus, it's got the Cairo monogram, but it's a beardless likeness and we find in these earlier centuries we either have beardless likenesses or we have some bearded representations which have got none of the precision of these portraits from the sixth century on. So we're now into a question,

13:57

of saying, well, what caused everybody to be so precise from the sixth century on? We have also to look at literary references, which say in the earlier centuries, the fifth, fourth centuries, and so on, St. Augustine is one person, for instance, who says we have no idea what Jesus looked like, what his earthly appearance was, and this is people theoretically closest to the time of Jesus, simply, even as early as the fourth century, exactly The exact details of his appearance had simply died out. There's no reference in the Gospels to what he looked like, whether he was bearded, clean-shaven, or what. So, how did these come about?

14:41

Could it have been the shroud that was actually responsible for this new likeness of Jesus in art? Let's look at the next slide, please.

14:53

Forgetting for the moment what the shroud might have been in history, there are some indications that the shroud was around. And I'd like to draw your attention to, if I can work this thing, yes, to some details which were first brought to light by a very distinguished Frenchman whose grandson is in fact present here today. I refer to Mr. Paul Vignon.

15:21

who developed an iconographic theory back in the 1930s which was showing that various Byzantine portraits of Christ had certain details to them which seemed to derive from the Shroud. If you look at this picture with quite a naturalistic likeness, you should be able to make out a kind of topless square between the eyebrows here. the artist has been very naturalistic in many respects but he put this very unnatural feature in now why did he do this if we look at the shroud we can in fact see and this is probably some irregularity in the weave or something we

just don't know is a kind of topless square exactly the same now there are about 15 details which are all of them

16:15

comparatively elusive.

16:17

They don't occur, not all details occur in every portrait, but they keep on meandering in and out of Byzantine portraits. If you look at the next slide, for instance, what we'll see, this is a very famous Byzantine work of art, the Daphne Pantocrator. We can see the square just there, which has in fact become rather stylized, There's a little triangle below the eyes here, quite meaningless so far as any natural feature is concerned. And yet, if we go back at the moment, can we turn back to the previous slide?

16:52

We should be able to see that little triangle just under there. It's these sort of features that keep on recurring that seem to suggest that the shroud was around. Well, if so, what was it? If we go on now, two slides, please.

17:11

The other interesting aspect to the whole question is the fact that while we may not have records of shrouds bearing images in existence before the, well, the 1204, shall we say, what we do have is multitudinous references to images of Jesus's face on cloth. The most famous of these is, for instance, one you're probably familiar with, the Veronica.

17:46

And this is a story of Saint Veronica who was supposed to have rushed out in the streets of Jerusalem as Jesus was passing by on the road to Calvary and wiped his face.

17:58

a very pious legend which unfortunately when you trace it back historically has very little provenance certainly in the form that it's come down to us today earlier than about the 1300s and seems to derive from an earlier cloth of which it was a copy

18:19

Now, there are many cloths like the Veronica, but the one they all seem to derive from is what we shall see on the next slide, a mysterious one. This is the cloth called the Mandylion of

Edessa, and this is, again like the Veronica, a cloth which seems to have had an image on it of Jesus, Most of the information we have is relating only to a face. The copies we have of it are many and varied, but as we study it more carefully, although that might not look to you as anything particularly relating to the Shroud, as we go into it in more detail, we can see that there are all sorts of parallels if we think for a moment that these people in the early centuries may have only been aware of the shroud in a folded form so that only the face was visible.

19:18

Before I go on to the next slide, I'd just like to point out to you that here again we see some of these Vignon markings little triangle here, a sort of, again, a stylized version of the forehead markings and so on. Many others, by the way, there's deformations in the nostrils and so on. But we're seeing these Vignon markings in copies of this cloth also. Next slide, please.

19:44

Now, what do we know about the origin of this cloth and why is it that this one is thought of as the granddaddy of them all? Well, the story of how this cloth came into being is distinctly murky. Unfortunately, this is where historians are dealing in the stuff of legends and stories when one gets back to the first century AD.

20:08

and to the reign of Abgar V, who was a monarch of this city here, a very scruffy little town called Urfa in eastern Turkey, but which was a distinguished city just outside the borders of the Roman Empire, sort of a buffer state between the Parthian and Roman empires in the first century A.D. Now, according to the story about Abgar and

20:37

this cloth. What happened was that Abgar was sick of a disease and sent a messenger, Jesus asking him to come and cure him. Well, when this messenger arrived, it would seem that Jesus was already dead, and so a disciple by the name of Adai was sent with something

20:57

which was later to be known as this cloth of Edessa. In the earliest records we have about the fourth century AD, this something is referred to merely as a painted portrait, and its existence at that stage is not known, and it's obviously a tradition about it is extremely vague.

21:22

But then in the 6th century, and if you remember it was the 6th century which is when we noticed these portraits suddenly started to change, in the 6th century we know that a startling

discovery was made in the walls of the city of Edessa, above a gate of one of the walls, that was found immured in a niche

21:45

this cloth that was supposed to have been given to Abigail those years before. Now, when we get to the sixth century, we suddenly find that the whole story becomes transformed, and suddenly we are told that this was a divinely imprinted likeness of Jesus's face.

22:03

There are stories at the time that it seems to have been created by some form of perhaps Jesus washing himself and wiping his face with it, This suggests a watery type of image and we know how diffuse in appearance the shroud image is. So we get all sorts of indications like this that there was something of a shroud character involved. Other descriptions talk of it a moist secretion without coloring or artificial stain.

22:34

The cloth is brought in 944 to the emperor of Constantinople, his sons,

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I said to have found it extremely blurred. One historian suggests they might have been drunk at the time, but it is also, of course, possible that they were looking at the image of what we see on the Turin Shroud, and without the negative image, of course, they would have seen an image that would be blurred. Let's look now at the next slide, please. And we can just see on this one, one of the later images

23:08

icons that were made of this cloth, which is just showing the quaint details of the Abgar story. Now, the important thing so far as this cloth is concerned is not to take any one representation as being representative of the appearance of the original, Byzantine artists were quite notorious in terms of just changing things around to suit their particular whim. Very few of them would have had access to the original. But if we look at another likeness, we will see, next slide please, we will see that we're getting to have a picture of a face

23:48

on what is usually a cloth which is set landscape-wise in relation to the face. Different from the normal portrait manner, an artist normally puts a portrait, portrait style. This is set landscape-wise. This seems to denote something of the original. Let's look at the next slide, and we can see that, in fact, this is one of the earliest representations of this cloth of Edessa.

24:19

It shows an apparently disembodied head on, again, a rectangular piece of cloth

24:28

and if we look at the next these bobbles by the way you can forget those these are just simply artist decoration one gets all sorts of different decoration that occur in these these pictures but we are getting to build up a consistent picture of a disembodied head on a cloth this is one of the most reliable likenesses because we know that it was very close to where the Shroud or the the cloth of Edessa was at the time and that in fact the cloth was around and able to be viewed at the time this is about the 11th century we can see another one if you turn to the next slide sorry this is in fact showing you now the Shroud itself and if we perhaps just can flick back momentarily to the other one

25:18

and then back again to the shroud, we can see that it is possible that the artists who were producing that previous picture were working from this sort of place, but they would not seem to have been aware of the body. Now, is there any justification for believing the shroud to have been, or this cloth of Edessa, to have been folded at the time? Well, there is. One of the references to it describes it as having been tetra-diplom, which means doubled in poor. And if, in fact, any of you would like to try the experiment of

26:02

doubling a piece, a full-length representation of the shroud, and then giving it four more folds, so you literally double it in four, you will find that the face pops up in a disembodied style in exactly the manner that you see here.

26:23

There seems, therefore, the possibility that it was in this form that the shroud was preserved in the early centuries. But again, one has to ask oneself, well, why should anybody want to present the shroud this way? Why were they not able to get the access to the other elements of the cloth to see that it was a shroud? The answer here would seem to have been that we can detect from some of the representations and the literary descriptions that it was mounted on a board and was probably mounted in this way right back in the first century AD when it was brought to Edessa, when we can start to put ourselves in the minds of the people who came across this cloth in the tomb hypothetically nearly 2,000 years ago.

27:19

I think, assuming that there was an image on the cloth at the time, and it hadn't come about at a later stage, we would, with 20th century minds, expect them to go rushing around saying, Eureka, look, here is a marvelous image of Jesus, this must be proof of the resurrection, and let's make a big song and dance with this.

27:43

We have to recognize

27:45

that the first Christians were first and foremost Jews, and there were two things about this cloth which would have certainly caused them to have a lot of second thoughts about doing anything like that. The first aspect was that the shroud bore an image, and images were anathema to the Jews, they didn't go in for the same sort of

00:02

I think she's doing very well, don't you?

00:08

The quality of Egyptian linen was prized and sold at very high profits. A linen very soft of a very high price.

00:22

The textile factories were under the direct supervision of the local government and the workers were inscribed in the corporation for the purpose of maintaining a production monopoly and assuring a constantly high quality.

00:35

Linen was woven in pieces of 20 meters by 1.70 meters, more or less.

00:41

Pieces of linen were regularly exported everywhere in the Mediterranean area, including Palestine. the Rossellini expedition in Egypt has discovered many papyri showing the various phases of flax manufacture. After weaving, the piece of linen was washed in boiling water, in which was added papaverum Heracleum, or saponaria officinalis, as is stated by Theophrastus in his Historia Plantarum. Theophrastus says that papaverum is very similar to saponaria.

01:16

After that treatment, the linen became beautifully white and clean.

01:20

One peculiarity of the shroud is the technique used in the weaving, a herringbone technique. This requires very advanced technology compared with what we know was in use 2,000 years ago. The hand loom must be provided with special combs into which the threads of the warp are inserted alternately so that the shuttle passes not under one single thread but at least under two or four following the design required so as to obtain a diagonal effect. This technical peculiarity founded on the shroud

01:54

excuse me, found on the shroud, caused great perplexity concerning the antiquity of the cloth. However, certain discoveries have been made and their dating may help us.

02:05

The herringbone weaving technique first appeared in Europe during the so-called Hallstatt civilization of the seventh century BC. Professor Hunt has reproduced these finds in his work, .

02:20

There are some textiles with a simple diagonal weaving and others with a herringbone weaving very similar to that of the shroud. Other samples have been found in Britain, in a grave at Colchester, probably of the year 60 BC, and others, woven in wool, at Chesterholm.

02:38

Other finds came from the caves of Morabat, geographically nearer to the site of our studies. However, the most important discoveries concerning funerary cloths are from

02:53

a town founded in the year 130 AC, which rapidly became a center of a very rich Hellenistic lifestyle. An extensive and well-preserved necropolis was found and excavated, providing an enormous amount of catalog materials, some of them similar to the shroud in shape.

03:12

Among them, there are two funerary cushions, which must have belonged to persons of importance.

03:17

They were two women. The first one was covered with a death mask.

03:25

Vivian Sabina died in the year 137. This helps us to date the grave and the cushions. This is important because the cushions are covered with a cloth woven with the same herringbone technique.

03:42

One other similar piece of

03:44

and this is like flax, it doesn't mean linen, she says, was discovered in Italy at Ercolanum, a town covered by the ashes of Vesuvius in the year 79 B.C. Antinopolis and Ercolanum were well-known residential centers whose vias were inhabited by selected people.

04:06

It is therefore quite possible that a linen corresponding to the technical data of the shroud should have been sold in Jerusalem at that time.

04:14

Let us take a brief look at the various discoveries concerning the old tombs in Jerusalem and in the Diaspora, which might be contemporary with the Shroud. These tombs in Jerusalem and, for instance, in the Jewish catacombs in Roma, Villa Torlonia and Sant'Agnese are all excavated or hewn in rock. The places chosen were always as dry as possible. They look like rooms, often containing places for many burials, from

04:44

two or twenty or more.

04:46

Sometimes there is an entrance chamber and a second one where the corpses were buried. We find stone sarcophagi, sometimes decorated, or or else a pit in the center of the room or benches along the walls. Sometimes the four types are found together as in the burial caves of Mount Scopus at Jerusalem.

05:14

The imprint we see on the shroud is that of a man lying in rigor mortis on a horizontal bench with something, a stone, a cushion, under his head. This position is in no way contradictory to all that we know about the old Jewish tombs. The excavations carried out by the Pontificia Commissione di Archeologia in the Jewish catacombs of Villa Torloni in Rome

05:36

brought to light many well-preserved tombs in which a brown oily coating, a patina, was found. It was clear that this was spices and perfumes. But the most interesting discovery, because of its bearing on the shroud and the gospels, was that the inside of the tombs, the benches, the walls, the ceiling, the floor, were plentifully sprinkled with these funerary spices.

06:00

Probably belonged to poor Jewish families. Nevertheless, the quantity of spices spread over and around the bodies was enormous.

06:12

One other piece of information is of some historical interest in this connection. In the year 1853, a French pilgrim, Louis Bonnage, visited the Holy Land and the Sepulchre. A Greek monk told him of the fire of 1808 and of the restoration the Greek carried out with the permission of the Turkish government. The Turkish laws recognized a building as belonging to whomever had restored it.

06:37

Bunel says that the Greeks restored the church and the sepulcher according to their own plans and removed the stones over the tomb. As they did this, they noticed a persistent and inebriating perfume of spices.

06:50

All these discoveries bring us to the debated point concerning the quantity and the nature of the spices which were in contact with the Shroud.

06:57

We believe that the man in the shroud was buried in a dangerous, hurried, and makeshift condition, awaiting a second, ritually complete stage of burial after the repose of the imminent Sabbath.

07:08

In fact, the body, against all the ritual prescriptions, was naked and dirty. The imprints show us the situation clearly.

07:16

Nowhere in the geographical area linked with this research has any shroud in similar condition been found. In the necropolis of Antinopolis, only two funerary shrouds bore a vague imprint of the face due to the reaction of resinous spices.

07:40

None carried the imprint of the body because they were normally washed and dressed as it was the universal Jewish custom.

07:55

The Gospel of John says that Joseph and Nicodemus wrapped the body in linen cloths with the spices. The Gospel of Mark says that the women brought spices to anoint the body after the Sabbath. These facts are not in contrast. According to recent research on the composition and the nomenclature of old perfumes and spices, there were two ways, one not necessarily excluding the other, of using spices for burials. Spices in very fine and well-mixed powders, or , the word used by John, who was an eyewitness, and spices mixed in oil, or .

08:30

There are two further reasons to suggest that Nicodemus used the powdered spices, or mikma. First, the very short time available to accomplish their aim. Secondly, if they had anointed the unwashed body, which was covered in blood, sweat, and dust, the oily mixture, the stafate, would have stuck to the linen, the skin, and the wound, so that it would have been impossible for the women to wash the body ritually on Sunday morning.

08:53

Moreover, the ritual anointings of the corpse were permitted only after the seven ritual washings. This explains why so large an amount of spices was bought to be sprinkled all around in the tomb, in order to preserve the corpse until Sunday morning.

09:09

Galenus Aetius Dioscorides and others scientific and medical authors of this period tell us that aloes and myrrh were used for burial rites because of their antiseptic and desiccating qualities.

09:24

Allows, they say, dry the skin without burning it.

09:31

If we consider the marks of wounds which cover the body, we should refer to the Roman custom of the days. We have a great deal of information concerning the punishment of scourging. Pere, in his book Catacomb de Rome, gives a very clear reproduction of a flagrum, flagellum, scorpio, plumbata,

09:52

various instruments designed for punishments of different gravity or even for executions. These instruments were found in the Roman catacombs and consequently their authenticity is certain. A closer examination of the shroud in order to reconstruct the scourging was made by Monsignor Giulio Ricci of the Centro Romano di Sindonologia.

10:13

It was possible to locate the strokes from the whip by encircling the small area marked by the end of a hypothetical whip. The uniform shape of the small round points would seem to suggest that we are dealing with wounds of a lacerated contused type. It seems that they were produced by pointed pellets of about 12 millimeters. They seem to be in groups of three, consequently made by a with three thongs, the ends of which were weighted with two little pointed balls.

10:42

There is a tradition concerning a low column to which it is said that the condemned man was attached during the scourging. Many pilgrims

10:49

Pilgrim of Bordeaux, Italia, Paola in the year 333 say they saw it in Jerusalem. At the present moment, it is impossible to discuss the authenticity of the column.

11:08

However, it is very interesting to note that the marks of the phlegm on the top of the shoulders give us evidence of the bent position of the body. It is possible to see that the blood from the wounds on the top of the shoulders flows toward the thorax.

11:22

The imprint of the shroud shows us that the whole of the cranium is covered by blood trickles from the occipital area to the bregma. She says that's up here.

11:30

It shows us that the crowning with thorns supposed origin of these wounds was carried out in a typically oriental way, not around the head, but on it. The crowns of oriental kings at that time were like a mitre, which covered the head. If crowning with thorns was in fact carried out in this oriental manner, it would correspond exactly to the John's description, they put it on his head, 19.2.

11:54

This is a very strange occurrence which went beyond Roman penal procedure. It is historically and archaeologically anomalous, which can give us decisive help in identifying the man of the shroud.

12:10

As regards death sentence and execution by crucifixion in Roman times, we may work more on historical information than on archaeological discoveries. However, the documents can also help us to read the imprints on the shroud more exactly.

12:24

In the dorsal area of the man on the shroud, there are two large contusions. Those condemned to death on the cross had the horizontal piece of the cross tied behind their shoulders on the way to the place of execution. Their arms were outstretched and tied to the wood. There are very careful descriptions of vicinus claudius and justinus.

12:45

The vertical part of the cross was always fixed firmly into the ground and used for several executions. It was called the stipes. The horizontal part of the cross was called the patibulum.

12:59

If there were several condemned men, they were fastened to one another by a rope in a strange and characteristic way. A rope from the left calf was attached to the left end of the patibulum. The right end of the patibulum was attached by a long rope to the other condemned man walking ahead in a grim chain.

13:18

Studying the imprint of the shroud, it has been possible to reconstruct the difficult and painful way corresponding to the Roman laws, the man of the shroud walked to the place of his execution. On the left leg are the mark of the rope which tied him.

13:35

The marks of the falls are clearly visible on the face and on the left knee. They agree perfectly with the information collected about Roman abduccio,

13:46

the way to the execution place by eyewitnesses of the time. It should be added for a better estimation of this study that Roman historians say, meaning to die on the cross and meaning to die on the way. In Roman law, the two were equivalent.

14:09

the way the crucifixion was carried out was not an unalterable right but was subject to the whims of the executioners josephus an eyewitness of the siege of jerusalem in the year 70 says that the romans crucified the jewish prisoners in various positions as a mark of their contempt a man was attached to the cross by ropes or by nails or by both together in the case of the man on the shroud there are the unquestionable marks of nails

14:37

We have archaeological information concerning the shape and the form of the nails in use for these executions. I refer to the famous discovery at Jivat Hamitvar in Israel of the tomb of a crucified man named Johanan Bar Eitekiel. His feet were still held together by a single iron nail, 18 centimeters long, the same shape as the nails used in the buildings at that time for the roof carpentry.

15:04

The Roman technique of crucifixion permitted the condemned men some desperate movements, provoked by the terrible pain, but above all by the necessity to raise himself up, pushing on his feet to avoid asphyxia. In fact, a man hanging from a cross, there are the famous experiments conducted by Professor Hermann Müller in Cologne, rapidly suffers severe anoxymia, even if he is simply tied at the wrist by a cloth.

15:31

The movements on the cross of the man buried at Midvar have been anatomically described by Professor Niku Haas.

15:38

On the radial bone of the right arm, a large abrasion is still visible. This was due to the rotation of the arm around the nail.

15:46

The shroud shows us something very similar, although different in the mechanics of the movements. Raising up, pushing on the nail in the feet, and drooping down, hanging mainly from the arms. The magnitude of the movements was calculated by the divergence and consequently the calculation of the angles between the two different trickles of blood flowing in two different directions on the left forearm and two similar trickles flowing in a comparable fashion on the sole of the right foot. On the shroud imprint we find one further detail which is of interest for an archaeologist, the wound on the right hematorax.

16:22

It is a wound from a sharp weapon four centimeters wide.

16:26

In recent excavations at Jerusalem, many Roman lances used during the famous siege were found. It is interesting to note that the width of the lance at its largest point is four centimeters.

16:37

The foregoing is a summary of the conclusions arrived at by the Rome Center for Shroud Studies on the basis of archaeological and scientific research. I hope this account may have clarified some points and that the studies of all of us may lead to an even greater understanding of what we are perhaps justified in calling the greatest archaeological find of our time.

17:17

Thank you very much, Dr. Ciliotto.

17:20

Before we get to the summary papers, I'd like to call for just about a one-minute stretch break. We can all sort of stand up, stretch our legs, say hi to the person next to you, and then we'll get started. But stay where you are, because we're not going to go out into the other areas.

17:51

part of our two-day symposium on the Shroud of Turin. We're now going to have three persons who have been very much involved in the Shroud research.

18:12

And they will be speaking in turn. Their names are Dr. Rogers, from the Los Alamos Scientific Laboratory, then Dr. Jumper, formerly of the Air Force Academy Colorado, presently of Wright-Patterson Air Force Base, Air Force Institute of Technology, and Dr. Larry Schwalbe of the Los Alamos Scientific Laboratory.

18:41

The first speaker, Dr. Ray Rogers,

18:47

has a, in my opinion, rather amazing capacity for simulating information and doing something with it.

18:54

So I think he was very much a natural to be involved in trying to put everything together as best we can. That is a difficult problem because scientists have

19:10

are notorious for disagreeing with each other. And believe me, that happens here within our group just like any other research group as well. So when you try to put together something that everybody can kind of live with, it's a non-trivial task.

19:32

All three of the speakers have attempted to do this. Now there have been a lot of meetings here within the project to try to coordinate all this input into some meaningful fashion. So without any further ado, I'd like to first of all introduce to you Dr. Ray Rogers, who will be followed then in turn by the other two speakers.

20:09

This one's easy.

20:11

I've been talking to people around from various lines of work, some of the press and some of the theologically inclined and the scientists, and we've, as John said, argued our points among ourselves for what seems like lo these many years now, and it occurred to me that what I really wanted to do, before we open things to discussion and questions, was to explain our philosophical model for the program. I don't think, you know, you've heard the word hypothesis over and over again and lots of little things like that, and I'm almost positive that we aren't all on

the same beam. So let me explain a little bit about what it is that we use as our homogenizing philosophical model among us. It's called scientific method.

21:04

It's a classical method that arose at least back into the renaissance and it has very specific elements in it these are recognized and that's what makes these these elements make an operation scientific it's not all the little black boxes or it's not the tremendous knowledge and libraries or anything like this of any given person it's scientific method of philosophical approach to things It's the thing that allows us as scientists to decouple our personal opinions from the observations and the hard facts of any sort of an operation. It isn't really valid to walk up to somebody and ask him what his personal bent in religion or anything like that is if he is practicing scientific method.

21:59

And you can check it by the elements that he tells you

22:03

his program okay what are some of these elements in the first one of course is to state the problem to identify the goals now that sounds very easy but what are the problems and what are the realistic goals that can be managed from something like the the shroud project

22:23

Now, science can attack anything that can be observed in a reproducible, reliable way. And the shroud, unlike ghosts and UFOs and Bigfoot and things like that, can be demonstrated to exist. It's there. It's a material object.

22:40

So it's perfectly scientifically all right to do a scientific study on the shroud. You can observe it and you can try to explain it. That can be then observed. The goal, the problem is to observe it and try to explain why it looks the way it does to you currently. You can't say anything about how you think it might have looked a long time ago unless you've got data that allows you to extrapolate. Can't do anything else. You can try to explain why it is the way it is now.

23:14

To test its authenticity, we can't even agree on what authenticity is. All we can do is try to explain the way it looks now.

23:24

Okay, number two is to assemble all of the pertinent data. Things have been done before, it's been observed before, get all of the data together, and now you run into another one of the problems. What is pertinent data? It's fairly obvious that the sorts of things like the Gilberts and Schwalbe and so on have presented black box type operations that don't have personal opinions.

23:54

All you do is write down the numbers and you present them. Okay, that's pertinent data. Now, what about somebody's subjective observation of it?

24:03

I think I saw something on it that would have proved Ian's theories in history or anything like that. What about gospel accounts? Are these pertinent data? No two people are going to agree on what is pertinent data, and a lot of the arguments among the individuals involved in the program and in any program in science revolve around what are pertinent data. That has to be settled before you can go on. And then on number three, you derive hypotheses.

24:36

All these are imaginings of how could it have happened. Whatever the goal is, how could that observation exist? You put these all down, and it's very important to use a classical method known as the method of multiple working hypotheses. The worst thing a scientist can do is to choose one hypothesis, dig in, and protect it to the death.

25:05

You have to use multiple working hypotheses, and this is certainly one place not to exercise a closed mind.

25:13

you can cast any kind of a hypothesis you want with a shroud you can say i believe that that was painted in the black forest by elves and that is a perfectly legitimate hypothesis to propose and you better test it right along with all the others okay get your group together and try to make to get as many hypotheses as you can it's an open-ended game and there's another problem in science You can never prove that you have identified all of the hypotheses.

25:44

We may have missed hundreds of them that are important to this program.

25:49

Then, you have to make your observations.

25:52

You have to make the observations based on your hypotheses. You design the observations to test the hypotheses. This was one of our problems with the Shroud. We had observations that were reported to us before we went to Turin, We read everything we could find. We got the photographs from Pia and Henriette.

26:15

And we looked at them and tried to generate as many hypotheses as we could, and then design the observations to test them. You had to test, for example, Pierre Assis, it's a painting. So the X-ray radiography, that's the way you look for paintings, variations in paintings. A lot of the things that we designed in the way of observations came down hard on hypotheses that turned out to be intrinsically weak. but you design your observations to test the hypotheses.

26:46

And then you test the hypotheses against all of the data. Sometimes some of the data fall. If you've got something that's a little shaky in the way of information, you may prove by other observations that it's no good, and you have to throw it out. But if you can shoot any of your hypotheses down, get rid of them don't sit there and protect them just throw them out keep the ones that are the most probable and keep testing them that's where you get your objectivity and it's testable objectivity you can show other people what you're doing and they can say oh you're full of beans or something then when you've gotten maybe one or a few hypotheses left you can make predictions on the basis of those hypotheses and do experimentation just like

27:35

He said, I think that if it was the result of a latent image process and accelerated aging sorts of things, that I can achieve the same kind of spectral characteristics by, and then he tries a whole bunch of things. And that is your experimental test for the system. You can extrapolate, you can use all kinds of bits of evidence to test your observations. And this is exactly what we have been trying to do since the very beginning. And the little isolated pieces that you have seen and have heard reported are bricks in the wall that we're trying to build. And now we'll try to give you an idea of what we think the wall looks like. And feel free to shoot holes in it. That's what everybody should do. Don't leave any stone unturned if you can turn it.

28:30

It's fun and games. Throw everything at it you can.

28:35

Shall we put the wall together? Believe it or not, yesterday... Yesterday I had a paper I was going to read. As the days evolved, I'm down to a couple of pieces of paper with some sketchy notes which I changed two minutes ago.

29:04

It reminds me of a joke I saw some time ago with BC in it, the cartoon strip. This guy is sitting listening to this guy talking and the sun's coming up and then it's high noon and then the sun's going down. He says, is there any questions? And BC says, could you repeat that? And that's what I feel like I have to do here. But I'm not going to repeat it because I think this morning we had a group of papers which went all the way as far as they could go people said what was on their mind all i want to do is remind you of a few things that we've done uh if i could have the first slide please and the house slides down a bit no thank you that's not it that's not the slide would you take that off please it should be a color picture of the

30:01

Four from there. Vern, would you go up, please, if we have problems?

30:07

No, that's not it.

30:09

Not it. Advance four times, please.

30:18

Stop. Back up. Okay, focus that.

30:32

Now, this is the subject of our observation, and as you know and you've heard over the past few days, we did a certain battery of tests to try and find out what was on the cloth. The battery of tests were the photographic imaging, which consisted...

00:02

uh if i could respond to that one i'm not sure that john actually said such a thing but i would say uh i will go as far as i think the team would go in as a kind of at least a majority it may not go over to to the um there's certainly

00:23

but I would say that in general, I think people are beginning to think that there was a dead body under a cloth, but even that we cannot prove.

00:33

I don't think that anyone would go beyond that statement to thinking that it's the burial cloth of Jesus. I don't think that anyone has allowed themselves the privilege of having that kind of an opinion, simply because we have access to the information, and until the carbon dating comes out, i for one would not like to be made the fool of and i think a carbon date is essential at this time oh i don't think that would be appropriate i don't know uh i think we'd have to raise our hand first to see if the team would want to raise their hands so i'm sorry that's just not appropriate Please come up here.

01:25

I didn't want to be quite so public about it. Senora Ciliato just went downstairs and escaped, but while I was eating lunch with her, she suggested something that is mostly for the team. Well, I've got you all in one spot. The idea of the aloes being a desiccant and the idea of there being lots and lots of it in the tomb as opposed to what we thought of and sprinkled around as a powder as opposed to what we thought of, it's pretty interesting with respect to the textual question over there, I think. I don't know whether a desiccant would make linen more stiff or whether its weight would press it down give it a little bit closer contact and tend also to draw moisture from the body more than we had normally thought through the linen to give a greater image i just tossed that out i thought it was a very interesting idea okay so that was on the part of who was that maria celiato okay do you have a question on that side i have one question over here

02:22

My name is Joan Peake, and I'm from Clifton Park, New York. And as I was listening to the talk, I was interested in the particle talk about the absence of myrrh and aloe-type particles. And Dr. Marie Gambishi, is that her name? Celiato's work would also seem to indicate that we should find particles of that in the shrubs. Then when I saw the mites in Dr.

02:50

ritchie's talk i wondered could it be possible that the mites might have eaten the yellows and the myrrh they must have been there to eat something something must have attracted them and i just throw this out as an idea that occurred to me anybody want to comment on that one uh al i'm talking about team members commenting so i think you should be aware what we said we've tested Coptic and Pharaonic mummy cloths that Dr. Ricci provided, we have no trouble finding the presence of vegetable dyes on those.

03:25

They've existed longer even than this is postulated to have existed. We do not see any evidence of vegetable dyes in the Shroud Tribal.

03:34

I'm sorry. As far as I'm concerned, there's no evidence of any aloes or any myrrh anywhere near contact with that cloth. I think the reason we don't see it is because it wasn't there. I think that's also the conclusion of Dr. Rigi, is that not, that he did not find any?

03:54

If you want to say, Dr. Rigi, first we want to say that about the, what the mice have to eat, that they have a cellulose, a metabolic cellulose, you see, cellulose, they eat each other. They don't eat anything else than the cloth to eat. and am i correct in saying that he did not find any more or else yes that's so we have two separate uh well actually more than that we have not found any more or howls period he doesn't see murray question on your side john

04:41

The absence of the carbon dating test is a limitation in determining the age of the cloth, yet we've seen a couple slides come up here on the coins and the eyes. I was wondering why there has not been any discussion as to the relevancy of the coins and the eyes to determine a tentative dating if you already have assumed that it is a dead body who was crucified, then the coins would seem to be a relevant determination of age.

05:09

I'm glad you asked that question. We have, I think Vern Miller has done, the reason I am glad you asked the question is that there had been an awful lot of things in the press about the work of Father Filus on identifying some kind of structure on the coins. And Vern Miller met with Filus and looked extensively at some possible images that might be what files is uh... looking at night i thought vernal or was prepared to take that or you don't okay would you find in the meantime don you want to comment on that okay just pending pending burns

06:04

uh no one else that i know in looking at the images has seen the characters that father phyllis reports okay so none of us can say yes they are there neither can we say they are not there until you've examined every bit of data okay so basically since we cannot say they are there or not there there's not much you can say now that

06:28

We'll see what Vern has to say. Yeah, and you notice Don says that he knows of. I think many of us have seen what Files is talking about, and our opinion is that we just don't interpret it the

same way. We think he's looking at something that is just an artifact. And when Vern shows up, I'll put him on, but here he is. Vern, would you come up and comment on the possibility of seeing inscriptions on coins?

06:56

Okay, we also had an additional thing that artifact may be handicraft, so Vern's going to explain artifact, or he can use another word. I didn't mean to throw that.

07:15

Okay, well, I'm not sure where we are. We have a slide on the screen now to discuss that. We would get it. Would you turn on the projector and put the first slide that's left on it?

07:25

Would you turn it on? Just a switch there. Some electrical engineer or something can... I had an opportunity to work with Father Pylos about a month ago. We spent a week going over all of the photographs that were taken in the 1978 investigation. That was fast. That was the one. Yeah, and then it'll go from there on.

07:55

And we were looking to find anything in the present photographs that he sees in these pictures from the Henri series. So I'd be happy to explain his words to, or as I understand them, it's what he's saying, but this is a first century coin.

08:18

Could we get the lights a little bit, please? Yeah, I think you should here. But this is a first century coin, a lepton coin, and it has this stamp, a little of this, and there's some lettering around this point. Now, of course, this coin is in existence, and it certainly isn't the one that was on the shroud, but Father Pylos feels like there were other coins, and it might resemble this particular coin. I understand these are all hand-stamped, and we do have some point experts who will explain that better, and that they're pretty individual, that not one or no series would look identical.

09:01

Now, encircled in red here, this is very difficult to see, is a copy of a copy of a copy of the 1933 photographs. And these characters through here,

09:15

are what Father Phyllis suggests are these coins. So once we plant that in our mind, and I suggest that to you, you'll probably be able to see them. Now the question has been is why can we see them rather clearly there and not in the other photographs? And the other question is are these artifacts of this coin or a coin like this?

09:42

and i have an opinion about that from studying the other photographs if you're going to the next series maybe that'll help a bit now we're looking uh in this eye and you'll have to stay right on that focus so that it doesn't go in and out we want to look at the weave

09:59

And there are some details, and these will be landmarks that I can point to as we go on. Now this little marking here is a stain of some type. I haven't identified that, but I'll show it to you in color as well. And that's our landmark, and we go up past this dark area and into right here. This is the point where he sees these letters, and you can see some character there now.

10:22

Now this is the reverse image, so when we see

10:26

dark or light here against dark of course it's the reverse of that it's a darker image against the light part of the cloth and when we go back it's going to be a reverse of that but my contention is if you can see it in any one of them you should see that in all of them and i'll get to the end of my what i feel about it is that the What we're seeing is light and shadow, crowns of the threads and shadows cast from cylindrical-shaped threads and fibers. And depending on which way this cloth was photographed from the lighting, if it was raking lighting from what particular distance, will enhance those shadows, make them larger or smaller, and the highlights larger and smaller. And you can make out anything you want to out of it. Now, if we go on to the next slide, and I can show you again.

11:15

Stay right on the focus more. See, again, these slides were reversed left or right so that we could stay in the same area. So there's our landmark. Focus once more, please. You're past it.

11:26

You've got my close-up eyes, and I've got your long-distance eyes. There we are. Now, here's the mark, and this would be that point, and you can go right straight up from that, and this is the area we're looking at. Now, you can't see anything, even from the back of the room there. Is that all right?

11:44

Now let's go to the next one, which is a bit closer, and I think it's now up there closer. You can see the weave very well.

11:51

And all I have to do is find that landmark, which is a big goo god right there, I think.

12:00

Is that it? Oh, yes, this is the blood stain.

12:06

Keep going in on that focus, because I'm...

12:09

If you're far away, you'll be able to see it better than I will.

12:18

So this would be the area and this is a dark spot here.

12:25

This and this here. Well, right in here is where we're supposed to see those lettering characters.

12:36

And if you stare here long enough, and I tell you long enough, you'll be able to see it. Now this, I believe, this is the Littowis.

12:45

Now I spent a week with it, so I know right where I'm looking. Now, you know, the thing that Eric and I have talked about is that I've looked at a lot of photographs and computer enhancements and things of this area, and there are some very interesting features, and I'd like the research to continue, and I think that if it went

13:07

Slowly, I'm certain that there are some spherically shaped objects there that have a dimension to it from what I've been able to observe. And I'm concerned about identifying characters that couldn't be resolved in something like this. Yes. Yes.

13:34

There. This is the lettering? That's too small. Yeah, that's it, huh? Okay, if you buy that one, I've got a...

13:49

at a marshland in New Jersey, I'd like to show you. Okay. Now, if you would go to the next slide, please, because, see, one of the things we're looking at, high-compact representations of this same image that I'm showing you here in color now is much more... less contrast and we see into the shadows and into the highlights of the detail so nothing has been removed and your eye can't put physiologically all those things together. Now if we can find the same place, is that the same place do you think that we were just looking? There's your mark down at the bottom. Oh, I see.

14:29

Now we go right up this series of threads and we can follow the weave pattern. If you'll focus once more for me.

14:39

There, that's good. Now go up to here and right there. This area right in here is what we're looking for as far as lettering.

14:58

Dropping a little?

15:03

Well, I think that that demonstrates pretty well what we're dealing with anyway. There are some various densities in the same color, and there are some densities in other color. And if we filter and play around with these, we can pull them out and make it show almost anything we want to.

15:24

okay we can have the house lights up and the slide projector off i think the point here is that we have tried to look at this and we do not see any substance to what he is seeing and what verne

said at the end there is that in order to see the full picture of what he's saying he sees we must examine things on the cloth which are different colors and due to different lighting conditions which means that they are simply accidents in the way that the thing is there that's the way that we're interpreting them we do we don't at the moment we do not find any credibility to it do you want to tell them where where the idea or first suggestion of coins came from i i hate to do it but it wasn't no i think that's i think it's jackson and i did this uh that's why i asked you to do it yeah all right

16:22

There appears to be some kind of a disc-shaped thing there, and Vern has found that. It does seem to be slightly elevated in intensity above the background. Some time ago, when we found this distance information in the image, if you were to get a relief from that on the VP8, you can see these disc-shaped things elevated slightly above the background. the location of the eyes uh john and i ventured a comment that they might be uh coins uh and i guess we all have things we wish you had not said but at the moment uh my feeling is that that i don't say they are don't say that they are not uh i think it's more important that we understand

17:18

the image formation process than look at these kinds of things.

17:23

And so I understand, and the only reason we were interested in is, like someone mentioned, if you could date a coin, you could date the image, so to speak. It's a very sort of exciting kind of a thing. But at this point in my life, I think that that's something that we have spent enough time doing at the moment and has led to nothing which we could call definitive, or even approaching that position.

17:55

There is a question. Yeah, I'd just like to add just one little thing to that. When we first looked at this three-dimensional image, It does appear that there are little disc-like objects on the eyes if you interpret the image in that manner.

18:13

And I think that was really the genesis of this idea of coins, but to be able to go and read any possible inscriptions on such objects, if even they are, as Eric says, coins, and I think that ought to at least be seriously considered. I do feel that, but to go to the point where you say that this is somehow, If you can read inscriptions on this with all the noise that exists on that image, you've seen how difficult that is.

18:48

You have the next question. Please identify yourself.

18:52

I'm Roger Richards. And like most of the audience, I couldn't get tickets to all the sessions, so I'm going to take a risk here of asking the obvious.

19:03

It's been pointed out several times that the image is only on the upper virals of the cloth, that it only appears on one side and not on the other side other than the fluid that seeps through. That's been referred to as the top of the cloth. What I'd like to know is which is the inside of the cloth and which is the outside of the cloth as it was wrapped around the body.

19:32

The two theories that were on the last summary slide, and most theories that you can think of quickly, would seem to imply that the image would form on the cloth closest to the body, that side of the cloth.

19:49

We don't know what formed the image. I don't think we can really rule out immediately that it did not form on the outside. But if it did form on the inside,

20:02

then it would be not only a negative type image, but it would be a mirror image.

20:08

So my question is, well, the important point that I suppose you can think of it in that way is that the side wound would actually have been on the left. My question is, has that been spoken to at all yet?

20:29

Are the slides? Let's just start, if that were the case, if it was formed from the inside and you were looking at a mirror image, as you say it would be a wound on the left side would appear on the right side of the person image it turns out that the thing on the shroud is on the left side of the image which means that it would be on the right side of the body underneath so either you saw some things backwards which is very easy to do happens all the time slide goes in backwards

21:06

Well, in other words, you're assuming that the image did, in fact, appear on the inside. Well, of course, you can't rule out the idea that the image would form on the outside. I don't know if anybody wants to speak to this.

21:22

But the blood, well, the blood stains go away.

21:25

First thing you should point out, we don't have any evidence that it actually wrapped the body. That's an opinion, not a scientific fact.

21:34

Yeah, that's true. And the cloth body distance information that we have, the correlation curve, has come from the assumption that there was a body under cloth and get a correlation curve. And the only problem with that is you would like to close the loop and say, therefore, it was a body under cloth that caused the image, except for without the mechanism. you really cannot close the loop it might have been several step process getting to the image but that's the only thing i i know that we have that address that even addresses that question and uh as advers just said we we have there is no definitive proof that there was a body under the cloth as i say it's an opinion that some of us share but not all not everyone thank you

22:25

Dr. Ciliato said that other shrouds have been found with images, facial images on them, which leads one to believe that that phenomenon maybe is not that uncommon. I wonder if the team has any plans to investigate the images on any of those shrouds for comparison purposes to see if the mechanism is the same and the information that they get off those shrouds is similar to this information.

22:51

i think if unless somebody in the group has a response to that my understanding is i have seen pictures of these images and they are smeared and they are not similar that similar to the shroud image in that the resolution is damaged i also understand that those images penetrate the cloth and they are more images due to decomposition than due to you know unknown causes i don't know more than that i don't know and is there anybody who would contradict what i've just said i see dr regie from turin shaking his head yes so i think that that must be the case is that essentially correct ma'am on the uh maybe joan or dr canelo and we might speak to that could we take the next question well we may have something to add to that

23:48

I'm Tim Mulroney from Bell Laboratories, and my question's kind of an easy one. I've seen most of the slides here have figure one, figure two, and I've seen a couple of the articles. Is there going to be where I can get a copy of all these published papers or a list of where they're published? Some of these are in pretty obscure journals. The answer to that is that eventually there will be a set of reprints

24:14

The journals, I think, are not so obscure. For example, I wouldn't call applied optics an obscure journal.

24:21

And archeology is, I think you can find these things. We do have a bibliography available, I believe, if you contact

24:30

Anyone here, they could probably give you a bibliography of things that are already published. But the answer is that there's, at least that I know of, there are at least two plans to do, in one case, a partial binding of reprints, possibly reset. and the other one is a simply a binding of reprints and that is when we get a significant number of papers that we think are no there are no none coming in for a while we'll essentially end the project with the final report which will be composed of a set of reprints probably very limited i don't know who you'd get in touch with to to get such a thing tom tom de mahala would you like do you have anything to add to that question as to where people can go to get information He said no.

25:25

Dr. Cannella, we'll have a comment here. It was Mrs. Ciliato that asked me to tell that some of these images that she saw or have been reported have something similar as appearance to the contact images that Pellicori showed.

25:44

and they are very broad features of face. They have nothing like the resolution of the shroud, but there might be something similar there is.

26:00

Okay, so that essentially confirms what we thought.

26:04

Go ahead with the next question.

26:09

My name is Greg Sherman from Clinton, Connecticut, and excuse me if this question has already been brought up. I've only been here for the latter part of today. What brought me here today was I was reading a newspaper article about the Shroud, and it stated that there was no evidence of holes or tears in the Shroud, which would have been...

26:33

there if the body was removed by somebody tearing or unwrapping the shroud to remove a body. Is there any scientific evidence as to how the body could have been removed if, per se, there was a body in there?

26:50

I have a hypothesis. Lift the cloth off the body.

26:56

That's an hypothesis. I suppose we'd have to test it with the observations. Let me ask a question. Are you referring to the notion that bloodstains are so-called intact? Is that what you're referring to? I'll try to give my response to that.

27:22

When I was in Turin looking at the Shroud, one of the first things that struck me when I looked at the bloodstains was that first of all, they looked red. Number two, it was material that was on the cloth. And number three, this is the important one I think, the relevant thing, is that the bloodstains look like they're coming apart. They're ablating, they're crumbling. And how

27:50

one could make a statement in light of that as to what the initial condition of those blood stains were when you see them today as being eroded.

28:01

I don't think that one can make that kind of a conclusion just based upon what we see today. I agree.

28:16

I'm Bridget Smith from Croton. I'm the host of New York. I have a question regarding the blood.

28:22

First, I would like to make a comment as a normal person. As a believer, I didn't need any additional proof.

28:31

I want to thank the scientists for all their work. I feel as though I've been

28:36

taking part in a two-day autopsy with very, very technical data, and I think some of us really just came to mourn. My question on the blood is, in all this time, wouldn't real blood have decomposed, and wouldn't it have caused the decomposition of the clot? Dr. Heller? No.

29:10

I think that the chemistry of the blood is well understood at this time and that we are seeing degraded blood in all sorts of stages from whole blood down to the final product.

29:31

I'm Giles Carter from Ypsilanti, Michigan, and I would like to ask a question of the pathologist if he would take a look or maybe remembers the picture of the fingers. We had a comment in the paper yesterday, I believe, on the too long fingers due to possibly the distortion produced by the drape of the claw. However, if you look at the

30:00

Unless, being an abnormal person, my fingers are not normal. If you look at the length from the tip of the finger to the base of the finger and compare that length to the tip of the finger to where the nail was driven through the wrist,

30:19

It would seem to me that, according to the photographs that I've seen here, that distance is too great to be just an elongation of the finger. In other words, if the finger itself were elongated, you would still have this ratio being about 1 to 2, whereas it looks to me like it's maybe 6 tenths, well, 1 to 1.4, something like that.

30:51

Yeah, unfortunately, I believe that the pathologist had to leave him.

30:57

I think that, John, would you like to mention, or is Bill Urquhart? It's a good observation, though.

00:10

Yeah, okay, it looks like it's outside of three standard deviations. It is a problem It's still within a Gaussian distribution We we probably should look at that in some more detail Especially now that we know that we're identifying such things in the finger region by these extreme color separations that Don Lin showed we know that the finger area is not just body images we had suspected but blood image as well which means that there's some contact mechanism in play at that point it may be that we're seeing something uh in the way of blood there which appears to be a finger we should look at that i agree There's another thing I might point out that when we talk about mechanisms we stop short of saying simple mechanisms and we have not at the moment considered any combination of mechanisms and it seems apparent from these recent color stretches that it's possible that there could be multiple mechanisms in play and I think that that question that Professor Carter asked does bear on that exact point.

01:31

I have one over there. I'm not sure. You may have partially already answered my question, but earlier this afternoon's session, there was a graph on the board here that showed the hypothesis for the image, whether it was artifact or whether it was from a genuine body. and then in the area of the genuine body category um there was the vignon vapor graph and the pellicori uh contact theory and yet the uh yesterday we had from the uh from the vpa image analyzer we see the results that there had that there was probably some kind of a the three-dimensional element suggests that there might have been some kind of a projection mechanism involved and i was just wondering um since you were willing to take hypotheses of black elves in the woods why these why the possibility of the projection mechanism was not considered as a viable hypothesis even though it does suggest the element of the supernatural

02:40

Now, I'd like to just respond to that first, I guess, and whoever else.

02:49

I think you're probably referring to that one visual aid that I put up at the last of my series of talks. Please remember, all that was was an attempt to put a graphical reconstruction of what I think the various image shading and mappings would come together as.

03:11

I don't want to tie us down to thinking that that particular reconstruction depicts exactly what must have happened. I mean, I'm not trying to say that there is an information mechanism implied here, just a sort of a mnemonic kind of a device to be able to help us maybe have some insight or to be able to kind of graphically show what we're dealing with.

03:40

As far as the image formation mechanism, there are so many things about this that are puzzling.

03:48

I don't think we're anywhere near any satisfactory explanation. We probably should have the little Jewish boy answer this one. Okay.

04:06

uh we have two people who'd like to address that question so say here just a simple comment practice probably what my college was going to say we haven't ruled out projection mechanisms the problem is we can't make them consistent with the chemistry research projection mechanisms usually involve ionizing ionizing radiation side mechanisms dad would not give us the chemistry we said but put it out this morning that's our problem

04:31

We know some good ideas about the physics. We know some good ideas about the chemistry. We don't have to put the two together in a simple way.

04:39

Okay, before I answer the question the way Murray thought I was going to answer it, let me say something about the projection business. We've done a lot of experiments on that. I don't know whether Joan Janney's around or not, but she has done...

04:55

a lot of trials on different kinds of radiant energy falling on various kinds of cloth under all kinds of circumstances. And what you find out with these projection-type things is that, as Al said, the chemistry is entirely different when you hit a cloth with a highly energetic radiant energy flow. UV light, for example, in an intense burst, blows the surface of the cloth off. It's almost like you detonated an explosive on the surface of the cloth. It puts a shockwave through the cloth and sort of powders it. Infrared causes it to pop like popcorn. Nothing that she tried made cloth color the way the image appears. All she did was make it disappear. The other item is that we're not

05:45

I think I heard an implied accusation that we would ignore the supernatural.

05:52

We can't observe the supernatural. If you can give us a matched litter of volunteers who will volunteer to be resurrected and let us do experiments on them, then we've got something to go on. Otherwise, we don't. Larry put his slide together to cover the things that could be observed in terms of scientific measurement, and that's all we can talk about.

06:17

My name is Dolan. I'm a Philadelphia lawyer only.

06:25

The question is purely factual.

06:28

Does microphotography show tiny traces of cotton in the crevices of the linen from the immediately previous run of the loom for 38 inches of the total width and no such traces for the remaining five inches of the width indicating that the cloth as we have it is composed of two pieces made at slightly different times and later put together.

07:03

It was reported elsewhere, else when, back in 1973, that someone from the European Center stated that there were traces of cotton in the weave of the loom.

07:16

We have not been able to observe this microscopically. Any cotton that we have seen is apparently accidental or superimposed.

07:26

We have had conversations with several textile experts, one of whom is here, who's the curator of textiles for the Cleveland Art Museum, who tells us that in ancient times there were linen weavers and there were cotton weavers and they never got their twine confused. That those looms that were used for cotton were done by the cotton weavers and those for linen by linen weavers. And admixture is something that neither Sheena or any of her colleagues had ever heard of. I have a bunch of things I want to say to this. First, we've got a pretty good reading

expert here in the audience who worked very carefully with me at some of the radiographs and some of the pictures that Boone had last night.

08:20

I think we have evidence, first off,

08:24

Indeed, there is cotton in the weave itself of the main body of cloth. The reason I say this very emphatically is that we had one tiny, tiny little bit of thread, a so-called genus thread, from the heel area, about a quarter of an inch long, that was wrapped in polyethylene. It was one of the ones, in fact, that was pretty interesting to me because when I took it to the mass spec at the University of Nebraska, they said, aha, polyethylene. And I said, whoops.

08:54

Turns out that the mass spec is sensitive enough to find the polyethylene. Well, this had been poked and prodded with a lot of maybe dissecting needles and things because lots of people were interested in it. What interested me most was the thread that had the most blood spec on it was cotton. It was not linen. And it was indeed twisted in with the linen. I don't know whether cotton absorbs blood a little bit more. I suspect it does. I think linen...

09:19

is not quite so absorbent. We subsequently looked and I think we found that all the cotton on it was not an accident. However, we don't have that much thread from the side strip. Well, looking at it last night, oh, before this, we looked at the radiograph for a long time one evening, trying to follow a thread through from the main body across the seam as it is that to see whether it is indeed a separate piece or whether it's a tuck or a piece of cording sort on the back or just what it might be. We think we can follow, maybe,

09:57

two or three threads across. It's very difficult because the radiographs were not that sensitive and also because the Holland cloth underneath has a very strong pattern also. So you follow the thread across and you think, aha, I've got it, but you find out it's the Holland cloth, not the shroud. And so this is pretty tricky, but it looks as though from some of the things I've seen up here, the bands, remember you saw heavy dark bands and lighter bands, looks as though the bands go clear across.

10:27

There was one particularly interesting one that I think Don Lynn had that he flashed across so fast I couldn't see very well, showing that the color indeed was the same. That was the image

enhancement, the diodes thing. The color was the same, clear cloth. I think that would not be if it were two separate pieces of cloth.

10:56

the water marks go through so this must have been sewn on before the fire many of them do go straight across uh kate and i last night were looking at one i pointed to ray's jacket lapel and i said it takes a pretty good seamstress to sew a seam and then top stitch it and not flip it a little bit look this is the way it would look if they'd sewn it on they wouldn't have been able to 14 feet of steam that straight unless they've been trying very hard to really match up the piece of cloth why would they do that i don't know but then we found several places indeed there was a little job however it looks as though if it had ever been severed it is the same piece of cloth that would mean that i don't think you would find different cotton among the others the whole thing though doesn't mean a thing

11:44

It couldn't prove authenticity. It couldn't disprove authenticity. We wouldn't know why it was put on, but it's fun to think about. It's fun to look at. Does it prove? I agree. That's one of the great fun things to think that that might be attached.

12:00

No interest to anyone. Excuse me, if we keep to our schedule, we've got about five minutes before we are to finish, so why don't we... finish up with these uh with the people who are here to ask questions then we'll dismiss the symposium okay and i believe we have three questions this this and that that's it okay so those are the last my name is michael fitzgerald i just happen to be one of the people who believe that jesus christ was raised from the dead and uh i guess my question is one of logic

12:43

I understand that science cannot analyze spirit. Science can only analyze that which it can see, hear, smell, taste, or touch.

12:54

Then, and plus there's other people here, the religious people, who would really like a comment on that.

13:02

Is it or is it not the cloth that Jesus Christ was wrapped in when he was raised from the dead? Yet science says they can't give you that answer.

13:11

Yet I'm impressed by all that scientific data.

13:15

And I'm sure they were financed for this project by a lot of people who wanted that answer. So therefore, before you even start on this project, you should logically go and see what the Bible says about this specific topic.

13:36

And the Bible is very specific about it. It's very precise.

13:41

And the fact of the matter was that Jesus Christ was not wrapped. He was wrapped in a linen cloth by Joseph of Arimathea.

13:55

Nicodemus came along and wrapped him in ascendant, which is strips of cloth about that wide, wrapped as a mummy, which was a traditional wrapping at that time. I'm sorry, we're going to have to call a question. if you you have a specific question sure we are well that's it if you were going to analyze something and say well we're going to analyze this thing and uh we're going to come up with an answer first thing in scientific method you've got to state the problem what's the problem your problem is we found a cloth we want to analyze it so that's what this isn't this is just some cloth

14:31

Right. Well, I'm sorry. I understand what you're saying, but let me make this comment relevant to that exact question.

14:39

We do not operate in a vacuum of things that have been done on the shroud. There are many, many groups in the United States and in the world that have examined this shroud from the perspective that you suggest.

14:53

There are very, very few. In fact, we may be the only one that has examined the shroud totally in the scientific context.

15:01

That is what distinguishes us from the other groups. We have tried to publish in the scientific literature. Now, I know that people, undoubtedly, we receive some money from people who are religious, and we appreciate every cent we've got because this has come out of our own pockets as well. But let me say this.

15:21

Even if you are approaching the question from a religious standpoint, it seems to me that you would like to have a body of information which is taken from an objective group which does not violate the scientific approach and which you can rely on because you can check the information in the scientific literature. That is what we've been trying to do and I think we've been pretty objective about what we've been doing and then the information is there for all who wish to speculate and it's there and it's been refereed by an unbiased audience and the information is facts. Seems to me that's available.

16:04

Thank you very much. I certainly don't disagree with that. I think you're tremendously objective, and I learned a lot from this about scientific methods, scientific data. But I guess the bottom line of it all is, is what are you going to believe in life? Is it going to be scientific data or the Word of God? My name is John Latham. I'm from Boston.

16:28

I plan on directing the question to the pathologist. I know he's not here, so I think it's awkward for anyone who can answer. The question is, what would be the way of detecting body decomposure on a linen which has come into physical contact with a cadaver?

16:42

And is the absence of evidence of decomposure unusual in these cases? John Heller, would you address that question? And then I think we have a comment by Bill Modern. following there are a variety of decomposure products such as cadaverine and others no such product of any kind whatsoever was found on the shroud that's all we can tell you there was none found okay that answer your question sir you hear the answer okay

17:24

Excuse me, we've got one comment by Bill Maher here, I think, on the last question. The gentleman just left a while ago and says, what can you believe in, either scientific fact or religion?

17:41

My answer is simply this. I can believe in both. Thank you.

17:54

that was bill modern from san diego laboratory also add to that but it's not only can we believe in both i think it's our right to believe how we believe and how we interpret but we have to be objective too ready with a question

18:16

My name is Lisa Traynor, and I'm a student. I would just like to ask a member or members of the team to comment on the accuracy of carbon-14 data.

18:26

Is Bob Denninger here? Bob, would you comment on that, please?

18:35

You can just tell me no. But is he up in the balcony? Don't leave the wall.

18:44

Bob vinegar has looked into this carbon dating question on several occasions and He can certainly answer the question of how accurate carbon dating might be and I just remind you that Bob vinegar is a PhD physical chemist as well as the physical priest What was the question? How accurate is currently? most of the new methods for carbon dating using the accelerator technique will sign their names to work plus or minus 120 years you take a look at their data it's probably about 50 years they just like to double it just to be on the safe side this is the last one right here

19:45

I'm Mike McManus again, I promise.

19:52

I'm interested in what remaining agenda you see, if any, for your work. I heard a reference that you're going to publish in a reasonably expeditious time, and that will be the quote, end of the project.

20:05

Are there areas, other than this carbon dating, where you feel you want to pursue more, and Is there a need, if so, for contributions? And if so, where should they be sent so that we can tell readers about them? Well, I'd like to respond to that if I could. There is an awful lot of interest in the research on the Shroud, and I think that's obvious.

20:34

What we have attempted to do is to take some data and then try to analyze it.

20:41

And we're at the point of time when we're making available all of our thinking and presenting our data to the public and to the scientific community.

20:56

Now, I think what happens in the future largely depends upon people other than our own group. It depends upon what interest is there. I don't believe that the interest in the shroud is suddenly just going to go away as I dismiss this symposium.

21:15

I would hope not.

21:18

As far as I'm concerned, we have still not achieved the basic objective, and that is what caused the image. That's a scientific question and something we can answer. We have failed, in that sense, to be able to put all this together. This has been said many times here by various people.

21:38

That's not saying we ever would be able to put together scientifically what the shroud is. And there could be a lot of reasons for that. So I think, I guess what I'm saying is that whatever would happen in the future, I think largely depends upon people such as yourselves.

22:02

Anybody else want to respond to that?

22:06

Okay, I would like to make a comment on that.

22:12

I think that it's been suggested in many of the papers that we've seen here that the answers to the questions have raised some new questions. There's no question about that.

22:25

We have a situation where we set up a nonprofit corporation which was specifically tailored for a one-shot evaluation of information on the shroud and would end a logical conclusion with a final report we are not at the stage yet of building that final report when that will come we're not exactly certain of course carbon dating is something that's foremost in our mind we would like to do that within the context of the group as it stands at the moment beyond that I think what you'll see is that the

22:58

The arrangements that were made if I'm not mistaken I think this was sort of the consensus in setting up this particular nonprofit organization will Come to an end and it will evolve into some other kind of thing which Will consider questions that have been brought up But I think you will see continued work. I think you'll see a lot of the faces change and

23:22

I think that many of us have really burnt out and would like to spend a little time doing something other than shrouding.

23:30

And so you will see faces change, but I imagine things will continue. And at the moment, I'm not soliciting funds, but there is a mechanism for taking funds in the present organization, and my understanding is that those funds, the organization will remain as it is for a short while.

23:51

I don't know how short that might be a year or so or more. I don't know. But there's certainly a mechanism for taking those funds, and any funds that were still in the hands of the group would pass on to the evolved group. And I don't think we've ever had too many funds. Carbon-14 is going to cost us. Yeah, carbon-14 will cost us.

24:16

The old one was like $550 in 1968. I don't know what it is now. The accelerator is like a lot more than that.

24:25

How much did you say? In 1968, it cost you $550 to get a carbon-based. Yeah, and I'm sure in 19, say the date again. In 68, it was $550. So you imagine with the new equipment and stuff what it would probably cost. I am not soliciting funds or anything like that. But it would be New Tech Corporation, I suppose, would get there in Amston, Connecticut. I don't know what the zip code is right now. I think I can give that information.

24:55

If anybody is interested in helping the project and would like to make a donation, you can do it. We don't have this written down. This is sort of a spur-of-the-moment thing. But you can send it to the Shroud of Term Research Project Incorporated Post Office Box 1, Amston, A-M-S-T-O-N, Connecticut, 06231.

25:25

I'll repeat that. Shroud of Time Research Project, Incorporated, Post Office Box 1, Amston, Connecticut, A-M-S-T-O-N, Connecticut, 06231.

25:45

Your donations would go entirely to support the research, but it does not go into the pockets of the scientists. It never has.

25:57

Okay, with that... Yes, and before we close, may I do this? We have had the best of attention by Connecticut College, and we are very appreciative. You've been most gracious hosts, and I want to thank you on behalf of the entire group. for taking such good care of us.

26:26

In addition to that, Tom DeMahal took in literally hundreds of volunteers to help set up this, both the symposium and the exhibition of the pictures and so on. And we give you our The greatest thanks as well. Thank you very much.

26:51

Okay, one last thing here. Tom B. Mahala.

26:55

Tom B. Mahala.

26:57

Did I say, should I have said Postal Box 7 or should I have said 1? Either.

27:04

Okay, keep what you have. It's Post Office Box 1.

27:08

Okay, with that, I'd like to dismiss the symposium. Thank you very much for coming. Thank you.