

**The Methods and Techniques  
Employed in the Manufacture of the  
*Shroud of Turin***

by

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## DEDICATION

This thesis is dedicated to the loving memory of  
Prof Thomas Herbert Matthews BFA, MFA, D Litt et Phil.  
1936-1993

*Adversus solem ne loquitor*

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## TABLE OF CONTENTS

<b>LIST OF PLATES</b>	:		x
<b>LIST OF FIGURES</b>	:		xvi
<b>CHAPTER ONE</b>	:	<b>INTRODUCTION</b>	1
<b>SECTION 1.1</b>	:	<b>BACKGROUND TO THE RESEARCH</b>	1
<b>SECTION 1.2</b>	:	<b>THE STATEMENT OF THE PROBLEM</b>	5
<b>SECTION 1.3</b>	:	<b>THE STATEMENT OF THE SUBPROBLEMS</b>	6
<b>SECTION 1.4</b>	:	<b>DELIMITATIONS OF THE RESEARCH</b>	6
<b>SECTION 1.5</b>	:	<b>THE HYPOTHESIS OF THE RESEARCH</b>	7
<b>SECTION 1.6</b>	:	<b>THE IMPORTANCE OF THE RESEARCH</b>	8
<b>SECTION 1.7</b>	:	<b>METHODOLOGY</b>	8
<b>SECTION 1.8</b>	:	<b>DEFINITION OF TERMS</b>	9
<b>SECTION 1.9</b>	:	<b>OUTLINE OF THE RESEARCH PROJECT</b>	10
<b>CHAPTER TWO</b>	:	<b>THE HISTORICAL BACKGROUND TO THE SHROUD OF TURIN</b>	13
<b>SECTION 2.1</b>	:	<b>GENERAL INFORMATION</b>	13
<b>SECTION 2.2</b>	:	<b>THE DOCUMENTED EVIDENCE (1357 AD-1898 AD)</b>	19

TABLE OF CONTENTS

<b>CHAPTER THREE</b>	<b>: EARLY THEORIES PERTAINING TO THE IMAGE ON THE SHROUD OF TURIN</b>	<b>27</b>
<b>SECTION 3.1</b>	<b>: EARLY TWENTIETH CENTURY THEORISTS</b>	<b>27</b>
<b>SECTION 3.2</b>	<b>: THE MEDICAL EVIDENCE</b>	<b>58</b>
<b>SECTION 3.3</b>	<b>: HUMANISTIC ICONOGRAPHY OF THE THIRTEENTH AND FOURTEENTH CENTURIES AND THE SHROUD</b>	<b>68</b>
<b>CHAPTER FOUR</b>	<b>: THE SEARCH FOR A VIABLE IMAGE FORMATION THEORY</b>	<b>81</b>
<b>SECTION 4.1</b>	<b>: THE 1973 COMMISSION</b>	<b>81</b>
<b>SECTION 4.2</b>	<b>: THE 1978 COMMISSION</b>	<b>85</b>
<b>CHAPTER FIVE</b>	<b>: THE PHOTOGRAPHIC HYPOTHESIS</b>	<b>117</b>
<b>SECTION 5.1</b>	<b>: GENERAL BACKGROUND: PHOTOGRAPHY AS AN IMAGE-FORMING TECHNIQUE</b>	<b>117</b>
<b>SECTION 5.2</b>	<b>: THE POSSIBILITY OF THE SHROUD OF TURIN BEING A PHOTOGRAPH</b>	<b>135</b>

TABLE OF CONTENTS

<b>CHAPTER SIX</b>	<b>:</b>	<b>THE HISTORICAL EVIDENCE FOR MEDIEVAL PHOTOGRAPHIC TECHNOLOGY</b>	<b>147</b>
<b>SECTION 6.1</b>	<b>:</b>	<b>THE CAMERA OBSCURA</b>	<b>147</b>
<b>SECTION 6.2</b>	<b>:</b>	<b>LIGHT SENSITIVE CHEMICALS</b>	<b>164</b>
<b>SECTION 6.3</b>	<b>:</b>	<b>LENSES</b>	<b>174</b>
<b>CHAPTER SEVEN</b>	<b>:</b>	<b>PRACTICAL EXPERIMENTS EMPLOYING MEDIEVAL TECHNOLOGY</b>	<b>176</b>
<b>SECTION 7.1</b>	<b>:</b>	<b>GENERAL OBSERVATIONS</b>	<b>176</b>
<b>SECTION 7.2</b>	<b>:</b>	<b>THE PRELIMINARY EXPERIMENTS</b>	<b>177</b>
<b>SECTION 7.3</b>	<b>:</b>	<b>THE PRACTICAL INVESTIGATION (PHASE ONE)</b>	<b>186</b>
<b>SECTION 7.4</b>	<b>:</b>	<b>THE PRACTICAL INVESTIGATION (PHASE TWO)</b>	<b>192</b>
<b>SECTION 7.5</b>	<b>:</b>	<b>ULTRAVIOLET SPECTRUM</b>	<b>194</b>
<b>SECTION 7.6</b>	<b>:</b>	<b>THE PRACTICAL INVESTIGATION (PHASE THREE)</b>	<b>199</b>
<b>SECTION 7.7</b>	<b>:</b>	<b>THE PRACTICAL INVESTIGATION (PHASE FOUR)</b>	<b>202</b>

TABLE OF CONTENTS

<b>SECTION 7.8</b>	<b>:</b>	<b>THE PRACTICAL INVESTIGATION (PHASE FIVE)</b>	<b>203</b>
<b>SECTION 7.9</b>	<b>:</b>	<b>THE PRACTICAL INVESTIGATION (PHASE SIX)</b>	<b>208</b>
<b>SECTION 7.10</b>	<b>:</b>	<b>THE PRACTICAL INVESTIGATION (PHASE SEVEN)</b>	<b>211</b>
<b>CHAPTER EIGHT</b>	<b>:</b>	<b>CONCLUSION</b>	<b>217</b>
<b>SECTION 8.1</b>	<b>:</b>	<b>GENERAL OBSERVATIONS</b>	<b>217</b>
<b>SECTION 8.2</b>	<b>:</b>	<b>THE EVIDENCE IN SUPPORT OF THE PHOTOGRAPHIC HYPOTHESIS</b>	<b>217</b>
<b>SECTION 8.3</b>	<b>:</b>	<b>CONCLUSIONS</b>	<b>221</b>
<b>SECTION 8.4</b>	<b>:</b>	<b>THE NEED FOR FURTHER RESEARCH</b>	<b>234</b>
<b>BIBLIOGRAPHY</b>	<b>:</b>		<b>236</b>
<b>ABSTRACT</b>	<b>:</b>		<b>246</b>

## LIST OF PLATES

PLATE	DESCRIPTION	PAGE
1	Enhanced photograph of the <i>Shroud of Turin</i> .	15
2	Enhanced photograph of the <i>Shroud of Turin</i> showing the negative image (front view).	16
3	Enhanced photograph of the <i>Shroud of Turin</i> showing the negative image (back view).	16
4	Unenhanced photograph of the <i>Shroud of Turin</i> showing a detail of the negative image of the upper torso (front view).	17
5	Unenhanced photograph of the <i>Shroud of Turin</i> showing the negative image of the head (front view).	18
6	Enhanced negative photograph of the <i>Shroud of Turin</i> showing the positive image of a crucified man, (front view).	25
7	Enhanced negative photograph of the <i>Shroud of Turin</i> showing the positive image of a crucified man, (back view).	25
8	Enhanced photograph of the <i>Shroud of Turin</i> showing the negative image of the head.	26
9	Enhanced photograph of the <i>Shroud of Turin</i> showing the positive image of the head.	26

PLATE	DESCRIPTION	PAGE
10	<i>Christ Pantocrator</i> from the Catacomb of St. Pontianus, c 750 AD.	37
11	<i>Christ Pantocrator</i> from the Church of Daphni, c 1050 AD.	39
12	<i>Christ Enthroned</i> from the Sant' Angelo in Formis, c 950 AD.	40
13	<i>Christ Enthroned</i> from the east narthex of Hagia Sophia, c 950 AD.	41
14	Detail of <i>Christ Enthroned</i> from the east narthex of Hagia Sophia, c 950 AD.	42
15	Detail of <i>Christ the Merciful</i> from the portable mosaic in Berlin, c 1050 AD.	43
16	<i>Christ Pantocrator</i> from the Cefalu Apse.	44
17	Water colour facsimile of the <i>Shroud of Besançon</i> .	47
18	Direct contact print of a human face, (after Vignon).	55
19	Photograph of the negative image created by Colson's vaporographic experiment.	56

PLATES

PLATE	DESCRIPTION	PAGE
20	Photograph of the positive image created by Colson's vaporographic experiment.	56
21	Painting depicting Christ in the <i>Shroud</i> by Rovere, c 1689.	57
22	<i>Crucifixion</i> by Rubens, c 1610.	66
23	<i>Crucifixion</i> by Giotto, c 1305.	71
24	<i>Lamentation</i> by Giotto, c 1305.	72
25	<i>Crucifixion</i> by Duccio, c 1319.	73
26	Magnified view of image stained linen fibrils from the <i>Shroud of Turin</i> .	92
27	Magnified view of blood stained linen fibrils from the <i>Shroud of Turin</i> .	92
28	Three-dimensional, computer enhanced photograph of the <i>Shroud of Turin</i> .	93
29	Three-dimensional, computer enhanced photograph of the <i>Shroud of Turin</i> , (detail of the head).	94
30	Cardboard reconstruction of the <i>Shroud of Turin</i> , based on computer enhanced image.	95
31	Photographic image produced with a pinhole.	129

PLATES

PLATE	DESCRIPTION	PAGE
32	Photographic image produced with a lens.	129
33	First recorded illustration of a <i>camera obscura</i> . c 1545.	130
34	Illustration of a portable <i>camera obscura</i> c 1646.	131
35	Suggested reconstruction of how a medieval 'photographer' may have produced an image on the <i>Shroud</i> .	141
36	Series of photographs, simulating the effect of the sun's illumination of a human face over an eight hour period.	142
37	Photograph of an apparatus consisting of two plano-convex lenses.	181
38	Photograph of the mobile screen.	182
39	Photograph of the plaster head.	183
40	Photograph of a test strip showing gradation of tone possible with silver nitrate reagent.	184
41	Photograph of a negative image of a pair of scissors produced with silver nitrate reagent.	185
42	Photograph of the synthetic quartz lens used in the final phases of the practical experiments.	201

PLATES

PLATE	DESCRIPTION	PAGE
43	Positive photograph showing the negative image produced in phase five (after fixing).	206
44	Negative photograph showing the positive image produced in phase five (after fixing).	206
45	Photograph showing the typical set-up of a test exposure in the final phases of the practical experiments.	207
46	Positive photograph showing the negative image produced in phase six (before fixing).	210
47	Positive photograph showing the negative image produced in phase six (after fixing).	210
48	Positive photograph showing the negative image produced in phase seven (before fixing).	213
49	Positive photograph showing the negative image produced in phase seven (after fixing).	214
50	Negative photograph showing the positive image produced in phase seven (after fixing).	214
51	Comparison of the negative image of the Shroud (plate 5) with the negative image of phase seven (plate 49).	215

PLATES

PLATE	DESCRIPTION	PAGE
52	Comparison of the positive image of the Shroud (plate 9) with the positive image of phase seven (plate 50).	216

## LIST OF FIGURES

FIGURE	DESCRIPTION	PAGE
1	Schematic representation of the <i>Shroud of Turin</i> showing the 'Vignon Features'.	38
2	Diagram showing how the <i>Shroud of Turin</i> may have been folded in order to create the <i>Mandyion</i> , (after Wilson).	48
3	Table of cotton thicknesses as found in the <i>Shroud of Turin</i> , (after Raes).	86
4	Comparison of image formation theories with image characteristics in the <i>Shroud of Turin</i> .	113
5	Graph showing the plausibility of image formation theories in terms of the image characteristics in the <i>Shroud of Turin</i> .	114
6	Diagram showing the principle of image formation with the employment of an aperture.	127
7	Diagram showing the principle of image formation with the employment of a bi-convex lens.	128
8	Diagram showing the effect of a small aperture diameter on the quality of the image.	132
9	Diagram showing the effect of a large aperture diameter on the quality of the image.	133

## FIGURES

FIGURE	DESCRIPTION	PAGE
10	Schematic representation of the three-dimensional crystal lattice formed by silver halide ions.	134
11	Diagram showing Al-Haytham's theory of pinhole images, <i>c</i> eleventh century.	155
12	Diagram showing the path of radiation through the human eye, according to Roger Bacon, <i>c</i> thirteenth century.	156
13	Table showing suitability of various optical materials to UV transmission.	197
14	Diagram showing how the Shroud of Turin was prepared for exposure (frontal image).	225
15	Diagram showing how the Shroud of Turin was prepared for exposure (dorsal image).	225

# CHAPTER ONE

## INTRODUCTION

### 1.1 BACKGROUND TO THE RESEARCH

Since the seventeenth century, a relic, which claims to be the burial cloth of Jesus Christ has been housed in the Royal Chapel of Turin Cathedral. This historically, unique artifact, which can be safely documented to the middle of the fourteenth century and which is known popularly as the *Holy Shroud of Turin*, continues to be honoured by many devout Roman Catholics. This is despite the various attempts by a number of scientific commissions (held this century), to discredit it as a divine product. Indeed, the most recent of these commissions (1988) has, with the aid of modern carbon dating techniques, supported the interpretation that the *Shroud of Turin* was produced in medieval times, *ie c* 1260-1350 (Ostler, 1988:56; Anderson, 1988:25). (This finding has convinced many people that the *Shroud* is nothing more than a clever forgery, one which was produced for the sole purpose of deceiving the Catholic world of the late thirteenth century (Smullen 1980:112).

However, this conclusion is far from satisfactory since it fails to address a number of very important issues, *viz:*

If it is to be accepted (as popular opinion seems to indicate) that the *Shroud* is, in fact, a

product of a medieval band of forgers, intent only on profit and gain and who, conceivably, could have quite easily satisfied the needs of the credulous with a production far less sophisticated than the *Shroud* actually is, then why is our culture (with its highly sophisticated level of technology and expertise) still unable to explain its means of production, far less duplicate it?

Similarly, why does this relic not contain the vestiges or stylistic minutiae characteristic of the culture that produced it? For example the *Shroud* depicts a highly naturalistic, three-dimensional (albeit negative) image of a naked man who has apparently been tortured and crucified. This image was produced at a time (see 3.3) when Christian art (although tending towards naturalism and humanism in certain centres such as Florence and Rome), was more normally characterised by the fairly rigid stylistic conventions as found in much Italo-Byzantine (*c* 1235-1285 AD) and Byzantine (*c* 550 AD-1285 AD) images of Christ). Similarly, the authority of orthodox ecclesiastical teaching in the late thirteenth century would have ensured that Christ be depicted with the marks of the nails in his hands and with the marks of a crown of thorns. However, the *Shroud* not only shows Christ uncharacteristically naked, but with the marks of the nails in his wrists and with the marks of a 'helmet' of thorns.

In addition to these uncharacteristic, possibly heretical depictions of Christ, the image of the man in the *Shroud* displays a degree of anatomical/medical knowledge that simply was not available to a medieval natural philosopher let alone a medieval forger of relics.

Indeed, the depiction by the *Shroud* of such anatomical details as the reflex action of the thumb when an object is forced into the wrist at the *Place of Destot* was not documented until this century (*ie* the early 1930s). (See Chapter Three.)

It is because of these and other seeming paradoxes, that most sindonologists, since 1898, when Secondo Pia accidentally discovered the *Shroud's* photographic qualities (see 2.2.3.1), have alluded in different ways to the suggestion that the *Shroud* could almost be a photograph taken of an actual victim of a crucifixion but for the fact that photography was not invented until 1827. In this regard, the following statements by Rinaldi (1972:64-5) are typical of the sort of views expressed before the carbon-dating of 1988:

The concept of a negative became known only through the invention of photography in the nineteenth century. No artist of any earlier period could have conceived the idea of producing a picture in negative... That this body [image] can only be the Body of Christ is the inference of learned scientists, particularly of noted physicians and anatomists who have examined and studied the figures of the Shroud as photography reveals them. [*ie* as positive images] They have marvelled at the natural and anatomically perfect proportions of the Body, with its true perspective and with a wealth of details whose fidelity to nature is unsurpassed... We might say that photography has unlocked the secret of the Shroud.

Incredibly, this myopic view was still prevalent after 1988, as the following statement by Ostler (1988:56) reveals:

The dating dispute may be settled, but the shroud remains as mysterious as ever, reason: it bears an inexplicable life-size image of a crucified body, which is uncannily accurate and looks just like a photographic negative — occurring centuries before photography was invented.

Thus, the *Shroud* still remains an enigma to art historians, the scientific community and the Roman Catholic Church, viz:

- \* the image on the *Shroud* does not (strictly speaking) conform to the tenets of Roman Catholic orthodoxy (or Protestant fundamentalism for that matter) (See Chapter Three);
- \* the image on the *Shroud* does not belong stylistically to the art of any culture extant in the thirteenth or fourteenth centuries; and
- \* as far as the scientists and historians are concerned, photography (as the art of producing and/or fixing stable records of the images of nature through the action of light on light sensitive materials) was only discovered five centuries after the period in which it is believed the *Shroud* was produced.

However, if one considers the phenomenon of the *Shroud* in isolation, without recourse to either popular misconception, biblical texts, religious orthodoxy, the iconographic tradition of the church or even the established dogmas of scientific opinion, *ie* if one considers the facts as they are presented by the *Shroud* itself, it would seem that the only possible and logical way that the image on the *Shroud* could have been produced is by means of photography. This provisional conclusion seems outlandish only once it is placed within the context of our present-day understanding of medieval cultures and their respective

levels of technology. In other words, if it could be proved that our present understanding of certain aspects of medieval technology was inaccurate, it would not only help to solve the mystery concerning the *Shroud's* method of production but perhaps more importantly would force us to re-evaluate the kind of knowledge (*ie* which specifically relates to the Shroud's manufacture) available *c* 1200-1357 *AD*.

This research would appear to be pointless if it were not for the fact that the *Shroud of Turin* does in fact exist, that it does indeed date from at least 1357 *AD*, that it not only displays many of the characteristics found in modern day photographic negatives but goes further in that unlike modern photographs the image in the *Shroud* is three-dimensional (a fact borne out by computer enhancement experiments undertaken in 1978). (See Chapter Four.)

## 1.2 THE STATEMENT OF THE PROBLEM

This research proposes to investigate the more probable methods and techniques employed in the production of the image on the *Shroud of Turin*.

### 1.3 THE STATEMENT OF THE SUBPROBLEMS

- 1.3.1       **The first subproblem:** to evaluate critically all existing data which is relevant to the phenomenon of the image on the *Shroud of Turin*.
- 1.3.2       **The second subproblem:** to evaluate critically the various technical image formation theories as proposed by previous researchers of the *Shroud of Turin*.
- 1.3.3       **The third subproblem:** to determine whether there is any evidence for a medieval society having been able to produce the image on the *Shroud of Turin* by means of a photographically related technique.
- 1.3.4       **The fourth subproblem:** to determine whether it is possible to produce an image which duplicates the image on the *Shroud of Turin* employing only those materials, apparatus and kinds of knowledge known to have been available to persons living between 1200-1357 *AD*.

### 1.4 DELIMITATIONS OF THE RESEARCH

It should be clear from the onset, that this research is undertaken within a very specific

context, *viz.*: its function (see 1.2 and 1.3) is to determine the procedure(s) by which the negative image on the so-called *Shroud of Turin* was propagated. In this respect, it is neither the fundamental rationale nor the aim of this inquiry to examine either the aniconistic or iconographical considerations of this historically unique image of the crucified Christ, except where such aspects appertain directly to the issue of its physical fabrication. In short, this inquiry deals primarily with a phenomenological analysis of the methods and techniques which were most likely employed in order to manufacture the *Shroud's* enigmatic image. Any questions that are specifically associated with the original, viable function of the *Shroud*, its *raison d'être* and the responses that it once conceivably invoked from its originators and/or many audiences that it has been presented to over the last seven centuries, would have to be dealt with in a future body of research, which (it is suggested) would in itself be quite worthless without some cognizance of the contentions postulated in this present thesis.

## 1.5 THE HYPOTHESIS OF THE RESEARCH

- 1.5.1 By investigating the phenomenon of the *Shroud of Turin* it will be possible to recreate its mode of production.

## 1.6 THE IMPORTANCE OF THE RESEARCH

- 1.6.1 If it is proved that the image on the *Shroud of Turin* was in fact produced by means of a form of photography between *c* 1200-1357 *AD*, it would necessitate a complete reappraisal of the history of photography as we currently understand it.

## 1.7 METHODOLOGY

With the delimitations of this investigation in mind (see 1.4) the following methodology will be employed, *viz*:

- 1.7.1 A critical re-examination of all relevant *Shroud* image formation theories will be undertaken.
- 1.7.2 A stylistic analysis of relevant twelfth, thirteenth and fourteenth century images of the dead and/or crucified Christ will be made.
- 1.7.3 A search will be made for any documented proof of the existence of photographically related materials, apparatus, and/or knowledge in any medieval society in existence between *c* 1200-1357 *AD*. (See 1.8.1.)

- 1.7.4 Practical experiments relating to the *camera obscura* and the possibilities of negative photographic techniques employing medieval technology will be undertaken.

## 1.8 DEFINITION OF TERMS

Certain terms which appear in this investigation are employed in a specific context. For the purposes of clarity these terms and their respective meanings are listed below, *viz*:

- 1.8.1 **Medieval:** refers to any European, Arabic, Jewish, Asian or north African society in existence between *c* 1200-1357 *AD*. These dates are determined both by the results of a recent carbon-dating (see 1.1) as well as by the fact that the *Shroud* is clearly documented from the year 1357 *AD* (see 2.2.1.1).
- 1.8.2 **Photographic technology:** refers to any methods and/or techniques (known or unknown) which if applied (consciously or accidentally) result in a permanent or semi-permanent record of reflected and/or projected light and/or radiation on a chemically receptive material or support.
- 1.8.3 **Naturalistic image:** refers to any depiction in any medium or material which manages to approximate an object as seen by the human eye. In this regard,

it is accepted that a 50 mm lens with a 45 degree angle of vision (from a physiological perspective), roughly approximates the view as seen by one eye even though the eye itself has an average internal focal length of 22 mm and an external focal length of 17 mm for far distant vision. (Mannheim, 1982:569-70; 831-62; Alpern *et al.*, 1970:13-62.)

## 1.9 OUTLINE OF THE RESEARCH PROJECT

The thesis is arranged according to the following outline, *viz.*:

Chapter One is the introduction, wherein the problems and parameters of the research are stated.

In Chapter Two an historical overview is given of the more important details concerning the *Shroud of Turin* from its first recorded exposition at Lirey in 1357 *AD*, until the discovery of its photographic qualities in 1898 *AD*. Briefly this account deals with the following periods, *viz.*:

- \* the *Shroud* at Lirey (1357-1453 *AD*)
  
- \* the *Shroud* at Chambéry (1453-1578 *AD*)

\* the *Shroud* at Turin (1578-1898 AD)

In Chapter Three a review is made of the first real attempts by early twentieth century researchers to formulate a viable image formation theory. In this regard, Vignon's 'vaporographic' theory is critically re-evaluated and refuted. In addition, an account is given of the findings of various medical authorities such as Barbet, Bucklin, Willis, *etc* (see 3.2), as to the anatomical verisimilitude of the image of the man in the *Shroud*, the nature of his injuries and their correspondence to the Biblical accounts of Christ's passion and death.

In Chapter Four a critical account is given of the more important findings of the 1973 and 1978 scientific commissions, both of which were able to study the *Shroud of Turin* at first hand. In this regard, each of the major image formation theories put forward by the participants in these investigations, and their respective decrements are noted. From the accumulated data concerning the nature and structure of the image on the *Shroud* it is shown that only a form of radiation (light) could have caused the 'impression' on the *Shroud*, which in turn points to the possibility of photography being the image forming technique.

In Chapter Five a general account is given concerning the basic principles of pinhole images, *camerae obscurae*, light sensitive chemicals and modern photography. In the light of this information a hypothetical account is given of the methods and techniques that

would be required in order to duplicate the image as it appears on the *Shroud of Turin*. In this context a list is made of the kind of documented evidence that would be needed to substantiate the hypothesis that the *Shroud of Turin* is a product of some form of primitive photographic technology in existence between 1200-1357 AD.

Chapter Six presents the documented evidence which supports the contention that the technology was available for persons to produce a negative photographically induced image well before 1357 AD.

Chapter Seven is a record of the practical experiments undertaken with medieval knowledge, apparatus and chemical substances in an attempt to duplicate the kind of image contained in the *Shroud of Turin*.

Chapter Eight is the conclusion, in which the research is evaluated and further research indicated.

# CHAPTER TWO

## THE HISTORICAL BACKGROUND TO THE SHROUD OF TURIN

### 2.1 GENERAL INFORMATION

The *Shroud of Turin* is an ivory-coloured linen strip, woven in a herringbone twill which measures 14 feet 3 inches by 3 feet 7 inches (c 1100 mm x 4300 mm). On this cloth can be seen a faint image (in pale sepia) of both the front and back views of a naked and tortured man. The cloth itself is made up from two sections of linen which have essentially an identical weave, viz: a large section of cloth (which constitutes by far the greater proportion of the *Shroud*); and a smaller section, (*ie* a small, narrow strip which is sewn to the edge of the main section). It is interesting to note that without this smaller section the *Shroud's* enigmatic image would be off-centre. (See plates 1, 2 and 3.)

Only since 1898 has it been appreciated that this image is modelled in the negative, much like a modern day photographic negative, *ie* all highlights are depicted as shaded areas, and conversely, all dark and shaded areas are shown as highlights. If the polarity of this image is reversed (*eg* by making a photographic negative of the *Shroud*) one can clearly see a positive, seemingly three-dimensional image of a man. This positive version of the *Shroud's* image is both highly detailed and naturalistic.

However, even without the benefit of modern photographic technology it is possible to recognise many features from the negative image alone - details that would have been obvious to persons living centuries before the age of photography. For a more comprehensive listing of those details that became visually accessible only with the aid of modern photography see section 3.3.3.

### 2.1.1 The image as it appears on the *Shroud*

The image is extremely subtle and cannot be readily discerned by the human eye at close range (see plate 4). In fact, most authorities who have had the privilege of seeing the *Shroud* at first-hand, confirm that the image is best viewed at a distance of some seven metres. Wilson (1978:9) describes this phenomenon as follows:

The astonishing aspect of seeing the Shroud itself rather than a photograph is discovering how pale and subtle the image appears. The color of the imprint can best be described as a pure sepia monochrome, and the closer one tries to examine it, the more it melts away like mist.

The frontal image (see plates 2 and 4) depicts a bearded man with long hair, his upper arms and legs lie straight. His forearms are bent at the elbow and cross over the pelvic area in such a manner that one wrist obscures the other. The hands show only four fingers as both thumbs are absent. The feet point downward. Except for the face, all parts of the body, both in the front and the back image, are covered with small regularly spaced brown marks. These latter marks are normally interpreted as being skin abrasions caused by scourging. The wrist (which is visible) contains what appears to be a nail wound, and



PLATE 1

Enhanced photograph of the

*Shroud of Turin*

(Weaver, 1980:740).

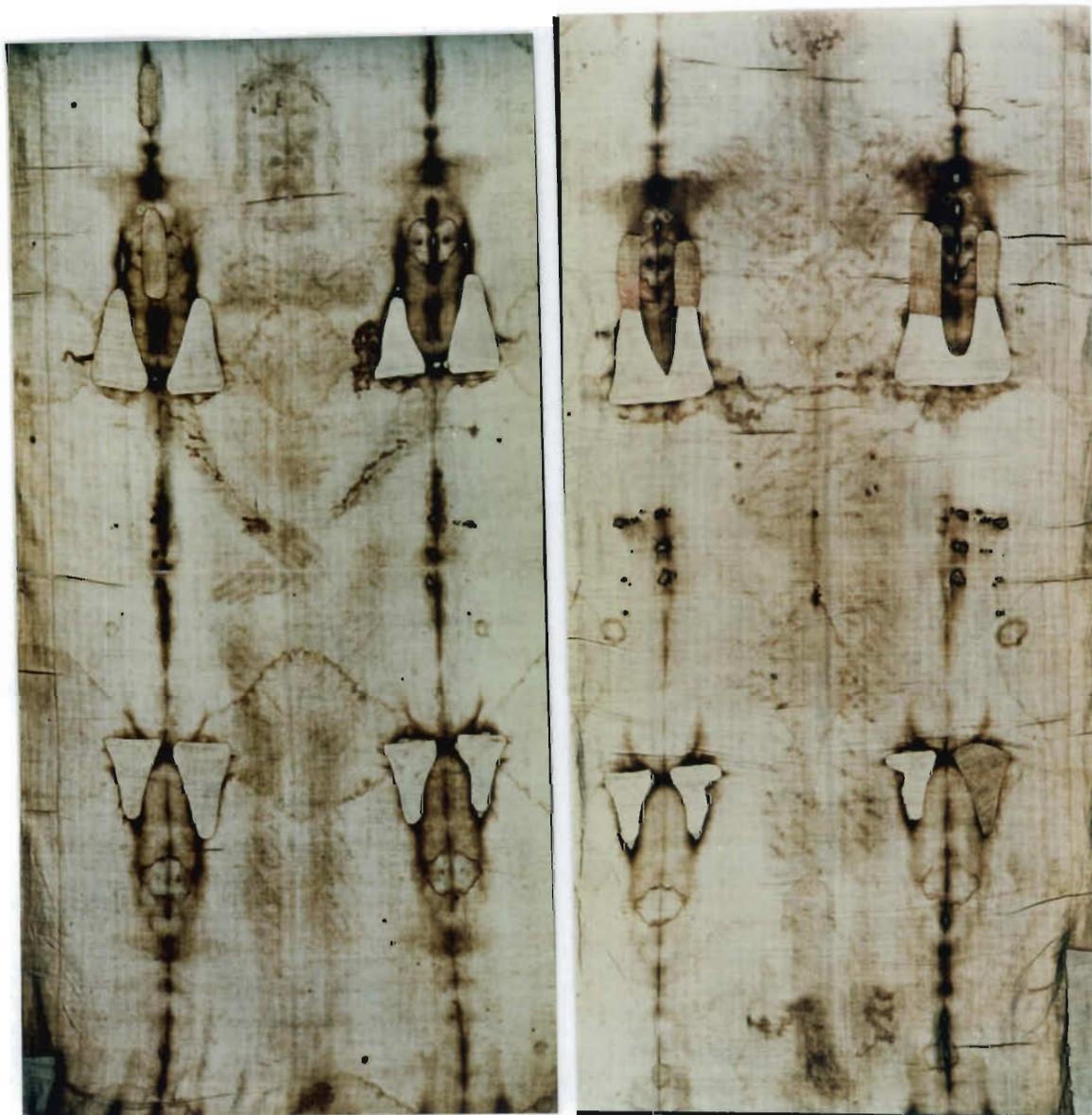


PLATE 2

PLATE 3

Enhanced photographs of both the frontal and dorsal views  
of the negative image of the man in the *Shroud of Turin*  
(Weaver, 1980:740).



PLATE 4

Unenhanced detail of the head and upper torso of the man in the *Shroud of Turin*, giving a clearer illustration of the subtle quality of the negative image.

(Weaver, 1980:740)



PLATE 5

Unenhanced photograph of the image of the head,

Detail from the *Shroud of Turin*.

(Weaver, 1980:740).

'blood' flows are clearly visible running the entire length of both forearms. Similar 'nail' wounds and 'blood' flows are visible on the feet.

On the side of the man's chest (in the front view) is a larger wound and 'blood' flow. This latter feature seems to be continued on the back view as a large 'blood' flow is visible across the man's back (see plate 3). The head of the man appears to be perforated in both the front and back views and a number of smaller 'blood' flows are visible - the most prominent being one in the shape of an inverted number 3 on the man's temple (see plate 2, 4 and 5). In addition, since 1532 AD, the Shroud's image has been marred and visually dominated by unsightly scorch marks caused by an accidental fire (see 2.2.2.1).

## 2.2 THE DOCUMENTED EVIDENCE (1357-1898 AD)

### 2.2.1 *The Shroud of Lirey*

#### 2.2.1.1 **Geoffrey I de Charny**

The first recorded owner of the present day *Shroud of Turin* was Geoffrey I de Charny, Seigneur de Savoisie et Lirey. The latter being a small village some 20 kilometres south from the city of Troyes. As yet, there are no records of how de Charny came to be in possession of this relic except a statement by his granddaughter, Marguerite de Charny who

asserted that the *Shroud* had been '*conquis par feu*' by Geoffrey I de Charny (Wilson, 1991:20). This possibly indicates that de Charny obtained the *Shroud* whilst on crusade.

The life of de Charny is well-documented historically: He was captured by the English at Calais on December 31, 1349 *AD* and during the years 1350-51 he was a prisoner of war in England; A ransom of 12 000 gold ecus (paid by King John II) secured de Charny's release and his subsequent return to France in or about July 1351. In 1353 he is known to have obtained from King John II financial aid for the establishment of the collegiate church of Lirey. In this connection, Henri de Poitiers (Bishop of Troyes, 1353-70) issued a letter to de Charny on 28 May 1356, in which he praises the Seigneur de Lirey for his efforts at having completed the building of this church (de Poitiers 1356). Shortly afterwards, on September 19 of the same year, Geoffrey I de Charny died a hero, using himself as a human shield to protect his king, John II on the field of Poitiers. The following year (1357) de Charny's widow, Jeanne de Vergy exhibited the *Shroud* at the newly built church in Lirey.

#### 2.2.1.2 **Jeanne de Vergy and Geoffrey II de Charny**

Geoffrey I de Charny was succeeded by a son whose name was also Geoffrey de Charny. To avoid confusion historians usually refer to him as Geoffrey II de Charny. His widowed mother, Jeanne de Vergy left Lirey for High Savoy in c 1359 and married a certain Aymon de Geneve, who was, incidentally the uncle of the future anti-pope, Clement VII.

In 1388, Aymon de Geneve died and consequently, Jeanne, a widow for the second time, returned to the de Charny lands in Lirey. From 1389 onward, the *Shroud* was once again exhibited in Lirey by Geoffrey II de Charny, much to the consternation of Henri de Poitier's successor, viz: Pierre d'Arcis (d'Arcis 1389)

### 2.2.2        **The *Shroud of Chambéry***

The history of the *Shroud* is well recorded from 1389 onward. In 1453 Geoffrey I de Charny's granddaughter, Marguerite de Charny (now in her seventies) placed the *Shroud of Lirey* in the hands of Louis, Duke of Savoy. It is evident that she feared for the safety of this important relic and knew that the powerful House of Savoy would ensure the *Shroud's* survival after her death. This presumption is supported by the fact that she had no heirs (even after two marriages).

From 1471 onwards, the ducal church at Chambéry was enlarged and renovated by Duke Amadeus IX (son and heir to the deceased Louis). In addition, Pope Sixtus IV granted special privileges to the clergy of this church and officially recognised the *Shroud* as an important relic of the Passion of Jesus Christ.

In 1502 the *Shroud* was officially deposited in the church. At this time the *Shroud* was folded four times crosswise and eight times lengthwise and was stored in a silver lined chest. This, in turn, was placed in an opening in the wall behind the altar, which was

protected by iron doors which had to be locked with four separate keys. Security was obviously very tight, and four persons were each entrusted with one of the four keys. This latter factor nearly contributed to the loss of the *Shroud* altogether. (See 2.2.2.1.)

In 1506 Pope Julius II (the warrior pope) gave approval for this church to be known as The Holy Chapel of the Holy Shroud (Sainte Chapelle). In addition a Feast of the Holy Shroud, complete with its own proper Mass and Office was assigned to May 4, now the Feast of St Monica (Cabrol, 1931:875).

#### 2.2.2.1      **The fire of 1532**

On December 4 1532, a fire broke out in the sacristy of Sainte Chapelle. Unfortunately it was not possible to obtain all four keys to the *Shroud's* repository at such short notice and only the quick actions of the Duke's blacksmith saved the *Shroud* from certain destruction. Two Franciscans and the blacksmith hastily retrieved the silver-lined casket (now melting) and unceremoniously doused it with water. Although their actions saved the image on the *Shroud*, they were too late to stop drops of molten silver from burning the corner of the folded linen, and forming a distinctive, symmetrical series of scorch patterns that are repeated some 24 times throughout the entire length of the unfolded *Shroud*. In addition, a large circular water stain is also repeated at regular intervals. Fortunately, except for the upper arms, neither the burnholes nor the water stains have seriously damaged the image itself. In 1534, these holes were cleaned and repaired by the Poor Nuns of St. Claire

(*Clarisses*). They removed the badly charred sections and carefully sewed in patches of altar linen. In addition, they backed the entire *Shroud* with a piece of Holland cloth.

### 2.2.3            **The *Shroud of Turin***

In 1578, Emmanuel Philibert of Savoy had the *Shroud* moved from Chambéry to his new capital in Turin. Today, the *Shroud* is kept rolled up with a lining of red silk on a velvet covered wooden staff which in turn is stored in a long, narrow silver chest. This chest resides within a larger painted wooden box in the altar of the Royal Chapel of Turin Cathedral.

#### 2.2.3.1        **Secondo Pia**

Exhibitions of the *Shroud* were commonplace in the sixteenth century, (every May 4) but these steadily declined until the nineteenth century. Indeed, there were only five exhibitions held in the 1800s, the last being in 1898, when a special exposition was organized to coincide with Turin's celebrations for the fiftieth anniversary of the Italian constitution (*Statuto*).

An amateur photographer named Secondo Pia was given the honour of making a photographic record of the *Shroud*. This was the first time such an attempt had been made, and considering the relatively primitive state of photography at this time, presented no easy

task (even for a professional). Pia had to construct a platform for both his large wooden camera with *Voigtlander* precision lens and himself. This was because the *Shroud* had been hung above the altar for the duration of the celebrations. Pia had many technical problems to overcome (including the breakage of his flood lamps due to overheating) and only on his second attempt on the night of May 28 did he manage to expose his glass photographic plates.

What happened next made photographic history. On developing the negative plate of his exposure (instead of seeing a shadowy formless negative image of the *Shroud*) Pia observed a positively modelled image of what seemed to be the dead Christ. (See plates 6-9.) From all accounts, Pia was stunned by what he saw, believing that a miracle had occurred. In fact, at first, the church authorities did not want to accept the validity of what had transpired, some even accused Pia of forgery. Even so the uproar that followed Pia's discovery created worldwide interest. Wilson (1978:15) describes the feelings of the time, as follows:

Throughout history, saints and holy men have claimed to see visions of Jesus. None has ever been able to provide material evidence. In archaeology, ancient tombs have been opened up to reveal, for a fleeting moment, the perfectly preserved remains of someone from the distant past-only for these immediately to crumble to dust. Yet, here, an ordinary man had an amazing 'vision' on a photographic plate, a vision capable of endless reproduction. And, above all, a vision seemingly of none other than Jesus Christ.

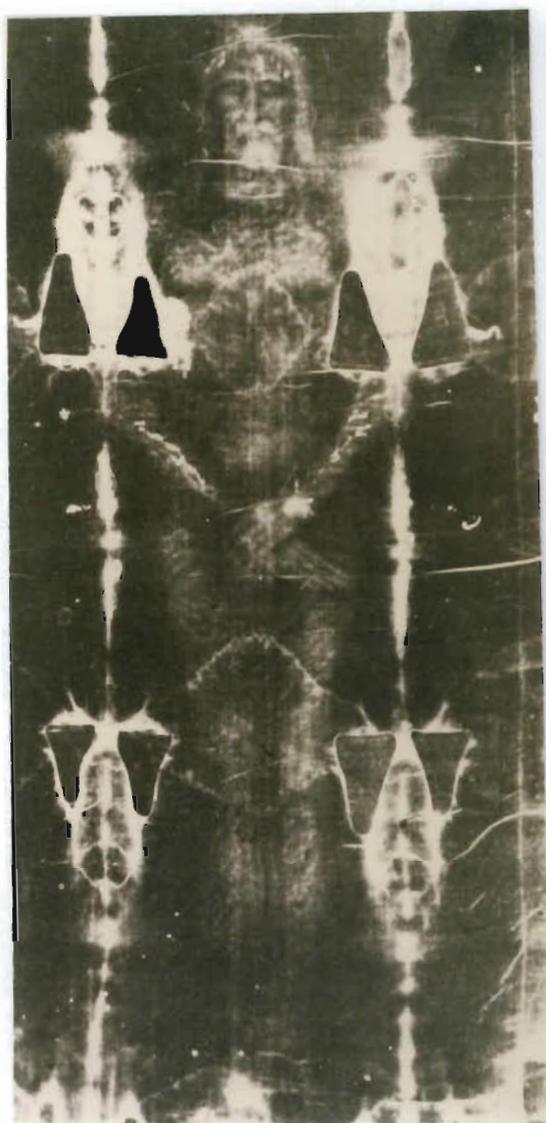


PLATE 6

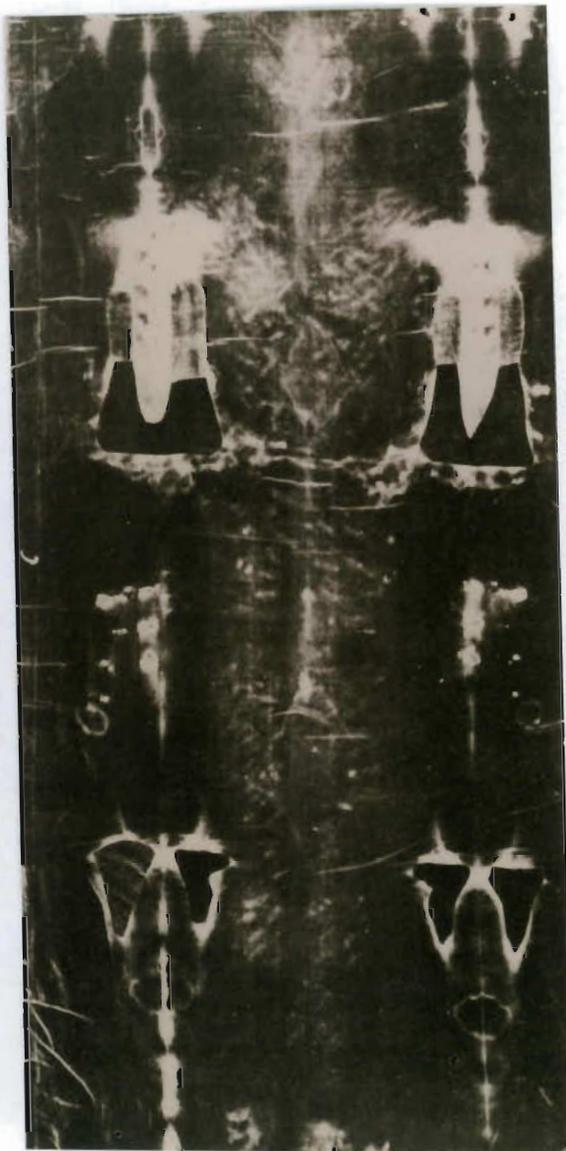


PLATE 7

Enhanced photographic negatives of the frontal and dorsal images on the *Shroud of Turin* showing a positive image of a crucified man.

(Rinaldi, 1974:ii).

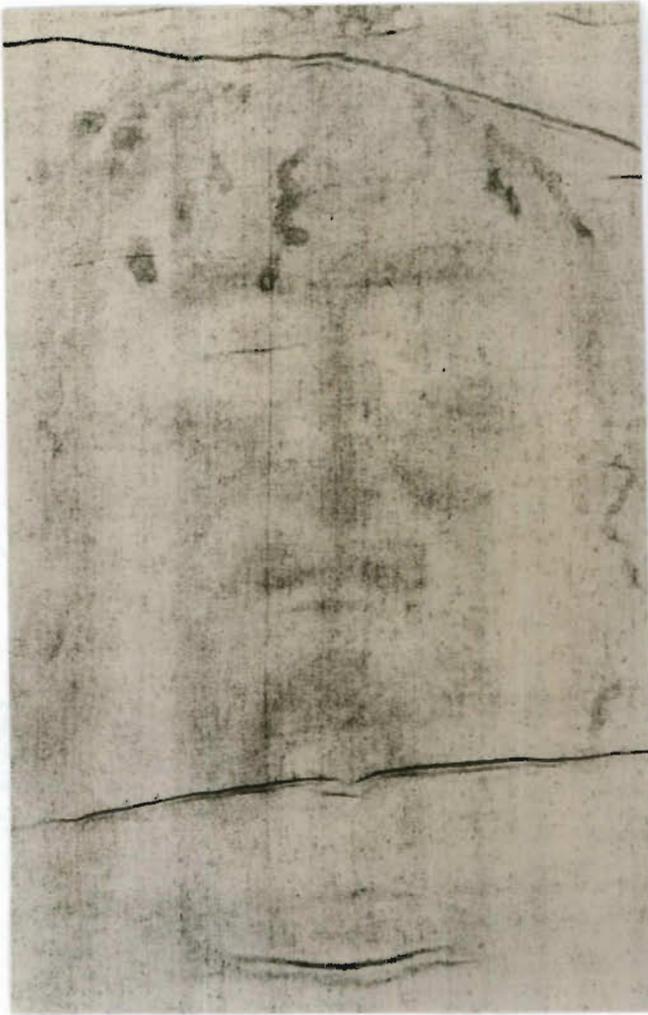


PLATE 8



PLATE 9

Photographic comparison between the negative and positive image of the head on the *Shroud of Turin* (Wilson, 1991:78-79; Weaver, 1980:753).

## CHAPTER THREE

### EARLY THEORIES PERTAINING TO THE IMAGE

#### ON THE SHROUD OF TURIN

##### 3.1 EARLY TWENTIETH CENTURY THEORISTS

By 1902, an estimated 3500 articles, treatises and books had already been generated in response to the heated debate concerning the *Shroud's* authenticity and the possible causes for its seemingly miraculous image. Remarkably, most of this literary output was produced in the four years subsequent to Secondo Pia's discovery of the *Shroud's* photographic characteristics. (See plates 6 and 7.)

Even at this early stage, there was a clear cut division between those authorities who wished to prove the authenticity of the Shroud (mainly within a religious context) and those persons, who while not necessarily doubting the existence of the historical Christ or even the validity of the Christian message, took a very sceptical stance as far as the *Shroud* was concerned.

It is interesting to note that both camps relied heavily on the Biblical account of Christ's passion (in particular, the *Gospels of St. Luke* and *St. John*) to both validate as well as refute the authenticity of the *Shroud of Turin*. Even Vignon (who at this time was an agnostic), often turned to the *New Testament* to support his claims. This is because he (like

most of the other pre-1988 researchers) was primarily concerned with proving or disproving the *Shroud* in terms of its claim to be the then 1900 year old burial cloth of the historical Jesus of Nazareth.

Not for one moment did these researchers consider the possibility that the *Shroud of Lirey-Chambéry-Turin* might also be investigated in terms of its qualities as *sache selbst* and/or its importance as an outstanding product of some (possibly forgotten) medieval technology. This tendency (to justify the *Shroud*, solely or partly in terms of Scripture) has survived right down to the present day, and has (as will be shown) also been one of the many stumbling blocks to any alternative attempt at resolving the mystery of the *Shroud's* image.

It would not be possible to cover every subtle nuance of the early twentieth century debate, but it is possible to look at the work of possibly the most important champions of the two major directions this discussion tended to follow. In this regard Paul Vignon was probably one of the *Shroud's* most ardent supporters (in terms of this relic's claim to be the burial cloth of the historical Jesus Christ).

Alternatively, possibly the most famous of the *fin-de-sièclè* authors to debunk the *Shroud* (in terms of its claim to be Christ's actual burial cloth), was Ulysse Chevalier, called by some 'the most learned man in France and perhaps in the entire world' (Weaver, 1980:743).

### 3.1.1 Ulysse Chevalier

Monsieur le chanoine Ulysee Chevalier's contribution to any debate concerning the nature and/or the history of the *Shroud of Lirey-Chambéry-Turin* is certainly noteworthy.

In the wake of Secondo Pia's discovery (c 1900), when many speculative articles concerning the *Shroud* were being produced, Chevalier stood almost alone as a champion of common-sense and rational thinking.

Chevalier, carefully compiled all known, verifiable documentation associated with the *Shroud* and its long history, and based on this evidence, he was able to proclaim that, not only was the *Shroud* not the original burial cloth of Christ but also that it was a product of the early fourteenth century. (Cf Bellet, 1902b:4.) This latter assertion was based on what Chevalier perceived to be clear stylistic links between the *Shroud's* imagery and the art of the late thirteenth and early fourteenth centuries (Chevalier, 1902b:1). It should not be forgotten that at this time (c 1900) none of the sindonologists and theorists (involved in the *Shroud* debate) had actually examined the relic at first hand. Indeed, for the most part, they had only seen reproductions of Secondo Pia's photographs. Bearing this point in mind, many early sindonologists, in an attempt to explain the nature and cause of the miraculous negative image, went to great lengths to create a believable hypothesis which would link the *Shroud of Turin* with the burial cloth of Christ.

A particularly popular notion, current at this time, was that during the Sack of Constantinople (1204 AD), when the spoils of war were being divided between the Church, the King of France, French nobles, prominent crusaders, the Doge *etc* (Riant 1875), the *Shroud* somehow came into the hands of the Bishop of Troyes, Garnier de Trainel (1193-1205 AD).

Garnier de Trainel, it was asserted, was closely related to the Champlitte family, who in turn, were allegedly the ancestors of the de Charny family. This possible connection between de Trainel and Geoffrey I de Charny formed the basis for a highly speculative argument (which, incidentally is still prevalent today). (*Cf* Wilson, 1978; Rinaldi, 1972:19-20.) Briefly stated, it was alleged that the *Shroud of Lirey-Chambéry-Turin* and another divine image on cloth housed in the Monastery of Blachernes in Constantinople (c 1203), were one and the same relic. It should be noted that the image from the Monastery of Blachernes was first recorded by Robert de Clary (or Clari) in his written account of the Sack of Constantinople in 1204 AD (*cf* Clari, 1966). In addition, as regards documented proof for this relic being taken by de Trainel (or anyone else for that matter), no description exists of either this specific cloth (with image) from Blachernes, or anything else even vaguely resembling it. Indeed, anyone who has studied the official lists of sacred objects and treasures 'taken' from Constantinople c 1204 AD (*cf* Riant, 1875:177-211), will readily agree with this interpretation. It must be noted, however, for the purposes of objectivity, that a Holy Shroud (*Saint Suaire*) is mentioned (Riant, 1975:206-7), which seems to date from c 1206 AD and which disappeared in 1792 AD. In addition, a fragment

of Holy Shroud (c 1241-6 AD) is mentioned (Riant, 1975:182-3), as being destined for King Louis IX's Sainte Chapelle in Paris. This is recorded as having been destroyed in 1792 AD.

Chevalier, who was prepared to deal only in hard evidence, was understandably highly critical of the attempts by researchers to transform pure conjecture into fact. Chevalier states on this score, 'apres avoir ainsi comble, par l'imagination, les vides de l'histoire, on tiendra la chose pour parfaitement demontree' (Bellet, 1902b:2). As will become apparent as this investigation proceeds, researchers of the *Shroud of Turin* would probably have achieved far more by today had they taken Chevalier's good advice offered them one century ago.

### 3.1.2 Paul Vignon

Another important 'objective' researcher of the *Shroud of Turin*'s image was undoubtedly Paul Vignon, who as early as 1902 had already produced a more or less 'scientific' overview of the *Shroud*'s qualities. In Vignon's first book, *The Shroud of Christ* (1902), he systematically examines each of the then current theories in circulation, highlights their respective weaknesses and finally offers his own 'vaporographic' hypothesis (see 3.1.2.2) as the only plausible explanation for the *Shroud*'s image.

In addition, Vignon possibly went further than most other sindonologists of his time

because he also tried to consider the relevance of the *Shroud*'s image from an art historical perspective; his only mistake being persistently to assume that the *Shroud* was the archetype for a subsequent development or evolution of the various art-historical portrayals of Christ.

This idea, commonly referred to as the *Vignon thesis* has had a serious impact on the theories of most other sindonologists in the twentieth century, most notably Rinaldi and Wilson. However, (as we shall presently discover) the complete opposite of the *Vignon thesis* is more probable, for it will be seen that if anything, it is the image on the *Shroud* which relies on previous art-historical models.

### 3.1.2.1 The *Vignon thesis*

In his studies of post-sixth-century Byzantine portraits of Christ, Vignon noticed that many such images shared common features and in addition these features could also be discerned on the *Shroud of Turin* (Vignon, 1939). For example, according to Vignon and Wuenschel (cf Wilson, 1978:84-5), the eighth-century *Christ Pantocrator* from the Catacomb of St. Pontianus, Rome (plate 10); the eleventh-century *Christ Pantocrator* from the dome of the *Church of Daphni*, near Athens (plate 11); the tenth-century *Christ Enthroned* fresco from the Sant'Angelo in Formis, Italy (plate 12); the tenth-century *Christ Enthroned* mosaic from the narthex of Hagia Sophia, Constantinople (plates 13 and 14); and the eleventh-century *Christ the Merciful* portable mosaic icon from Berlin (plate 15); are each

supposed to show an open-ended, three-sided 'square' shape between the eyebrows. Vignon further noticed that this strangely inorganic shape (which roughly corresponds to the furrow mark made when a person frowns) did not seem to belong stylistically with any of the other features of the respective portraits. Vignon also 'discovered' a similar mark on the *Shroud of Turin*. (See plate 10 and figure 1.)

Vignon's assumption (which is shared by many other researchers) is that the post-sixth-century images are based on the *Shroud*. Furthermore, to support this theory, an additional nineteen features (twenty in all) were also found by both Vignon and Edward Wuenschel to exist on pre-fourteenth century portraits of Christ which also could be discerned on the *Shroud of Turin*. Although Wilson supports this contention he does at least point out that, 'By no means every work featured every peculiarity' (1978:84), and goes on to state that:

Not all of the twenty markings deduced by Vignon and Wuenschel are acceptable. Because of the very imprecisions of the Shroud likeness, many seem too elusive to permit firm deductions (1978:85).

Because of these 'imprecisions', Wilson, (not unreasonably) whittles down Vignon's twenty features to fifteen. His thinking being here, that a Byzantine artist might have been able to see at least these fifteen features on the *Shroud* (see figure 1) had it been in existence between c 500 and c 1300 AD.

This revised list of features is recorded by Wilson (1978:85) as follows:

1. A transverse streak across the forehead
2. The three-sided 'square' on the forehead
3. A V shape at the bridge of the nose
4. A second V shape inside feature 2
5. A raised right eyebrow
6. An accentuated left cheek
7. An accentuated right cheek
8. An enlarged left nostril
9. An accentuated line between nose and upper lip
10. A heavy line under the lower lip
11. A hairless area between lip and beard
12. The fork to the beard
13. A transverse line across the throat
14. Heavily accented, owlsh eyes
15. Two loose strands of hair falling from the apex of the forehead.

It should be obvious to anybody that either the *Shroud* is *c* 2000 years old or it is not. If it is *c* 2000 years old, then and only then is it even remotely possible that Vignon's thesis is correct, *viz*: the *Shroud* was a blue-print for the depiction of Christ by artists in Byzantium after *c* 500 AD. Assuming for the moment that the *Shroud* is indeed *c* 2000

years old and that it was a blue-print for subsequent portraits of Christ, it would also be fair to assume that the 'divine' authority of the *Shroud* would have been considered to be absolute. In this case, surely, no artist would have dared to have deviated from what would have been considered the 'divine' image. Indeed, even if artists were not allowed to view the *Shroud* at first hand because of its sacrosanctity, they would surely have relied on either: previous portraits that had been sanctioned by clerical authorities; or the advice of clerical authorities who had viewed the sacred image of Christ personally. Instead, we find that although all Byzantine portraits do indeed possess a 'family resemblance' (in the Wittgensteinian sense), in actual fact, no two are ever identical. Wilson readily admits this, but then goes on to generate a rather personalised set of statistics to imply very strongly that an 'average incidence of an impressive eighty percent' (1978:85) of all fifteen features are to be found in (all?) Byzantine portraits of Christ. This claim is extremely misleading and not at all objective. Wilson seemingly limits his findings to the features contained in only three portraits, viz: the *Christ Pantocrator* from Delphi; the *Christ Enthroned* from Sant'Angelo in Formis (plate 12) and the mosaic of *Christ Pantocrator* in the Cefalu apse (plate 16). (Wilson, 1978:85.)

If one looks at the phenomenon of Byzantine depictions of Christ we find that in no singular case does a portrait contain all the fifteen features listed by Wilson. In addition, none of these portraits contains quite the same permutation of 'shroud' features as each other and many of the actual features which are (collectively) found on the *Shroud of Turin* are found on any other painted or mosaic face (*ie* saints, kings, *etc.*) produced in terms of

the various paradigms of Byzantine art and indeed many other cultures besides.

For example: Item 9 (an accentuated line between nose and upper lip), item 10 (a heavy line under lower lip), item 11 (a hairless area between lower lip and beard) and item 12 (a forked beard) are found in most depictions of bearded men. (In the latter case, Christ's beard is shown both forked and unforked in Byzantine portraits);

Item 8 (an enlarged left nostril) is not visible on any portrait cited by Vignon and Wueschel (without, perhaps, the use of much imagination). Indeed, whenever the nostrils appear to be 'enlarged' both nostrils are of equal size. Thus, at no point is emphasis given to either nostril;

Item 15 (two strands of hair) is only really 'visible' on the positive image (photographic negative) of the *Shroud*, thus making this feature unavailable to spectators before 1898. In addition, Byzantine artists more often depicted three strands and they normally lie from left to right or straight down from the apex of the forehead. Both styles are contrary to the direction indicated by the *Shroud's* ambiguous markings in its negative form;

Items 6 and 7 (accentuated cheeks) are only noticeable in one example cited by Vignon and Wilson (*viz: Christ Enthroned* from Sant'Angelo in Formis);

Item 2 (the three sided 'square' between the eyebrows) appears in all cases as a stylised



PLATE 10

*Christ Pantocrator from the Catacomb  
of St. Pontianus, Rome, c 750 AD.*

(Wilson, 1991:46-7.)

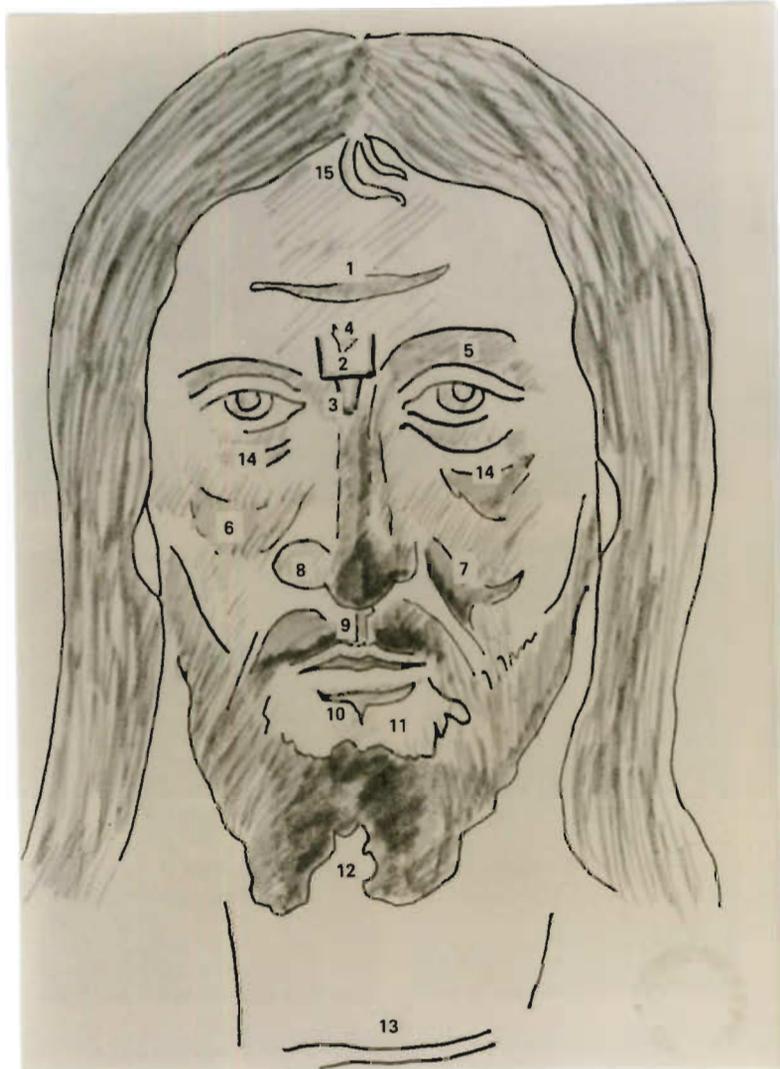


FIGURE 1

Schematic representation of the image of the head in the *Shroud of Turin*, showing the 'Vignon' features.

(Wilson, 1978.)

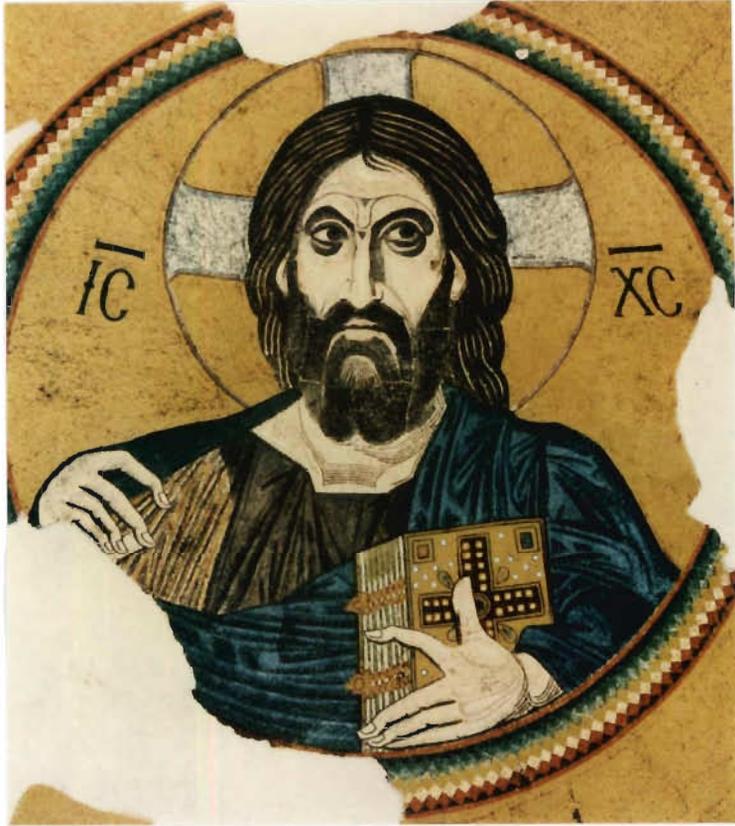


PLATE 11

*Christ Pantocrator,*

from the Church of Daphni, c 1050 AD.

(Grabar, 1953:114.)



PLATE 12

*Christ Enthroned,*

from the Sant' Angelo in Formis, Italy, c 950 AD.

(Wilson, 1991:46-7.)



PLATE 13

*Christ Enthroned,*

from the east narthex of Hagia Sophia

in Constantinople, c 950 AD.

(Grabar, 1953:91.)

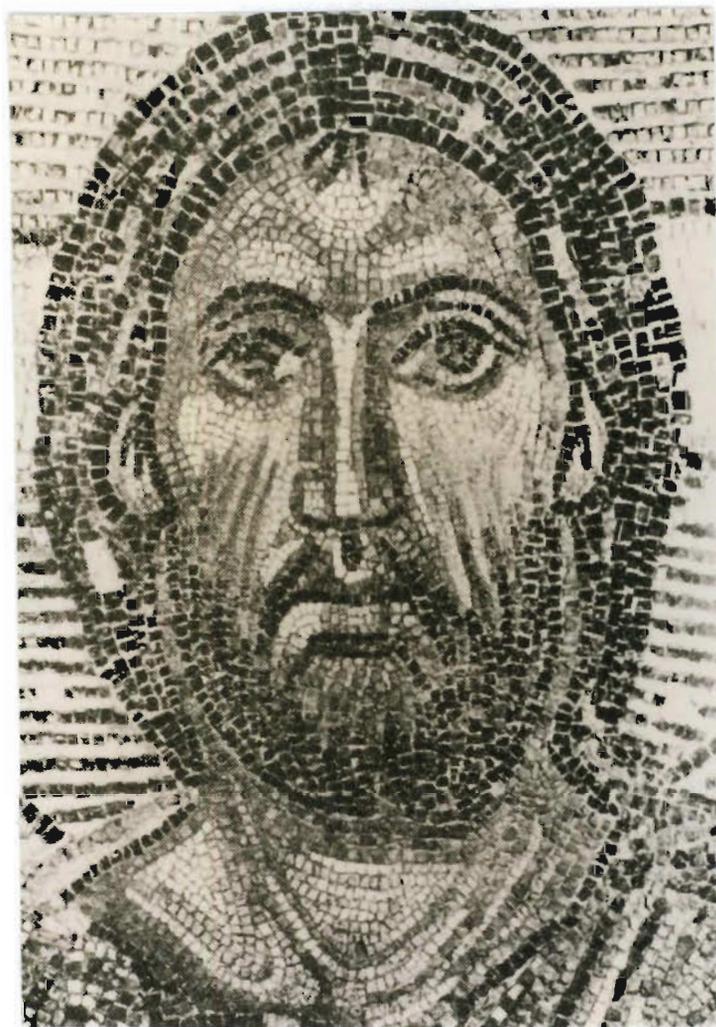


PLATE 14

Detail of the head of *Christ Enthroned*,  
from the east narthex of Hagia Sophia  
in Constantinople, c 950 AD.

(Grabar, 1953:91.)

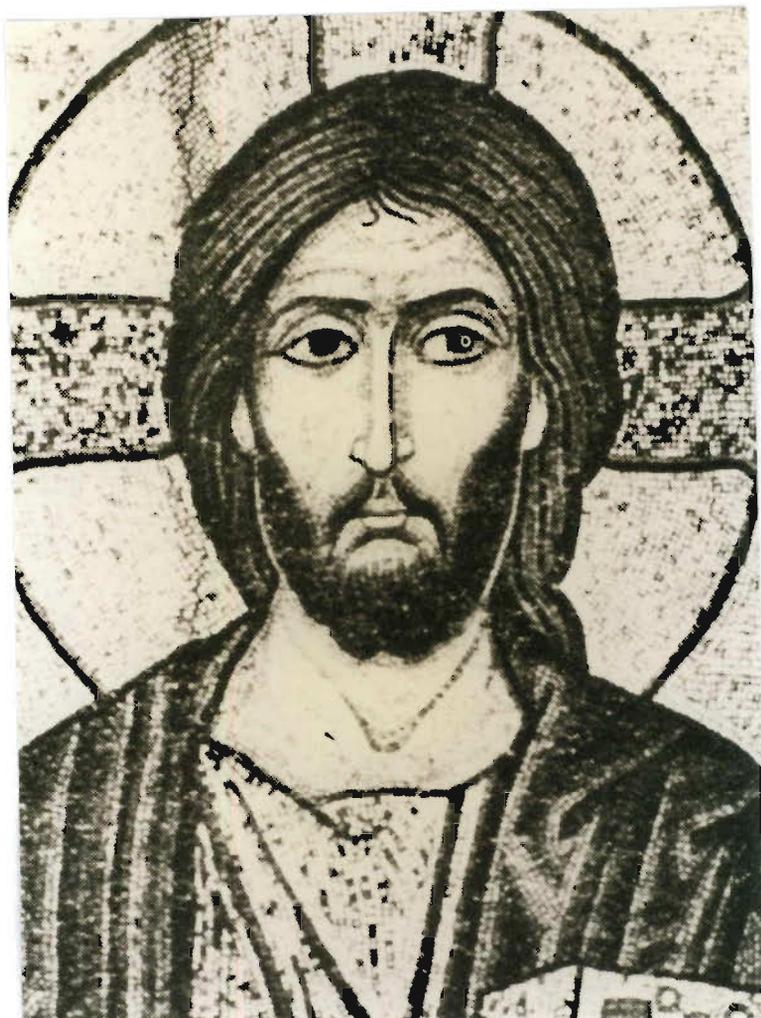


PLATE 15

Detail of the head of *Christ the Merciful*  
from the portable mosaic, Berlin, c 1050 AD.

(Wilson, 1978.)

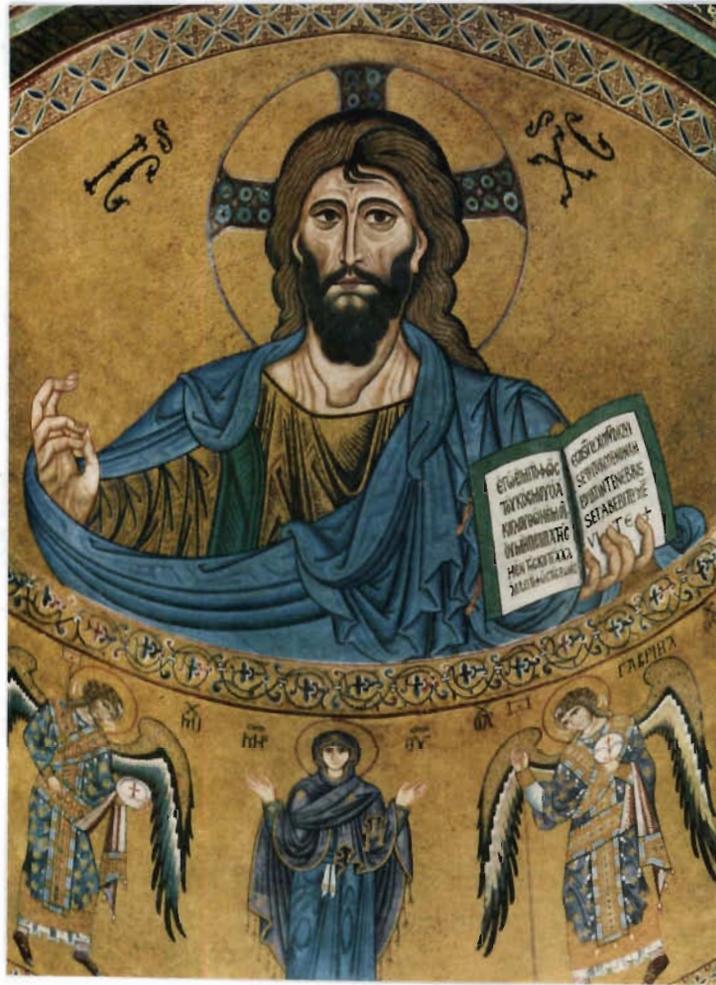


PLATE 16

*Christ Pantocrator* from the Cefalu Apse.

(Grabar, 1953:129.)

frown (and not a 'square') which is in keeping with the linear style of the respective portraits of Christ.

Indeed, the only 'Vignon' features that are always shared with the *Shroud* are item 3 (V shape at bridge of the nose) and item 14 (heavily accentuated, owlsh eyes). The latter feature, again, is common in all Early Christian, Byzantine and Coptic sculpture, painting and mosaic work.

For the sake of a different perspective, it is interesting to take note of some very obvious features that are invariably present in most examples of Byzantine portraits of Christ and which are not present on the *Shroud*, viz:

- \* Neat and tidy hair forming a definite domed shape to the top of the head, the ends of which are normally tucked behind the ears. This creates a shape that echoes the circular halo behind Christ's head (see plates 11, 12, 13, 14, 15 and 16);
- \* Small earlobes (see plates 11, 12, 13, 14, 15 and 16).

If the *Vignon thesis* has any merit, one wonders why these Byzantine artists would have consistently reproduced such standard features that are *not* visible on their divine 'blue-print'. Perhaps these features were included by the artists for cosmetic purposes? This is doubtful when one considers the many actual copies of the *Shroud of*

*Lirey-Chambéry-Turin*, including the well known *Shroud of Xabergas*, and the many surviving depictions of the *Shroud of Besançon* (plate 17). In all these examples the image portrayed has straight shoulder length hair and no ears.

Wilson also hypothesises that the *Shroud* was possibly presented in another format during its assumed residence in Constantinople (c 500 AD onwards). In this regard, he explains how the cloth could have been folded up and placed in a frame, in such a manner that only the head was visible to the faithful (see figure 2). This 'head' could then have been identical with the famed *Mandylion*, a painted image of Christ's Holy face on cloth, which was known to have been in Constantinople c 600-1204 AD.

The problem with this theory (within the specific context that it is presented) is that if we accept it as it stands, we would have to also accept that no one during a recorded 600 year period ever suspected that the cloth was folded and thus no one ever had occasion to open out the cloth! After all, if the linen cloth had been opened up, other, equally important features such as the distinctive wounds in the wrists would have also been observed and this fact would have filtered through to the artists. Finally, arguably the single most noticeable feature on the *Shroud of Turin's* image (whether the relic is folded or unfolded) is what appears to be a blood clot in the form of an inverted number '3' on the forehead. Is it not strange that these Byzantine artists failed to notice this feature? If the assumption here is that the artists wished to show Christ as he appeared before the crowning with thorns, then why do the same Byzantine artists fail to include this obvious feature on their



PLATE 17 . The *Shroud of Besançon* (from a watercolour facsimile by Pierre d'Argent).

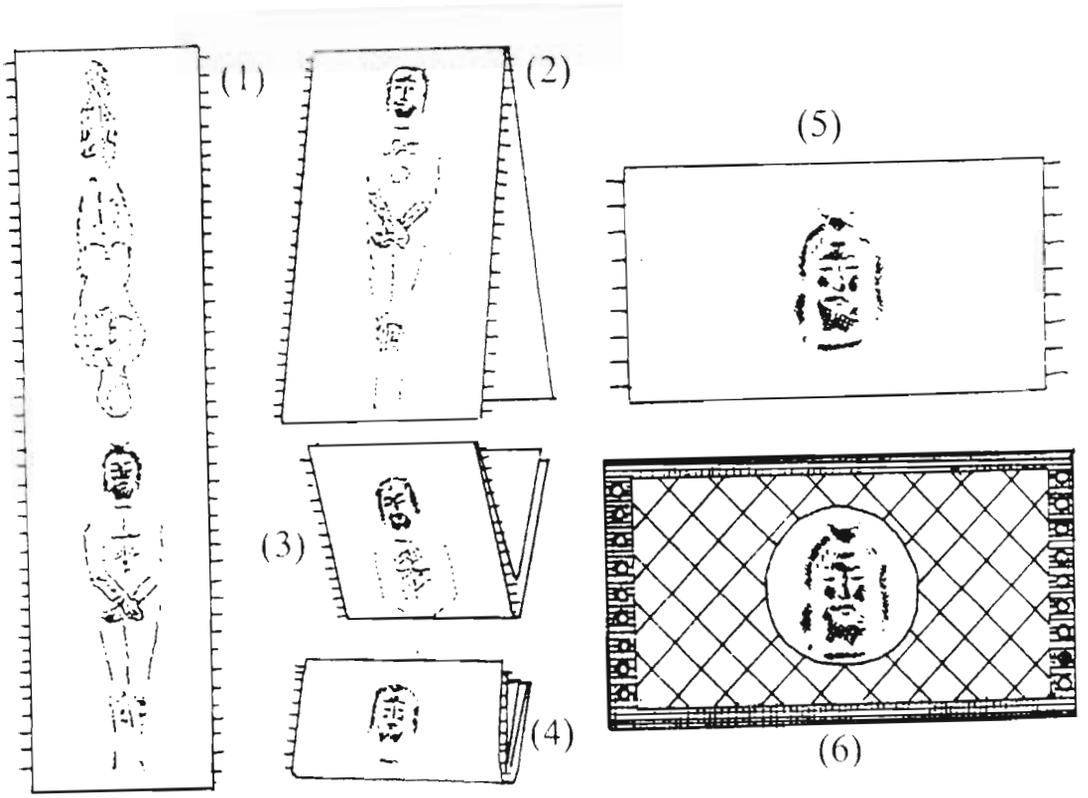


FIGURE 2

Diagram showing Wilson's theory of how the *Shroud of Turin* might have been folded so that only the image of the head was visible. (Wilson, 1991:142.)

respective depictions of the *Veronica* (the cloth that reputedly wiped the Divine face on the way to Calvary). After all, this event (according to tradition) occurred after the crowning with thorns, yet not once in the history of art (including Byzantine, thirteenth-century Italian and even known fourteenth-century and seventeenth-century copies of the *Shroud* itself) does the inverted '3' shape occur. In addition, these later documented copies of the *Shroud of Lirey-Chambéry-Turin* do at least record blood flows on the temple (unlike the hypothetical Byzantine versions). The fact is that the *Vignon thesis* is highly speculative. The supporters of this theory are literally attempting to define selected Byzantine depictions of Christ within a totally '*Shroud*' context. However, although it should be obvious that there exists far more evidence to dispute rather than to support the validity of the *Vignon thesis*, it would be short-sighted (at this stage) simply to dismiss it outright.

### 3.1.2.2 Vignon's *vaporographic print theory*

The impressions on the Holy Shroud are produced by chemical action, largely without absolute contact between the body and the cloth. Of this we have no doubt (Vignon, 1902:154).

Thus wrote Vignon over ninety years ago, when he first formulated his famous *vaporographic print* theory - an idea which developed from his series of experiments designed to reproduce what he saw on the *Shroud*. At a very early stage, Vignon realised that the information contained in the *Shroud's* image could never have been produced by simple contact between a corpse and the cloth, for two main reasons, *viz*:

- \* many areas that could never have come into contact with the *Shroud* (eg ankles, sides of the nose, neck *etc.*) were all recorded in the image; and
- \* even if these areas had come into contact (even briefly) the resultant image on the *Shroud* would have been distorted. This latter point is simple to prove (as indeed, Vignon did):

If one takes a person and covers his/her face with a layer of powdered red chalk or an oil based pigment (like grease paint) and carefully places a clean linen cloth over those facial features that can be seen on the *Shroud* it is possible to produce a negative image (direct contact print). However, on withdrawing the cloth, one is always left with an impression which is grossly out of proportion, viz: the nose is wide and negroid in appearance; the mouth becomes a grimace; and the face is stretched side ways. (See plate 18.) Based on these results, Vignon decided that the only way a surface (adequately prepared with a suitable chemical reagent) could receive visually perceivable information was either by radiation or gaseous vapour. He quotes the words of Colson who wrote an article in 1900 which reviewed 'the manner in which photographic films may be influenced by distant objects':

The actions taking place between substances more or less separated from each other can be divided into two distinct classes. Those produced by radiation (that is to say by a sort of vibratory movement, the source which acts dynamically on the sensitive plate), and those produced by gases or vapours which emanate from certain substances and act chemically on the sensitive plate. It is not difficult to distinguish between these two methods

of action. Radiation is transmitted through any given medium in a straight line through certain substances even of close texture and may present the same phenomena in reflection, refraction, diffraction, and polarization as in the case of light; whereas gases and vapours diffuse in air, and only penetrate porous substances (Vignon, 1902:154-5).

Vignon relied, at first, on Colson's own experiments concerning vapour. Colson had as early as 1896 already conducted experiments using zinc plates. Colson (Vignon, 1902:156), states that:

A thin plate of zinc, rubbed bright with emery paper, if placed in the dark room on a gelatinous bromide plate, will produce upon it an effect which after the action of a developer manifests itself by a tint of dark grey. To produce this action it is not necessary previously to expose the metal to the rays of the sun. The action is strong, and the grey tint is produced in a few hours, even at a distance of several centimetres. It passes through paper, thin cardboard, thin wood, albumen, gelatine, and porous bodies generally, and passes round obstacles; compact substances such as glass, metal, gums and crystallized substances interfere with its direct passage. The numerous experiments which I have made establish that this action is not a radiation such as occurs from radio-active substances, but is caused by the disengagement of zinc vapour...which ceases directly the surface of the metal has become oxidized by the moisture of the atmosphere. I have established the same property in magnesium and cadmium, but have failed with mercury, doubtless because it does not diffuse easily in gelatine.

In this process, the zinc 'vapour' accumulates on the gelatinous bromide plate and remains there until the plate is developed. With this information to guide him, Vignon (working in close collaboration with Colson) set about attempting to create recognizable images using vaporographic techniques. He discovered that if a metallic object which contained a relief image (such as a medal) was allowed to lie on a photographic plate, he could obtain a sharp focus image in those areas where the relief touched the plate and a soft focus image

in those areas that did not come into contact with the plate. In other words, the vapours had 'bridged' the gap and made an impression on the plate. All these experiments were conducted in a light-proof box to exclude the possibility of radiation. He describes one such experiment as follows:

M. Colson made a plaster mould about ten centimetres high from a head of Christ. He preferred plaster as he found it possible to make a small quantity of newly prepared powdered zinc adhere to it by friction. After charging the plaster with this active substance he placed it on a Lumiere plate *marque bleue*, gelatine side up, in a light tight box. The object only touched the gelatine at three points, and, if one may use the expression, the photographic plate saw a three-quarter view of the head. Forty-eight hours later M.Colson developed the plate (Vignon, 1902:158-9).

The resultant image (plate 19) is (like the *Shroud*) in the negative, and when the polarity of the image is reversed (*ie* making the negative image into a positive image, as in plate 20) its impression has a strangely three-dimensional quality not unlike that found in the *Shroud of Turin*. In particular, (as also noted by Vignon) it has the appearance of being lighted from above. This latter feature is also very characteristic of the *Shroud's* image.

Vignon then tried to find out if a human body could (like the zinc metal) produce some kind of chemical vapour that would react with a suitably prepared piece of cloth, the latter acting like a photographic plate. In this endeavour, he discovered that ammonia vapours turn a solution containing oils and aloes brown after prolonged contact. With this knowledge, Vignon then attempted to produce a recognizable image employing these same substances. A number of experiments were conducted involving a kid leather glove placed

over a plaster cast of a hand. The plaster was first impregnated with ammonia and then the glove was fitted over the plaster form (this action helped to control the amount of ammonia vapour that was released by the plaster hand). Over the glove was placed a linen cloth impregnated with an oil and aloes solution. At one stage he actually produced a negative image of the kid glove. Vignon (1902:167), states that:

The vapours were given off very regularly through the pores of the kid without staining the linen by too much water or letting the oil penetrate the damp glove. Working in this way we got an excellent impression of the back of the hand. The tips of the fingers have the same square aspect due to the glove having been too long. On the inside of the thumb the seams of the glove are plainly to be seen, while on the outside the image fades away rapidly and regularly. The print is sufficiently definite to show the likeness of a finger, but too diffuse to mark the actual outlines, and this may be said of all the fingers. On the back of the hand the slight depressions between the metacarpals are easily distinguished, the outer edge going off into an unfinished blot where the linen had been raised above the object by the higher position of the fourth and fifth fingers.

As interesting and enlightening as this may seem, there are a number of problems with this theory: firstly, all the impressions made by Vignon and Colson are indistinct compared to the relatively detailed *Shroud* image; secondly, Vignon never tried to put his theory to the test by placing a suitably prepared body under an oil-and-aloes-saturated linen shroud. Yet, based on the strength of the 'kid glove' experiments alone, he produced the following hypothesis, viz:

\* someone spread an unguent on the *Shroud* (such as myrrh and aloes) 'thus

rendering it sensitive to the action of organic emanations from the body' (Vignon 1902:164);

- \* a corpse, still covered in a layer of uric acid-rich 'morbid sweat' (the latter produced naturally by the body as a result of a highly stressful death) was laid out naked on the *Shroud* and then covered by the same (see plate 21);
- \* the urea, starting to ferment, produced carbonate of ammonia. The resultant ammoniacal vapours rose upwards and oxidized the aloes, thus producing a negative image (similar to the kind produced by zinc vapours on a photographic plate).

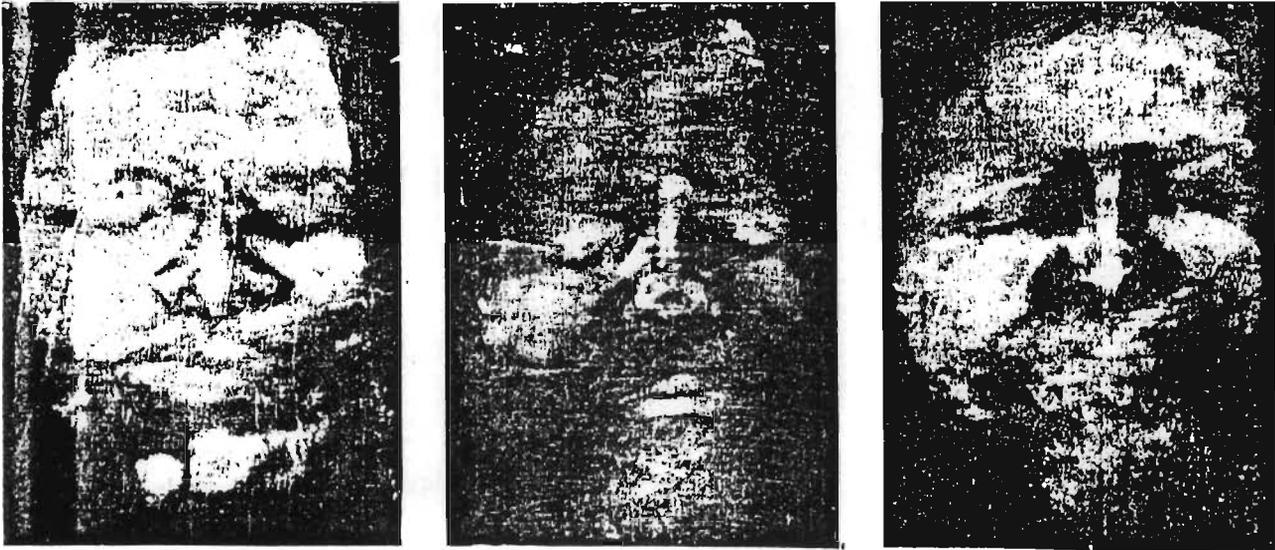
Vignon (1902:169-70), (rather abruptly) concludes from all this speculation that:

We will not at present proceed further with our chemical experiments. We have ascertained that aloes fulfils the ... conditions necessary for a substance which could produce such impressions as those found on the Holy Shroud...(and) keeping within the physical conditions of the experiment made with zinc we have crossed the limit which divides theory from practice. We attribute the impressions on the Shroud therefore to direct chemical action, spontaneously and even necessarily produced under conditions which can be clearly defined. We now know what name to give to these impressions, if any one seeks a new word-they are vaporographic prints.

Vignon, it would seem, did not want to conduct an experiment that crossed the bounds of human decency (*ie* he didn't see the need to use an actual corpse to prove what was for



*Photographic facsimiles of three impressions.*



*The same impressions as seen on the negative plates.*

IMPRESSIONS TAKEN FROM A LIVING HEAD SMEARED WITH RED CHALK

PLATE 18

Direct contact print of a human face produced by Vignon.

(Vignon, 1902.)



*Chemical impression.*



*Photographic inversion of the chemical impression.*

PLATE 19

PLATE 20

Comparative photographs of Colson's vaporographic experiment.

On the left is the original negative image and on the right

the positive image. (Vignon, 1902.)



PLATE 21

A painting by Rovere which illustrates  
how Christ was supposedly wrapped  
in the *Shroud of Turin*, c 1689 AD.

(Weaver, 1980:732.)

him already an obvious conclusion). This is strange, because he could have easily used a live person or even a dead animal to test his hypothesis. Vignon's famous *vaporographic print* theory literally evaporates in the light of recent photomicrographic and X-ray fluorescence investigations of the linen fibres (see 3.4), but even so, without the benefit of modern science it is still possible to take Vignon to task on a number of issues, viz:

- \* how could the reverse side of the corpse produce an image 'vaporographically' when the weight of the body would have distorted the image? The *Shroud* contains no such distortions.
- \* how could the 'scourge marks' register so distinctly on the *Shroud's* image?
- \* how did the people who laid the body to rest in the tomb manage to make the *Shroud* lie so straight horizontally over the body? (after all the laws of gravity determine that a large linen cloth normally drapes around a three dimensional object and the resultant 'vaporographic print' would be just as distorted as one made by direct contact).

### 3.2 THE MEDICAL EVIDENCE

Anyone who looks at the positive image of the *Shroud of Turin* is normally struck by the

amount of naturalistic detail which is certainly not evident in other images produced by western and eastern cultures before 1357 AD. Indeed, the positive image contained in the *Shroud* is extremely lifelike - a fact borne out by the number of medical practitioners and pathologists who, from the turn of the century until the present day, have actually managed to treat this image as if it were a real human body.

This medical examination of the man in the *Shroud* is extremely important because, although it offers no (immediately obvious) clue as to the actual process employed in the production of the image, it does most strongly support the view that an actual corpse of a classically crucified man was an absolute pre-requisite for the final 'impression'. This information will also be shown (at a later stage) to be helpful in deducing how the image was actually produced. Wilson (1978:21) states that

the interest of all these men has derived from the anatomical accuracy of the image and the totally lifelike character of the bloodstains. They have, for instance, been able to build up remarkably precise data on the physical characteristics of the man of the Shroud, data drawn from careful measurements of what is visible of the bone structure of the image.

In a similar vein, Rinaldi (1974:53) states that

[a]mong the Shroud's details which not even a present-day artist with the most consummate knowledge of anatomy and physiology could produce, medical men include the following: the perfect characteristics of a corpse in the condition of *rigor mortis*, with the added characteristics of one who died while hanging by the arms, such as the abnormally expanded rib case, the distended lower abdomen, the sharply drawn in epigastric hollow, *etc.*

In this connection it is enlightening to examine the more important findings of those three physicians who have, arguably, contributed the most to the medical debate on the *Shroud*, viz: Pierre Barbet; Robert Bucklin; and David Willis.

### 3.2.1            **The physiological characteristics of the man in the *Shroud***

From the observations of medical experts such as Bucklin and others, it is possible to identify a number of physiological characteristics of the man whose image now exists on the *Shroud*. In this regard, the photographic record of the *Shroud* depicts a man who (if he had in fact existed) would have had the following specific physiological characteristics, viz:

- \* a height of 181 cm;
- \* a powerful and well proportioned physique;
- \* a right shoulder lower than the left (possibly dislocated);
- \* facial features of the same physical type as modern Sephardic Jews and 'noble Arabs' (Wilcox, 1978:129-136);
- \* an age of between 30-45;
- \* shoulder length hair and a forked beard.

### 3.2.1.1 The nature and extent of injuries

The man in the *Shroud* has a number of injuries which have been identified by Dr. D.

Willis as follows:

- \* **superficial facial wounds, viz:**
- \* a swelling of both eyebrows;
- \* a torn right eyelid;
- \* large swelling below the right eye;
- \* a swollen nose (possibly broken);
- \* a triangular-shaped wound on the right cheek with apex pointing towards the nose;
- \* a swelling to the left cheek;
- \* a swelling to the left side of the chin.
- \* **traces of 'spilled blood', viz:**
- \* at least eight independent streams of 'blood' can be counted on the back of the head caused by independent puncture wounds to the scalp;
- \* at least four independent streams of 'blood' can be counted on the front of the head

also caused by puncture wounds. Vignon, who like others ascribed these streams of blood to wounds inflicted by the 'Crown of Thorns' stated that 'No painter, in his most elaborate work, has ever risen to such exactitude' (1902:30);

- \* **superficial wounds on the body, viz:**
- \* 90 - 120 marks, each about 4 cm in length, covering the entire body except feet, forearms and head. It has been postulated that these marks were made by two whips (specifically Roman *flagri* or *flagelli*), each of which had a number of thongs studded with lead balls. From the angle of the 'whip marks' it has been claimed that it is possible to deduce that the man in the *Shroud* was lashed by two men from the rear. (Stevenson, 1981:154; Rinaldi, 1972:28.);
- \* two large excoriated wounds which were clearly inflicted after the whipping. Willis states, 'These wounds could well have originated from the friction of some heavy object rubbing on an already damaged area of skin' (Wilson, 1978:25);
- \* excoriations with jagged edges to the region of the left patella and a contusion wound to the area of the right patella.

\* **stigmata, viz:**

- \* a puncture mark in the left wrist (at a point in the metacarpals known as ‘the space of Destot’) with distinct blood flows. The thumbs of both hands are missing, suggesting that they are lying flat against the palms. (See 3.2.2.);
- \* an assumed puncture mark and visible blood flows from the right wrist. The left wrist obscures the right wrist;
- \* evidence that the feet were pierced by a single sharp object (nail?) at the position in the metatarsal bones known as the ‘Linfranc joint’. The left foot was placed on the right foot. (See 3.2.3.);
- \* an elliptical wound corresponding to the space between the fifth and sixth ribs on the left side of the torso. From this wound flows ‘blood’ interspersed in some areas with clear patches. These patches have been interpreted as ‘water’.

Those areas associated with the *stigmata* have perhaps caused the greatest interest amongst these medical authorities. Of especial interest is the research undertaken on the wounds in the wrists and feet.

### 3.2.2 Dr Pierre Barbet

In the 1930s, Barbet conducted a series of experiments on cadavers at the St. Joseph's Hospital, Paris. The purpose of these investigations was to prove beyond doubt that the man in the *Shroud* had suffered death by crucifixion. Most people immediately associate this terrible form of capital punishment with the ancient Romans and obviously, the sacred personage of Jesus Christ. Of course many other cultures employed this form of execution, including the ancient Chinese, Persians and Carthaginians. It is interesting to note that after *c* 400 AD, crucifixion, as a form of capital punishment was outlawed by the Romans. If the *Shroud* were produced after 1260 AD (as the 1988 carbon dating suggests), there could not have been many persons who understood the technical aspects of this practice in either Western Europe or Byzantium.

Bearing this in mind it is important to note that certain aspects of Roman crucifixion had either been forgotten or were still not fully understood before Barbet's investigation.

#### 3.2.2.1 The nail wounds in the wrist

Like Vignon before him, Barbet was especially interested in the position of the nail wounds in the man's wrist (as depicted in the *Shroud*). He realized that if a person were nailed to a cross (in the manner described in the *Gospels*) the sheer weight of the body would tear the hands from the nails. In this context it would seem that the only way to attach a person

to a cross (in keeping with the more traditional interpretation of the event) would be by taking the weight off the palms of the hands by employing some additional support such as a rope binding the arms themselves. However, if a person were to be attached to a cross by the wrists (as suggested by the image of the *Shroud*) the body could be adequately supported. Barbet experimented by placing nails in the wrists of cadavers at the same point indicated on the *Shroud* and made an important discovery, viz: the thumb contracted over towards the palm of the hand. Specifically, this action is caused when an object (like a nail) passes through a point in the metacarpals known as the 'space of Destot'. This mechanical stimulus has been proved to be the result of the median nerve being touched by the nail as it separates the small metacarpal bones of the wrist. Amazingly, the *Shroud* clearly shows the same features on both hands. This single feature is arguably the most convincing evidence that the image in the *Shroud* is a naturalistic record of a crucified man in *rigor mortis*. Barbet (1953:183) commented that,

If these be the work of a forger, he must have been a super-genius as an anatomist, a physiologist and an artist, a genius of such unexcelled quality that he must have been made to order.

No artist in the history of art has depicted Christ quite like the *Shroud* image. Indeed, all the references in the *New Testament* and prophecies in the *Old Testament* clearly refer to the Messiah's hands being pierced (not his wrists). It is pointless (as many scholars have done *ad nauseam*) to point out that the Greek word for the hand can include the wrists and even, at a stretch, the arms themselves. Even if this latter point were accurate, the fact is,



PLATE 22

*The Crucifixion* by Peter Paul Rubens, c 1610 AD.

(Bertram, 1968.)

that (with one possible exception) no practising Christian since the Church's foundation, has ever been recorded to describe, sculpt, draw or paint a depiction of the Crucified Christ that places the wounds of the nails in the 'space of Destot'.

In this connection, it should be noted that an unusual version of the crucifixion was painted by Peter Paul Rubens in 1610. This painting depicts the nails in the wrists. (See plate 22.) However Rubens does not show the reflex action of the thumb as depicted on the *Shroud*. To date, no other record can be found for this phenomenon which precedes the work of Barbet.

Barbet (who started his investigations as a confirmed sceptic) was so impressed with the anatomical accuracy of the *Shroud's* image that he wrote:

I am a surgeon and, as such, well-versed in anatomy which I taught for a long time; I lived for thirteen years in close contact with corpses, and have spent the whole of my career examining the anatomy of the living. The idea that an artist of the fourteenth century could have conceived, let alone painted or stained these negative images is sufficient to disgust any physiologist, any surgeon...Please, do not even talk of it! This image is enough proof that nobody has touched the *Shroud* except the Crucified Himself (1953:73).

### 3.2.3 Dr Robert Bucklin

Bucklin's (1961:9), comments concerning the wound in the feet are noteworthy. He states that:

In examining the photograph of the right foot, we are able to make out an almost complete imprint. The border is slightly blurred in its middle part, but it still presents a very definite concavity corresponding to the plantar arch. More to the front the imprint is wider, and we can distinguish the imprint of five toes. The print is that which one might leave as he stepped on the flagstone with a wet foot. In the middle part of this footprint there is a small rectangular stain a little closer to the internal border. This mark is quite definitely the mark of a nail and it can be seen that the nail has passed between the metatarsal bones at the base of the foot.

### 3.3 HUMANISTIC ICONOGRAPHY OF THE THIRTEENTH AND FOURTEENTH CENTURIES AND THE SHROUD

From the preceding medical evidence (see 3.2) one can safely make two assumptions:

- \* Whoever produced the image on the *Shroud* and regardless of how they produced it, had to have had the corpse of a crucified man; and
- \* This unfortunate man underwent a crucifixion loosely modelled on the *Biblical* (textual) account of Christ's crucifixion and also the more traditional Catholic (and possibly Eastern Orthodox) iconography related to Christ's Passion and Resurrection.

It is also possible to make connections between the kind of iconography employed in the

image on the *Shroud* and the iconography of the late thirteenth and early fourteenth centuries. These latter assertions are supported by the details visible on the *Shroud*, all of which refer specifically to Christ's human suffering and indirectly to the eucharist. Geary reminds us that only from the twelfth century onwards did the cult of Christ become a real factor in Christian worship. He explains that:

Not only did the importance of relics diminish in the face of competition from universal saints, but they were particularly affected by the growing importance of the cult of Christ. Obviously Christ was always at the summit of Christian devotion, but the summit was for most of the early Middle Ages often obscured by clouds. Even in monasteries the cult of Christ entered popular devotion by stages; and only gradually, in the course of the twelfth century, did it become rooted in lay devotion. The process moved from the cult of a physical relic of Christ, the host, which was to be treated rather like other relics, through a stage of competition between this relic and other lesser relics, to the final popular recognition that the eucharist enjoyed a unique position in Christian worship (1978:28).

This growing interest in the centrality of Christ to the Christian faith was in turn supported by the teachings of St Francis of Assisi (died 1226 AD). Amongst other things, the Franciscan ideal helped to promote the concept that the faithful treat with their Saviour on a one-to-one basis. In particular, it stressed the incarnation of Almighty God as Jesus (Saviour) and as Emmanuel (God with us) (Matthew 1:18-25). In other words, God as man, subject to human temptation and doubt and ultimately the pain and suffering of dying a human death.

This transformation can be readily perceived in the development of the painted image in

western art from c 1200 to 1400 AD. The older, more symbolic (two-dimensional) Byzantine portrayals of Christ as Judge (which were normally to be found high in the domes of churches [see plates 11 and 16] and seemingly out of reach to mere mortals), were slowly supplanted by more naturalistic (three-dimensional) representations of Christ as a man who lived and existed in the world of men. (See plate 23: Giotto's *Crucifixion*, 1312 AD and plate 24: Giotto's *Lamentation*, c 1305.)

Depictions of the crucifixion from the time of Duccio (died 1319?) onward (see plate 25), increasingly emphasize Christ's physical suffering on the cross. In particular, the wound in the side and the flows of blood (especially along the forearms) become more pronounced. Likewise, the image of the man in the *Shroud* contains specific features which are synonymous with the kinds of humanistic iconography employed by the Roman Catholic world of the late 13th and early 14th century. In addition it is very obvious that this iconography often takes precedence over the more traditional aspects of Christ's Passion which are supported (to a greater or lesser degree) by the biblical account of the trial, crucifixion and resurrection of Christ.

It should perhaps be mentioned at this point that we must not confuse two quite separate issues, viz: the actual style of painting as found in many examples of thirteenth and fourteenth century art (produced variously during the Italo-Byzantine, International Gothic and Proto-Renaissance periods) and the iconography employed in these works. In this regard, we may safely state on the one hand there is a definite parallel between the kind



PLATE 23

*Crucifixion* by Giotto, c 1305 AD.

(Bertram, 1976.)



PLATE 24

*Lamentation* by Giotto, c 1305 AD.

(de la Croix, 1987:571.)



PLATE 25

*Crucifixion* by Duccio, c 1319 AD.

(Bertram, 1976.)

of iconography employed in the *Shroud* and certain paintings (especially from the Italo-Byzantine period onward), between the years c 1250-1350. For example, the emphasis on human suffering, viz: blood flows, flagellation wounds, pierced scalp *etc.* However, on the other hand, many of these paintings, because of the rising tide of humanism are also becoming increasingly naturalistic in terms of their painting style. In other words, the process of painting and the subjective depiction of such things as people, animals, the fashions of the royal courts, contemporary scenes, idiosyncrasies, *etc.* all conform to particular humanistic needs. In opposition to this, the *Shroud* is naturalistic primarily because of its means of production (whatever this may have been), because it is dependant on the physical remains of a crucified man.

The emphasis on Christ's human suffering is evident not only in the paintings of this period but also in the details of 14th century mystery plays and poetry. Indeed, meditation on the Passion of Christ was central to a medieval Christian. In this regard, Rieu (1975:33) states that this activity was the 'best act of faith and work an ordinary Christian could perform. His concentration helped him to understand the divine purpose and to avoid sin'. In the same vein, Owst (Rieu, 1975:33) quotes an unknown fourteenth century divine who states that:

By moche more it is lausom to ous to have the ymage of Crist in the cros,  
that we in havynge mynde on the deth of Crist mowe overcome the  
temptaciouns and the venym of the fende, the olde serpent.

The following three poems (typical of the times) stress the pathos of Christ's human body

and his suffering as manifested through the divine symbols, viz: the nail wounds, white flesh, scourged body, pricking thorns, and stretched arms *etc.* It should be noted that the examples that follow all derive from the meditations ascribed to St. Augustine. Note should be especially taken of the third poem which could almost be a literary equivalent of the *Shroud* itself:

White was his naked breast,  
And red with blood his side,  
Blood on his lovely face,  
His wounds deep and wide.

Stiff with death his arms  
High spread upon the Rood:  
From five places in his body  
Flowed the streams of blood.

(Rieu, 1975:36)

Look on your Lord, Man, hanging on the Rood,  
And weep, if you can weep, tears all of blood.  
For see how his head is hurt with thorn,  
His face and spear-wound spat on in scorn.

Pale grows his fair cheek, and darker his sight,  
Now droops on the Cross his body bright,  
His naked breast glistens, now bleeds his side,  
And stiff grow his arms extended wide.

Look at the nails in hands and in feet,  
And the flowing streams of his blood so sweet!  
Begin at the crown and search to the toe,  
Nothing shall you find there but anguish and woe.

(Rieu, 1975:38)

Man and woman, look on me!  
 How much I suffered for you, see!  
 Look on my back, laid bare with whips:  
 Look on my side, from which blood drips.  
 My feet and hands are nailed upon the Rood;  
 From pricking thorns my temples run with blood.  
 From side to side, from head to foot,  
 Turn and turn my body about,  
 You there shall find, all over, blood.  
 Five wounds I suffered for you: see!  
 So turn your heart, your heart, to me.

(Rieu, 1975:38)

There are also (at first appraisal) striking similarities between the injuries depicted by the *Shroud* and the accounts of Christ's passion and death in the *New Testament*. Because of this assumption, many authorities (prior to 1988) were convinced that the image was either a physical record of the historical Jesus Christ or a clever forgery designed for some as yet uncertain fraudulent purpose.

However, as has been seen already, a number of these details are purely naturalistic and refer directly to an actual physiological suffering of a man. In short, many of these details are not standard features of the classical (biblical) Passion of Christ. It is also important to note that not all of these details would have been visible to the faithful before 1898. However, these details were most definitely visible on the corpse necessary for the production of the image (at an unknown date prior to 1357). These details may be summarized as follows:

## 3.3.1 DETAILS SUPPORTED BY SCRIPTURE AND TRADITION

(Visible before 1898)

DETAIL FOUND IN SHROUD'S IMAGE	SOURCE OF INFORMATION
* The scourging of Christ	Biblical
* Bruises caused by the falls on the way to Calvary	Traditional
* The wounds in the feet	Biblical
* The wound in the side	Biblical
* The blood and water	Biblical

### 3.3.2 DETAILS NOT SUPPORTED BY SCRIPTURE AND TRADITION

(Visible before 1898)

DETAIL FOUND IN SHROUD'S IMAGE
* The application of a 'cap' of thorns
* The wounds in the wrists
* The missing thumbs

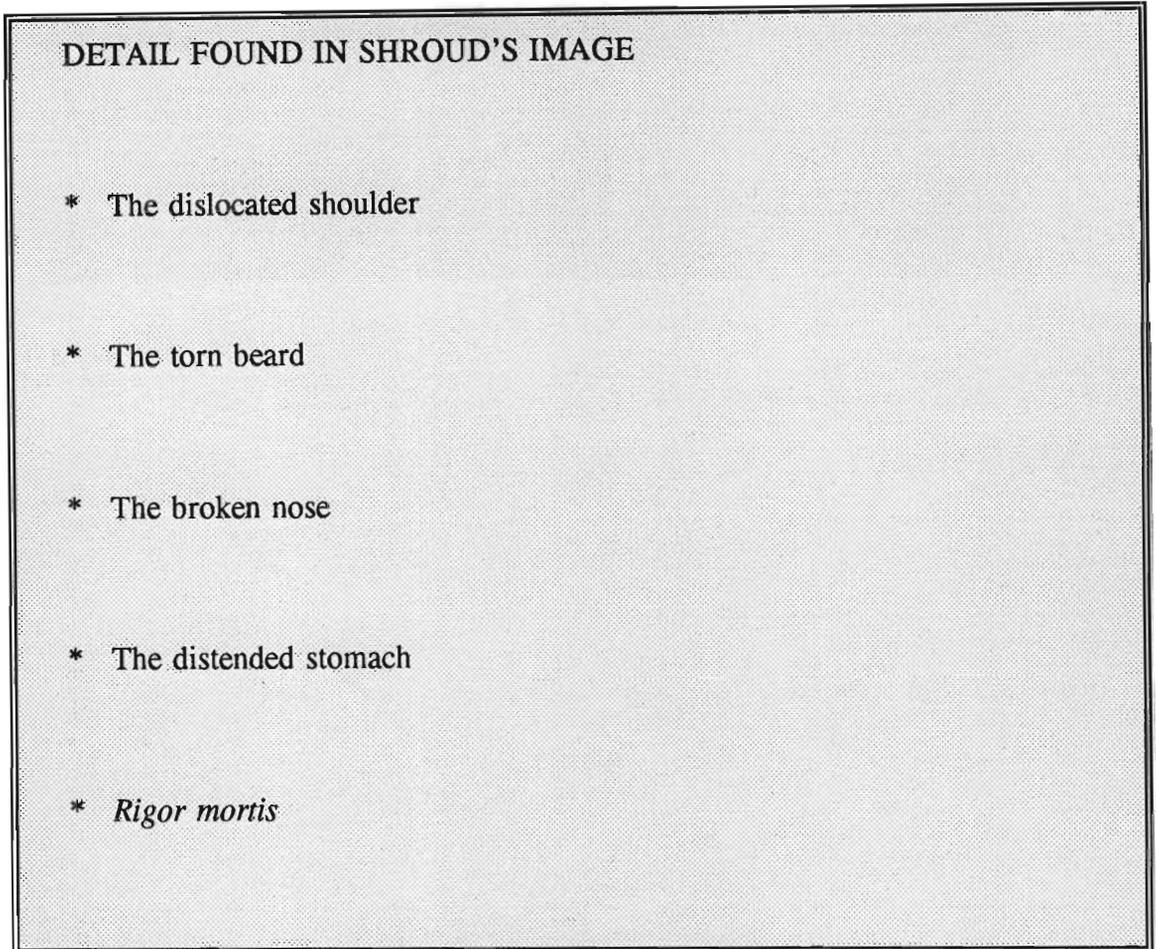
### 3.3.3 DETAILS SUPPORTED BY SCRIPTURE AND TRADITION

(Visible on the *Shroud* only after 1898 with the aid of photography)

DETAIL FOUND IN SHROUD'S IMAGE	SOURCE OF INFORMATION
* Bruises on the face	Biblical
* Christ bears the Cross (indicated by bruised shoulders)	Biblical

### 3.3.4 DETAILS NOT SUPPORTED BY SCRIPTURE AND TRADITION

(Visible on the *Shroud* only after 1898 with the aid of photography)



It would be well for the sake of objectivity and for the purposes of elimination to re-examine each of the various hypotheses that have been proposed for the cause of the negative image on the *Shroud*.

In this regard we are fortunate in that we have more precise technical data on the *Shroud* than earlier researchers but, as will be shown, even the so-called 'objective' and scientific

approach to the problem can also become myopic. It will remain the main contention of this thesis that the phenomenon of the *Shroud* itself will give us our best clue as to the methods employed in its manufacture.

## CHAPTER FOUR

### THE SEARCH FOR A VIABLE IMAGE FORMATION THEORY

#### 4.1 THE 1973 COMMISSION

Scientists were given their first opportunity to study the *Shroud* at close hand on June 16 and 17, 1969. On this occasion, the church authorities permitted a group of predominantly Italian researchers to investigate the *Shroud*. This investigation was intended primarily for the purposes of ascertaining the *Shroud*'s state of preservation and to make recommendations as regards the feasibility of conducting scientific tests at some future date.

As a direct result of this preliminary investigation, a number of samples were taken from the *Shroud* on 24 November 1973, for analysis by a second commission, many of whose members had made up the original 1969 team. In addition, the legal owner of the *Shroud*, King Umberto II, gave permission for the *Shroud*'s Holland cloth backing (that had been applied by the *Clarisses* in 1534) to be unstitched in a small area. This gave the researchers an opportunity to inspect the reverse side of the *Shroud* for the first time, and in this connection Silvio Curto (an Egyptologist) first noticed that no image was visible on the underside of the *Shroud*.

Four other members of the commission *viz*: Gilbert Raes (an authority on textiles), Guido

Filogamo (blood-analysis specialist), Eugenia Rizzati and Emilio Mari (forensic experts), were each given linen samples from the *Shroud*. Raes was given four samples: a 13 x 40 mm portion of cloth from the extreme edge of the background area of the frontal image, a 10 x 40 mm portion of cloth from the thin strip of cloth that is attached to the side of the *Shroud* (see 2.1 and plates 1-3), one 12 mm weft thread, and one 13 mm warp thread from the edge of the background area of the frontal image. All these samples were taken from areas that contained no image or burn marks.

Filogamo was given only two samples: one 13 mm thread and one 18.5 mm thread from the image of the 'blood' stain of the right foot on the dorsal image.

Rizzati and Mari (working for Giorgio Frache) were given ten samples: one 28 mm thread (with no image) from the bottom right-hand edge of the background area of the dorsal image; two threads (from a 'scourge' mark), measuring 8 mm and 10.5 mm respectively (the latter thread snapped on being withdrawn from the *Shroud*, Wilson, 1978:57); one 19.5 mm thread from the area of 'blood' flow across the small of the back on dorsal image, one 7 mm thread; two 12 mm threads; one 16 mm thread and one 17 mm thread from the area of the 'blood' stain near the right foot on the dorsal image (this latter area has the appearance of blood that has dripped onto the *Shroud* from the foot), and one 13 mm thread from the image of the 'bloodstained' right foot of the dorsal image.

#### 4.1.1 Gilbert Raes' investigation of the *Shroud's* textile properties

It is well known from examples of Egyptian, Palestinian and Roman linen cloths produced at about the time of Christ, that all have a tendency to be in a plain weave. This means that each weft thread passes under and over each warp thread that makes up the material. However, The *Shroud of Turin* is made up from a three-to-one weave. In other words, each weft thread passes under three warp threads and then over one warp thread, making a pattern of diagonal lines. This pattern is reversed at regular intervals of anything from 100 to 120 mm which creates a clearly defined herringbone composition. (See plates 26 and 27.)

Raes, in his investigation, discovered that the 13 x 40 mm portion of cloth sample (piece I of his report) contained traces of cotton which could accurately be identified as belonging to the species *Gossypium herbaceum*. This species of cotton is grown exclusively in the Middle East. However, the 10 x 40 mm portion of cloth (piece II of Raes' report) originating from the thin strip of cloth that is attached to the side of the *Shroud*, contained no cotton traces. In addition, although the type of weave used in both samples was identical, the thickness of the linen threads was not. This implies very strongly that either these two pieces of material were of different manufacture or that they were woven by the same manufacturer on separate occasions. (See figure 3.)

#### 4.1.2 Giorgio Frache's forensic testing for haemoglobin

Frache's task was to conduct a series of forensic tests on the *Shroud's* 'blood' areas. Wilson (1978:57-8), describes the nature of the research done in Frache's laboratory in Modena where tests were undertaken to identify the possible presence of haemoglobin on their samples taken from the vicinity of the 'bloodstained' image of the right foot:

[T]he fibres of each thread to be examined were opened out with the aid of a histological needle in order to show more clearly the character of the substance forming the 'blood' image. Under conventional microscopes the visibility of each thread was increased first by 63 and then by 285 diameters, so that the numerous vegetable fibres comprising each fragment of thread showed up clearly. The first thing the scientists noted was the absence of any encrustations of heterogeneous material, as would have been expected from the use of any artificial pigment. Instead, it could be seen that forming the image were fine yellow-red to orange granules ranged in diagonal bands that corresponded to the warp/weft pattern of the original weave. There were two very significant characteristics about these granules. As had been observed with the unaided eye when one of the threads had broken on extraction, the granules were found only on the surface fibres of the thread, leaving the fibres below quite clean. And, most intriguingly, no granules were to be found in the spaces between the fibres.

As it turned out, all the samples from the *Shroud* failed a standard benzidine test for haemoglobin. In addition, the microscopic orange granules failed to dissolve in either acetic acid, glycerin or potassium or oxygenated water. As will be noted later on, this finding largely contradicts the results of the 1978 commission (see 4.2). Thus, at this time, no definite conclusions could be made concerning the exact composition of the 'blood' areas on the *Shroud*. However, even though most of the 1973 research was involved with the actual linen material of the relic, some conclusions (albeit cursory) were made concerning

the nature of the image. For example, under magnification there exists no clear evidence of either paint, pigment or blood. In addition, the 1973 commission discovered for the first time that the image appeared only on the outer edge of the woven linen threads. In other words, only the outer fibrils that constitute each linen thread contained portions of the image. (See plates 26 and 27.) Further, only those fibrils on the image side of the *Shroud* were affected and no portion of the image is visible on the underside of the cloth. (A fact that was verified again in 1978.) This single discovery raised more questions than it solved, because it indicated that the image has not been caused as a result of staining, dyeing or painting. The fibres were not saturated or coloured through and there was no evidence of paint or pigment between the fibres or the fibrils themselves. Pellicori, (1981:38) states:

Thus the Italian work (1973), unable to conclusively characterize the 'blood' stains, intensified rather than settled compelling questions about the *Shroud* for scientists and ecclesiastics alike.

#### 4.2 THE 1978 COMMISSION

As could be expected, the results of the 1973 commission generated much interest from scientists internationally, and subsequently a number of Italian sindonologists lobbied in support of a proposed in-depth programme of non-destructive research by a group of American scientists. This team, which comprised specialists in computer technology, haematology, physics, organic chemistry, spectroscopy and X-ray analysis, was headed by John Jackson and Eric Jumper (US Air Force Academy).

	PIECE I	PIECE I	PIECE II	PIECE II
NUMBER OF THREADS PER CM	WARP 38.6	WEFT 25.7	WARP ----	WEFT 25.7
SIZE OF THREADS IN TEX. 4	16.3	53.6	18.0	73.1
DIRECTION OF TWISTS	Z	Z	Z	Z

FIGURE 3

Table of cotton thicknesses as found  
in the *Shroud of Turin* (after Raes [Wilson, 1978:54])

As fate would have it, 1978 marked the 400th anniversary of the *Shroud's* residence in Turin, and the legal owner of the *Shroud*, King Umberto II, granted permission for the relic to be put on public display for six weeks commencing August 21 1978. On October 8 the *Shroud* was examined by the Americans, who as early as 1977 had organized themselves as the *Shroud of Turin* Research Project Inc. (STURP). In this connection, Pellicori (1981:39) states that:

Perhaps no work of art or archaeology has ever been so intensively studied as the shroud was about to be. To probe the very atoms of the shroud's identity, a battery of the most sophisticated techniques available were brought to the task, many of them used in hair-splitting research on art forgeries and forensic problems.

The objective of this scientific arsenal, which included fluorescence, infrared radiometry, microchemical analysis, multispectral narrowband photography, optical microscopy, ultraviolet fluorescence photography, and visible, ultraviolet and infrared spectroscopy, was to investigate the *Shroud* as either a man-made (*ie* a painted/dyed) image or as a product of some (as yet unspecified) 'natural' origin. In addition, most tests were conducted in order to identify the elements present in both the image of Christ as well as those present in the 'blood' stains. In the latter case the scientists were especially keen to detect such trace elements as iron, potassium and phosphorous (the constituents of blood). By employing X-ray fluorescence, for example, it is possible to identify all elements which occur in relatively high concentration and are present in the material. This is accomplished by bombarding the *Shroud* with a beam of X-rays and then measuring the specific ways in

which a secondary stream of X-rays are scattered. (Pellicori, 1981:39.)

However, it should be carefully noted here, that the above mentioned investigation was undertaken within a very specific context, viz: to determine whether the *Shroud* and its image properties were a medieval forgery or the natural result of some older process (Adler, 1980:2742). In addition to, and as a result of this context, the research undertaken by the STURP research team was unavoidably coloured by one very notable factor, viz: the STURP team had brought along equipment which could only adequately deal with the analysis of those atomic elements and/or organic substances which are normally associated with such materials as dried blood, artist's pigments, dyes and stains. As will become apparent, even though the STURP team did set out to establish elemental variations among all areas of the linen cloth, because of their choice of equipment, they could only detect elements with an atomic number higher than 16 (see 4.2.4). Further, because for the X-ray fluorescence investigation the STURP team had only employed the use of Sn  $K\alpha$  excitation radiation, the detection of such elements as silver, cadmium and tin were precluded. Indeed as Morris *et al.* (1980:46) confirm, '[t]heir L-series fluorescence signals could be seen only if the elements [silver, cadmium and tin] were present in substantial quantities'. Indeed, it seems from the literature available to this author that the only element which was seriously investigated by the STURP research team was iron. The more important findings of the 1978 Commission are discussed below.

#### 4.2.1 John Jackson, Eric Jumper and the VP-8 image analyzer

John Jackson and Eric Jumper of the US Air Force Weapons Laboratory (working in collaboration with Bill Mottern) discovered that photographs taken of the *Shroud* by Guiseppe Enrie in 1931 contained three-dimensional information. In other words, the brightness of the image contained in the *Shroud* is directly proportional to the distance of the body from the cloth. This means that areas such as the nose and eyebrows are more intense than areas such as the sides of the face, the neck and the ankles.

This discovery suggested very strongly that the *Shroud* had never been in contact with a body at all. Rather, the two-dimensional surface of the cloth had encoded on it a record of a three-dimensional body. Stevenson (1981:63-4) explains that:

The mystery was that parts of the body not in contact with the cloth also appear on the image, and the brightness of these non-contact areas varies according to their distance from the cloth.

Unfortunately, Stevenson also tends to over-dramatise this important attribute of the *Shroud*. For example, he claims that a 'normal' photograph cannot generate a three-dimensional image because it is 'not sensitive enough'. He propounds that

Scientists can do something similar [reproduce a three-dimensional image] with photographs of stars and planets, where the object is far enough away from the astronomer's lens that its distance measurably affects the intensity of the light image received (1981:64).

Stevenson's comment reflects his ignorance as far as astronomy goes. Objects such as stars are so distant from the Earth that even at extremely high magnification they still appear as points of light. Indeed, all that happens at magnification is that one can see more stars than is possible with the unaided eye. As yet, the only star whose diameter can be readily determined by photography (let alone a three-dimensional image) from the Earth is the Sun.

Astronomers have in the past few years been able to determine the diameter of certain stars, but this method does not rely on photography alone. Stevenson (1981:64) continues:

[A] three-dimensional image cannot be created from any normal photograph, negative or positive. Modern lenses, films, and photographic papers are simply not sensitive enough to reproduce in a two-dimensional image the minute variations in light intensity emitted from different points on a three-dimensional object.

This information is very misleading. Firstly, if modern lenses and films are not sensitive enough to reproduce three-dimensional information how do they photograph the planets or other objects so far away from the astronomer's lens that their distance measurably affects the intensity of the light image received? Secondly, if modern photographs cannot contain three-dimensional information, how could Jackson and Jumper produce a three-dimensional image from a photograph of the *Shroud* taken in 1931? According to Stevenson (1981:64), Jackson and Jumper produced a three-dimensional replica of the man in the *Shroud* using a VP-8 Image Analyzer and he adds that the 'very fact that they were able to generate a three-dimensional photograph was in itself an intriguing piece of research, as well as a

technological *tour de force*'. The latter statement, of course is a contradiction of his earlier comments.

The fact is, that any visual information contained on a two-dimensional surface can be 'three-dimensionalised', depending on the context. Even an image of a form that had never been three-dimensional to begin with can be read (depending on one's reference point) as having volume. This point is easily proved by observing Jackson and Jumper's three-dimensional image of the *Shroud* (see plates 28-30). Areas such as creases in the cloth and repaired scorch marks (whose areas have no connection with the *Shroud*'s image at all but because of their physical existence have had to be included in the image analyses) have the appearance of two mountain ranges running on either side of the body. Where the image on the *Shroud* differs from a 'normal' image of a human subject is in terms of the employment of light and dark. With a 'normal' photograph, the subject's perceived 'volume' is dependent on the specific placing of highlights and shadows. Indeed, in most situations the subject to be photographed is side-lit, which emphasizes these areas of light and shade and thus gives to the image the illusion of three-dimensionality in its two-dimensional format. This basic, stock-in-trade technique has been well known to artists throughout the history of art. However, for an image analyzer to translate not only parts of an image as three-dimensional (such as the burn marks on the *Shroud*) but all the areas of an image working together as one, there must be a relationship between these areas. Such a relationship does exist in the image on the *Shroud* which makes it a good subject for computer enhancement. This is true of this



PLATE 26

Magnified view of image stained linen fibrils (Stevenson, 1981).



PLATE 27

Magnified view of blood stained linen fibrils (Stevenson, 1981).



PLATE 28

Three-dimensional computer-enhanced photograph  
of the *Shroud of Turin*, produced by Jackson and Jumper  
(Stevenson, 1981).



PLATE 29

Three-dimensional computer-enhanced photograph  
of the *Shroud of Turin* showing detail  
of the head, produced by Jackson and Jumper  
(Stevenson, 1981).



PLATE 30

Three-dimensional cardboard reconstruction  
of the image in the *Shroud of Turin*  
produced by Jackson and Jumper  
(Stevenson, 1981).

specific image whether in its original form or in photographic reproduction.

#### 4.2.2 **Jean Lorre and Donald Lynn's investigation**

Lorre and Lynn from the Jet Propulsion Laboratory in Pasadena, and also utilizing computer-assisted techniques, attempted to isolate any evidence of 'directionality' in the *Shroud's* image.

This latter feature is always present in such things as paintings, when the style and direction of application (by hand) of materials such as pigment, ink or dye can be determined. Their investigations indicated that the *Shroud's* image contained no 'directionality', strongly ruling out the possibility that a 'forger' had painted it.

#### 4.2.3 **Samuel Pellicori's photomicroscopic examination**

Pellicori, who was mainly responsible for the colour photomicroscopy work, took a series of coloured photomicrographs, (with a magnification of up to 20 times) of the 'blood' stains, the water marks, the scorches and burns, the body image and even the clearer background areas. He noticed that the colouring of the scorches, the water marks and the body image all appear similar against the background linen. Even at magnification he noticed that these areas tended to reflect light in similar ways except for the water stains. Pellicori (1981:41) comments that

the water stains had some distinct characteristics, notably that they penetrated the linen's threads to all depths, including around bends and into crevices in the fibre, which made for a darkish brown saturated appearance. The water stains also had an abrupt boundary where the unwetted areas begin.

However, as far as the body image was concerned, his findings were similar to those of previous investigations, viz: the image of the body consists of a straw-yellow discolouration which is restricted to the top three or four fibrils of each thread crown (see plates 26 and 27). Under magnification, the 'blood' stains appeared as red-orange amorphous encrustations trapped between the fibrils or the crevices. It appeared as if the *Shroud* had come into contact with a viscous fluid (like blood) and that this fluid had dried. The presumption was made that the solidified material (dried blood?) that had not been caught between the fibrils had simply fallen off or been eroded away over time. Pellicori (1981:41), informs us that

Close-ups of particular areas such as the apparent lance wound on the figure's right front side demonstrated a surprising contrast between the brownish background coloring of the blood stain and the exceptionally reddish particulate material caught in the fibrils.

Blood oxidizes and thus darkens in time, but the 'blood' of the *Shroud* seemed paradoxical in that on the one hand its coloration was seemingly in accord with its age (*ie* a minimum of 621 years by 1978), and on the other hand this 'blood' also contained particles that seemed too red in colour to be 'old' blood. However, by comparing the data of the

reflectance spectra of several blood samples (four-day-old blood was used and in one case was artificially aged by baking) with *Shroud* 'blood', Pellicori discovered, as did Adler (see 3.4.5), that there was a correlation in the spectrophotometry that indicated the *Shroud* blood to be *bona fide*. Pellicori (1980:1916), notes that

the absorption spectrum of a blood particle removed from the *Shroud* independently suggests that blood is present. Furthermore, the resemblance to blood as seen in the photomicrography of these areas is strong. The spectrum suggests denatured met-haemoglobin.

Yet another intriguing discovery made by Pellicori and other members of STURP which concerns the quality of the linen fibrils should be noted. The researchers observed that the fibrils that contained portions of the body image were slightly different in appearance to the fibrils that made up the background. In this regard, the weave of the linen is tighter and smoother in the background areas where no stain appears.

#### 4.2.4 Morris, Schwalbe and London's X-ray fluorescence investigation

This particular group of STURP researchers' primary goal was to provide estimates of elemental variations in the following areas of the *Shroud*, viz:

- \* 'blood' stains;
- \* image areas (which contained no 'blood');
- \* background areas (no image);
- \* scorch areas; and

\* patches (from 1534 *AD*)

(Morris *et al.*, 1980:40.)

Morris *et al.* (1980:40) states that:

The available equipment allowed detection of elements with atomic numbers greater than 16. With this information the relative concentrations of observed elements can be correlated with visible features or historical events and be applied to test various image forming hypotheses.

In other words, they could compare the problematic areas (*eg* 'blood' stain, image, scourge mark *etc.*) with those areas whose nature was better understood (*ie* the scorch of 1532 and the patchwork of 1534). If, for example, they were to find certain elements in the 'unstained' background material or image areas that did not appear in the patches this might help to identify a specific staining compound, dye or pigment. By employing the techniques of X-ray fluorescence, Morris, Schwalbe and London collected the individual spectra of an 'anomalous dark spot on the foot', a background area, a scorch, a sewn patch, an eye (image area) and the wound in the side ('blood' area). Allowing for errors (such as small misalignments of their apparatus and the varying thicknesses of the *Shroud*) the researchers found that the spectra definitely varied between 'blood' and 'non-blood' areas. Furthermore, the 'non-blood' areas were 'qualitatively quite similar to one another' (Morris *et al.*, 1980:44).

The main elements identified with any certainty on the *Shroud* included calcium, strontium,

and iron. Morris feels that the levels of calcium and strontium contained in the *Shroud* may be underestimated. However, Morris *et al.* (1980:45) caution us that

[b]oth calcium and strontium are relatively common elements. For instance we might expect considerable quantities of airborne CaCO<sub>3</sub> from the rich marble and limestone regions of northern Italy...Although other explanations are possible, the uniform calcium and strontium distributions might be explained simply as dust accumulations.

On the other hand, the levels of iron (unlike calcium) varied from one area to the next, but were generally higher in 'blood' areas. Interestingly enough, the background areas often contained higher levels of iron than the image areas that were investigated such as the face. This group believed that dried blood was a likely candidate for the 'blood' areas and that there was little chance that the image areas on the *Shroud* had been made with pigment or paint. Morris *et al.* (1980:46) states:

There appears to be no evidence of heavy element concentration differences between image (non-blood) and off-image points which would suggest an obvious forgery.

Like many of the other researchers involved in the 1978 commission, the Morris group learnt too late that their proposed experiments were inadequate to test the *Shroud* fully. Thus, as a result of their X-ray fluorescence testing, they formulated a number of proposals for future research. For example, with the correct apparatus it would be possible to confirm or rule out the possible existence of aluminium, sulphur, potassium, silver, cadmium and even tin traces on the *Shroud*. This point is very important, since it again

shows that even if the STURP team had wanted to test for the presence of such elements as silver or gold, they could not have actually done so with the equipment they had available to them at the time.

#### 4.2.5 Alan Adler and John Heller's spectroscopic tests

Adler and Heller conducted a series of tests on adhesive tape samples taken from those areas on the *Shroud* which correspond to the stigmata. In other words, pieces of adhesive tape (supplied by the *3M Corporation*) were impressed directly onto alleged blood areas of the *Shroud*, viz: the 'nail' wounds in the wrists and feet, the scalp and temple wounds and the 'spear' wound in the side. Their X-ray fluorescence investigation revealed that except for iron, no significant amounts of high atomic number elements appear on the cloth (Adler, 1980:2742).

Under a 1000 x magnification, Adler and Heller observed (on the adhesive tape), hundreds of linen fibrils and a single brownish red translucent crystal. They then prepared a simulacrum from a sample of woven, undyed, Spanish linen (approximately 300 years old) which had been impregnated with their own blood twelve months earlier. They (Adler, 1980:2742), commented as follows:

This [simulacrum] was sampled with ordinary Scotch Tape, and under microscopic examination several crystals and fibrils similar in physical appearance to those from the *Shroud* sample were observed. However, these all appeared to be slightly more garnet colored and less brown than the *Shroud*

fibrils.

The *Shroud* fibrils and the simulated fibrils were then examined by microspectrophotometry in the visible light range. Adler and Heller point out that because haemoglobin can exist in many different chemical states (*eg* it can be reduced, met-haemoglobin, denatured *etc.*) and its state of aggregation can also differ (*eg* film, crystal, solution) that for all intents and purposes, no specific spectrum exists for blood. Their findings, however, showed that both the *Shroud* 'blood' and the simulacrum blood contained porphyrinic material. In addition, as would be expected from very old blood, the *Shroud* 'blood' sample's spectrum compared favourably with the spectrum of fully oxidized denatured met-haemoglobin (perturbed acid met-haemoglobin). Adler (1980:2743) does however seem to advise caution at jumping to too hasty a conclusion here:

Although the spectra of the shroud fibrils are, in fact, indicative of such a spectrum (*ie* of old dried blood), the high degree of scattering from these solid samples makes the visible band shape features less distinct and does produce peak shifts from the solution spectra...Therefore, this identification is much less positive than desired.

Adler and Heller backed up their suspicions by comparing their results with reflection spectroscopy tests that had also been conducted on the *Shroud*'s 'blood' areas. These tests also indicated the presence of porphyrin. They (1980:2743), concluded therefore that 'the spectral data taken in aggregate are positive in confirming the presence of perturbed acid met-haemoglobin species on the *Shroud*'. Additional chemical tests were also conducted by Adler and Heller, whose main function was to ensure that it was aged blood and not

some other (non-blood) substance (such as simple iron salt) that was responsible for the positive reactions they had achieved thus far.

Unfortunately, the nature of these highly sophisticated experiments involved (amongst other things) the use of formic acid which rendered their test sample unusable for a final microspectrum test. 'Thus we were unable to provide this absolute final confirmation of the identity of the blood area material' (Adler, 1980:2744). Even so, it is highly unlikely from the tests conducted by Adler and Heller and indeed Pellicori (see 4.2.3) that anything other than blood was involved in those areas associated with the *stigmata*. Their summary of their investigation clearly indicates that aged blood is responsible for the image in the areas associated with the *stigmata* and in this regard, the following tests were performed:

- \* a visual examination;
- \* a positive association with iron by X-ray fluorescence was established;
- \* a positive Soret absorption and a reasonable correspondence to expected met-haemoglobin visible spectral shapes by both transmission and reflection spectroscopy was indicated; and
- \* a positive chemical conversion to a fluorimetrically characteristic porphyrin species seemed to confirm and give positive presumptive evidence for identification of the

alleged blood areas on the *Shroud* of Turin as, in fact, containing blood. (Adler, 1980:2744.)

#### 4.2.6 McCrone's painting hypothesis (1978)

As should be clear from the evidence obtained in 1969, 1973 and 1978, it is positive that the *Shroud of Turin* contains no particles of pigment or paint. It is true that Walter McCrone of *McCrone Associates* analyzed some of the fibrils pulled off the *Shroud's* surface by adhesive tape and claims that he detected the presence of red ochre. Red ochre is a pigment which contains iron oxide and a binder. This seems at first appraisal to support the possibility of some painting medium being employed in the production of the *Shroud's* image. However, if one considers that the microchemical tests as carried out by Alan Adler of the *Western Connecticut State College* detected no pigments or even binders for pigments of any kind to a level of less than millionths of a gram and that even McCrone was able to 'see' coloured particles only at several hundred magnifications, then we are left with the realization that even if red ochre is present in the *Shroud* it has nothing to do with the image itself. (Stevenson, 1981:135-8.)

It is worth mentioning that in the course of over 600 years the *Shroud* has been exposed to the elements on many occasions. The truth of this was borne out when a such items as insect legs and even nylon fibre belonging to a woman's pantihose were found on adhesive tape samples taken from the *Shroud*. (Adler, 1980:2742.)

#### 4.2.7 The major characteristics of the Shroud as of 1978

Stevenson summarizes the findings of the 1978 commission very well and the following list of criteria is based on his information. In this regard the *Shroud of Turin* has the following (verifiable) characteristics, viz:

- \* **Superficiality:** The image is essentially the discolouration of the uppermost fibres of the linen threads of the *Shroud's* fabric. The image has not 'penetrated' the threads nor is it visible on the underside of the *Shroud*.
- \* **Detailed:** The *Shroud's* image is highly detailed (see 3.2).
- \* **Thermally stable:** The *Shroud's* image was not affected by the heat of the 1532 fire.
- \* **No pigment:** It is certain that no pigment was applied to the *Shroud* and the image is not caused by pigment either.
- \* **Three-dimensional:** The intensity of the image varies according to the distance of the body from the cloth. The mathematical ratio was so precise that Jackson and Jumper were able to create a three-dimensional replica from the image.
- \* **Negative:** The image is a negative which is as visually coherent as a positive

photograph when its polarity is reversed.

- \* **Directionless:** The process that formed the image operated in a non-directional fashion. It was not generated according to any directional pattern as it would have been if applied by hand.
- \* **Chemically stable:** The yellow coloration composing the *Shroud* image cannot be dissolved, bleached, or changed by standard chemical agents.
- \* **Water stable:** The *Shroud* was doused with water to extinguish the fire in 1532. Although this has caused a water stain, the image itself does not appear to be affected.

The above characteristics of the *Shroud's* image were then compared with the various current theories for the image-formation process. On page 68 of *Verdict on the Shroud* appears a table which lists the above information. (See figure 4.)

Stevenson (1981:69) states that 'It is obvious from the chart that painting or application of some foreign substance appeared to be the least likely explanation for the *Shroud* image'. By the same token, light and/or heat seem to be the most plausible explanation for the image. If one accepts that water stability and chemical stability may both be covered by the same nomenclature then there exist nine main attributes of the image and five general

theories for the cause of these attributes.

To better visualize the plausibility of each image-formation theory, a tendency curve graph has been prepared (see figure 5). In this graph 0% represents 'no possibility'; 50% represents a 'possibility'; and 100% represents a 'definite possibility'. As can be seen by the graph, only heat and/or light (radiation) can possibly explain the nature of all nine characteristics of the *Shroud's* image. To make sense of both Stevenson's chart (figure 4) and associated graph (figure 5), it would be well to review each image formation theory in turn.

#### 4.2.7.1 Current image-formation theories

##### \* **Painting/Dyeing/Staining**

Even if an artist were able to apply some staining compound that contained a proportion of red ochre (as suggested by McCrone) the fibrils would be stained throughout, as is the case with the water stain caused by the Franciscan priests at Chambéry when they doused the smouldering *Shroud* in 1532. (See 2.3.) However, this problem aside, one must also ask how an 'artist' could possibly view what he/she were painting/staining. As has been pointed out already, the image is so subtle as to be almost indiscernible from close range. This would imply that an artist would have to stand at least three metres from the *Shroud* whilst he/she executed the 'forgery'.

Finally and probably the most incredible feature of all, the image has all the characteristics of a photographic negative, a fact that was only fully appreciated in 1898. How could anyone living in the thirteenth or fourteenth century have managed to paint, dye or stain a photographically perfect negative image of a crucified man, and more importantly why would they have bothered to have gone to such seemingly impossible lengths (assuming they had even understood these principles)? After all, an 'inferior' version (in negative or positive) would have sufficed, a fact borne out by the fact that both the *Shrouds of Besançon* and *Xabergas* (the latter still in existence) have been held in high esteem by their respective supporters for centuries. Indeed, both of these blatantly amateurish attempts at duplicating the *Shroud of Turin's* image (Vignon, 1902) have been revered for centuries as the genuine article.

\* **Prints produced by bodily contact**

There are four main hypotheses for this category of image-formation theory, viz:

The image of the man on the *Shroud* is:

- \* a natural chemical reaction between the *Shroud* and a corpse;
- \* a man-made impression caused by covering a red-ochre stained corpse with the *Shroud*;

- \* a man-made impression caused by covering a chemically- treated corpse, statue or a heated metal statue with the *Shroud*;
- \* a man-made impression caused by covering a heated metal relief sculpture with the *Shroud*.

All of these theories (with the exception of the last one) can be safely excluded for one major reason, namely that if the *Shroud* came into contact with all areas of the hypothetical corpse/body/statue that appear in the actual image, then that image should be grossly distorted. Vignon (as early as 1902) undertook a series of experiments to prove this point. He had a tautly held cloth placed over a face smeared with red chalk and carefully attempted to produce a *Shroud*-like image. His results were grotesque, noses were flattened and spread out, faces were too wide. (See plate 18.)

The last possibility, viz: the image is a man-made impression caused by covering a heated metal relief sculpture with the *Shroud*, (although logically acceptable) is highly speculative. Not only would the style of such a relief sculpture (which would have to have been akin to a modern photographic plate) be totally unknown to 14th century artists, its production (even if possible) would have been far more of a technical *tour de force* than the *Shroud* itself.

- \* **Scorching**

This possibility is excluded for the same reasons as identified for prints produced by bodily contact (see above).

\* **Prints produced by chemical action (Vaporography)**

Vignon's 'vaporographic' theory has to be excluded for three main reasons:

- \* The cloth of the *Shroud* (laid upon the cadaver) would not have suspended itself horizontally in order to produce a two-dimensional surface. The latter would be an absolute prerequisite to obtaining a vapour induced and still visually coherent three-dimensional image. Any distortion of the cloth's surface would have resulted in a distortion of the final image; and
- \* The pressure of the body reposing on the *Shroud* would have produced a dorsal image quite unlike the carefully modulated image that in fact exists on the *Shroud*. In other words the buttocks, calves and ankles are not compressed; and
- \* Vaporographic images are caused by chemical changes that would be evident throughout the fibrils of the *Shroud*. The image on the *Shroud* is in fact visible only on the outer surface of the fibrils.

\* **Supernatural and/or divine image**

Most researchers, after they have exhausted all the possibilities available to them for image formation, mention the possibility that the *Shroud* could be a miracle. Indeed, many people have suggested that the *Shroud of Turin* is in fact a 'fifth gospel'- one which visually affirms the Passion of Christ and which proves that Christ rose from the dead. In short, the *Shroud* was designed specifically by Almighty God to astound scientists in the twentieth century and to help those persons who cannot believe until they have (like St. Thomas) placed their hand in the wound in the side. The cautious words of Michele Cardinal Pellegrino (1970), are perhaps typical of the feelings of the faithful:

[T]here is that marvellous, truly noble and majestic Face which is revealed to us from the Shroud. No one with this in mind can be blamed for not taking the Turin Shroud lightly and not recognizing in it an extraordinary document of the Passion of Christ.

Authors like Stevenson, Habermas, Wilson and Rinaldi have all helped to compound this interpretation. However, this interpretation (which actually would fall outside the scope of this thesis) can be disputed very simply:

- \* If Christ had indeed been laid to rest within the *Shroud* (as is believed), and at the moment of resurrection a short burst of radiation had indeed emanated from his body (the latter causing a form of scorch on the linen) then as in the case of direct contact prints, much distortion would have been evident in the actual image.

- \* Why did this emanation fail to record the top of Christ's head and the two thin strips on either side of Christ's face?

Of course one could argue that a miracle does not have to conform to either the laws of nature or human logic. In this case no comment would be possible, yet those who claim the *Shroud* to be a Divine product, do themselves explain it in terms of a quasi-scientific context. Indeed, as has already been noted above, it is often suggested that Christ must have emitted a burst of radiation at the moment of the Resurrection. Within the confines of this paradigm, it should be fairly obvious to anyone that *if* Christ did indeed utilize some form of radiation to produce the image that now appears on the *Shroud of Turin*, then He would have had to have done it along the following lines, *viz*:

Before any image could have been made on the *Shroud*, it would have had to have been positioned absolutely flat against a two-dimensional surface (*eg* a wall) or suspending in space in such a manner that its surface maintained a strict two-dimensional format. Christ would then have had to have literally 'hovered' directly in front of the *Shroud* for a three-dimensional scorch-like negative image of His person to have been recorded. In this scenario, all parts of His body which were closest to the *Shroud* would have burnt the linen

IMAGE CHARACTERISTICS	IMAGE FORMATION THEORIES				
	PAINT, DYE OR PIGMENT	DIRECT CONTACT	VAPOUR	DIRECT CONTACT AND VAPOUR	HEAT OR LIGHT
SUPERFICIALITY:	NO	NO	NO	NO	YES
DETAILED:	NO	NO	NO	POSSIBLE	POSSIBLE
THERMALLY STABLE:	NO	POSSIBLE	NO	POSSIBLE	YES
NO PIGMENT:	NO	POSSIBLE	YES	YES	YES
THREE-DIMENSIONAL:	NO	NO	NO	NO	YES
NEGATIVE:	YES	POSSIBLE	POSSIBLE	POSSIBLE	YES
DIRECTIONLESS:	NO	POSSIBLE	YES	YES	YES
CHEMICALLY STABLE:	POSSIBLE	POSSIBLE	NO	NO	YES
WATER STABLE:	POSSIBLE	POSSIBLE	NO	NO	YES

FIGURE 4

Table showing the probity of the various image formation theories as compared to the specific characteristics of the *Shroud's* image.

(after Stevenson, 1981.)

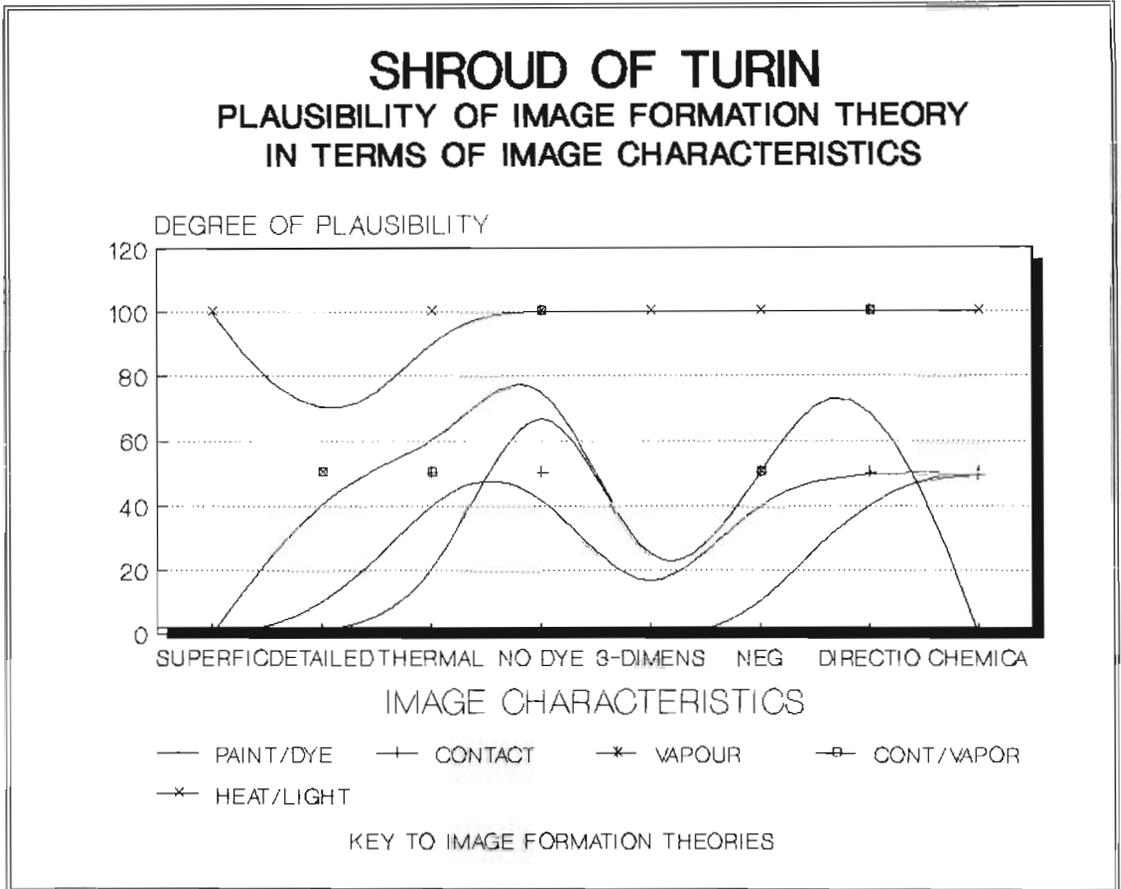


FIGURE 5

Graph showing the degree of plausability of the various image formation theories.

material more than those parts which were further away. In other words, features such as His nose, cheeks and forehead would have made more of an 'impression' on the material than features such as His neck and stomach. This operation would have had to have been repeated for the dorsal view. In short, a second 'burst' of radiation would have been required for this second image in its turn. It would not have been possible (without a mirror) for Christ to have scorched both sides simultaneously.

Most would surely agree that this necessary amendment to the 'radiation burst theory' simply highlights a more fundamental problem *viz*: the notion that the *Shroud* is a Divine product. Faith needs no such physical support. It is even possible to argue that Christ himself supports this contention when he compassionately explains to St Thomas 'Blessed *are* they that have not seen, and *yet* have believed' (John 20:29).

#### 4.2.8                    **A logical solution to the problem of image formation**

All researchers have at some time or another remarked on the surprising photographic nature of the *Shroud's* image. Indeed it is accepted that in every way the *Shroud* acts as a negative photographic plate. However, no-one to date has suggested that the *Shroud* could have been produced photographically. This possibility has not been given any 'attention', owing to the oft-quoted fact that photography was invented only in *c* 1827.

Yet, if one analyses the findings of the 1973 and 1978 commission one is left with the

logical conclusion that only some form of radiated energy (heat or light) could have formed the image. Logically speaking, the only way such an image could be produced by radiated energy is by employing some form of photography.

It is necessary, therefore, to investigate the plausibility (however remote this may appear at first) of somebody actually having the knowledge, the materials and the technology to have produced the image on the *Shroud*.

It should not be forgotten that the *Shroud* (regardless of how it was in fact produced):

- \* actually exists and therefore bears testament to some form of technology (albeit forgotten);
- \* has the attributes of a modern photographic negative; and
- \* was definitely manufactured sometime between the time of the death of the historical Christ and 1357 *AD*. It should be pointed out that the time of Christ's death is not speculative even though the exact date for this historical event is unknown. What is important here is that in view of the iconography employed in the image on the *Shroud* it is not possible for the *Shroud* to have been produced before Christ's death.

## CHAPTER FIVE

### THE PHOTOGRAPHIC HYPOTHESIS

#### 5.1 GENERAL BACKGROUND: PHOTOGRAPHY AS AN IMAGE-FORMING TECHNIQUE

In order to clarify certain terminology and concepts that are employed in this investigation, a brief overview is given of the more relevant details of modern photographic theory. It should be noted that much of this knowledge (although quite elementary to a photographer) is an absolute pre-requisite to understanding the import of this thesis fully.

##### 5.1.1 Light

Briefly stated, light is a term employed to cover one of the many kinds of electro-magnetic radiation which are found in nature. These radiations are found in the form of radio, radar, radiant heat, infra-red (so-called invisible light), visible light, ultra-violet, X-ray, and gamma rays. All forms of electro-magnetic radiation can travel in a vacuum and are thus independent of any medium or conductor. In addition, all forms of electro-magnetic radiation (including visible light) have a velocity of  $3 \times 10^8$  metres (186 000 miles per second).

There exist two basic theories concerning the nature of light, viz: the wave theory and the

corpuscular theory. However, in practical terms, it may be assumed that each separate ray of light travels in a perfectly straight line.

In modern photography, it is normally light as a visible radiation that is of interest, and in general terms it is true to say that only radiation that stimulates the retina of the eye to produce visual sensation may be referred to as light. This visible spectrum occupies a very small section of the total range of electro-magnetic radiation.

### 5.1.2 Pinhole images

If one takes a light-proof chamber (*eg* a box) and pierces one of its sides with a very small, sharp-edged hole (aperture), and if an object is positioned in front of this aperture, its image will appear inside the chamber. This image is inverted and forms on the inside surface of the chamber directly opposite the aperture (see figure 6). This area (which contains the image) is normally referred to as the image patch. This image can vary in scale and perspective according to the distance between the aperture and the inside surface of the chamber. In photography this distance is referred to as the image conjugate distance. If the image conjugate distance is small, a wide-angle lens effect results; if it is large, a long-focus effect will be obtained. Thus, in a pinhole camera, the angle of view of the image patch is effected by the image conjugate distance.

### 5.1.2.1 The pinhole as an aperture

The size of the pinhole (aperture) is fairly important, and in theory at least, the image becomes sharper as the diameter of the aperture diminishes. However, this action also reduces the amount of light entering the chamber and a point is reached where the image (although sharper) becomes too faint to distinguish clearly. Moreover, a point is soon reached where the hole is so small that the image actually becomes less sharp due to diffraction. Diffraction, here refers to the bending of light rays that are 'snagged' by the edges of the aperture. Alternatively, other problems occur if the aperture is too large for a specific image conjugate distance. For example, the image becomes brighter but also increasingly blurred as the dimensions of the aperture are increased. Modern cameras overcome these problems by the introduction of a lens which allows more light into the chamber as well as producing a sharper image. (See figure 7.)

Very successful photographs may be produced by using a simple pinhole camera. See plates 31 and 32 for a comparison of an image produced by a pinhole camera with an image produced with a camera and lens. In this connection the following extract from the Focal Encyclopedia of Photography (Mannheim, 1982:1125) is relevant:

Pinhole photographs have an all-over softness of definition which is substantially the same for all objects in front of the camera. There is no distortion, and the depth of field extends from the front of the camera to the horizon. Finally the photographer has absolute freedom to vary the perspective of his subject and the scale of reproduction by altering the relative distances of the plate and the subject from the pinhole. The disadvantages of the pinhole photograph are mainly the lack of crisp definition, the length of the exposure,

and the alteration of the 'f-value' with every change of plate distance.

In other words, as the image conjugate distance increases there is a corresponding fall-off of the light reaching the image patch. To rectify this one may either increase the length of exposure time or enlarge the dimensions of the pinhole. One of the advantages of a pinhole camera is that, although it is a very primitive device, its efficacy is automatic in the sense that no focusing is needed because a pinhole (plate 31) gives an infinite depth of field. (Horder, 1971:51.)

### 5.1.3      *The camera obscura*

A pinhole camera is in every way a scaled-down version of a *camera obscura* and the *camera obscura* is (as its name implies) nothing more than a darkened room or chamber. If a small hole (aperture) is made in one of the walls of the chamber (ideally a wall facing away from the sun), then an image will appear inside the chamber. This image (inverted) will be of whatever happens to exist outside the room and is in front of the aperture. (See plates 33 and 34.) As in the case of pinhole cameras, the size of the aperture (which should be as round and as sharp-edged as possible) affects the focus and clarity of the image. A pinhole for example, as we have already seen, produces a very small and relatively sharp image at an image conjugate distance of a few centimetres from the aperture. Alternatively, a larger aperture (measuring anything from one to two centimetres in diameter) can produce a large (life-sized and bigger) image which has an image conjugate distance of

several metres. In the latter example, however, the image is extremely blurred if the aperture is too large, yet the image brightness is excellent. On a clear, hot day, for example, the colours and shapes of objects, such as the sky, trees, flowers and people passing by, can be clearly discerned.

When the hole is reduced to suit a specific image conjugate distance and a sharp image is established, the brightness of the image is correspondingly diminished. (See figures 8 and 9.) It should be pointed out that even modern light sensitive photographic paper takes many minutes (sometimes even hours) to record these low light levels. It is, however, possible to obtain a life-size image which is both bright and sharp with the addition of either a bi-convex lens (magnifying glass), a plano-convex lens or even a pair of plano-convex lenses (see figure 7 and plate 37).

#### 5.1.4 **Light sensitive chemicals**

Certain chemicals are naturally light-sensitive. This means that when exposed to light they alter their chemical composition. Depending on the specific chemical involved this alteration may be visible or invisible (literally hidden or latent).

In photography, the particular wavelengths of light that have an effect on a specific light-sensitive chemical (in the form of an emulsion or a solution) are normally referred to as actinic light. In most cases, actinic light, as a term, would include the visible spectrum.

For example, in the case of the light-sensitive silver halides, viz: silver bromide, silver chloride and silver iodide, a latent image can be produced after relatively short exposures to actinic light in the form of sunlight.

These latent images can be reduced to a visible silver image by employing a suitable chemical developer. In modern photography the increase of sensitivity achieved by the use of developers is immense. Indeed, an increase in sensitivity of one thousand million times may be achieved by the use of developers. However, if these silver halides are exposed to sunlight for extended periods of time, a visible discoloration will occur without the aid of a developer. The chemistry involved in these processes (especially at an atomic level) is not fully understood even by modern photographic theorists and physicists, but in essence the concept behind the formation of latent and visible images may be explained by reference to the well-known Gurney-Mott theory.

#### 5.1.4.1 Gurney-Mott latent image concept

Langford explains that much of the knowledge about the formation of latent images is based on indirect evidence. Briefly this knowledge is as follows:

- (1) The latent image consists of quantities of metallic silver. Although following normal exposure these are far too small to detect by any known method other than development, prolonged exposure to actinic light yields chemically detectable quantities of silver. Also if an emulsion bearing a latent image is treated with chemicals (e.g. Acid Permanganate) capable of destroying metallic silver without affecting silver halides, the latent image is found to be

destroyed.

(2) The silver formed by light (photolytic silver) is concentrated on certain specks on the grain surface called 'sensitivity specks'. This can be observed under an electron microscope...

(4) Physicists have determined that a bromine atom consists of 34 electrons - of negative charge - orbiting a central nucleus of equal positive charge. Of these only the 7 electrons orbiting as the outermost band or 'shell' (...) need concern us. A silver atom has 47 negatively charged electrons and a nucleus of corresponding positive charge. (Only the one electron in its outershell is important photographically.) When bromine (as representative of any one of the three light sensitive halides. N.P.L.A.) and silver atoms are combined, as in silver bromide emulsion making, the bromine atom acquires the single outer electron from the silver atom. Both atoms become electrically charged or ions - the silver ion with its lost electron having a positive charge and what is now a bromide ion having a dominantly negative charge. These ions are mutually attractive and distribute themselves out evenly in the form of a 'crystal lattice' within the silver bromide grain.

(5) When light is applied to a crystal of silver bromide an increase in the crystal's electrical conductivity occurs...the current is carried by movement of electrons (apparently from the bromide ions) within the crystal lattice. (1975:161-3.)

Thus, it is possible to explain the chemistry behind the formation of latent images by means of the theory propounded by NF Mott and RW Gurney in 1938 (Attridge and Walls, 1977:93-8). It should be pointed out, however that there exist other equally convincing explanations of the actual process involved in the formation of latent images, but fortunately these minor variations need not concern us too greatly. After all, it is the physical and tangible results of employing the silver halides that has more direct bearing on this investigation.

The *Gurney-Mott* theory is pertinent to all the silver halides and for the purposes of explaining the principles of this theory it does not really matter which of the silver halides is to be discussed. In other words this theory is applicable to not only silver bromide, but also to silver iodide and silver chloride. For example, in a typical silver bromide grain there exist large numbers of small positive silver ions and larger negatively-charged bromide ions. These ions are evenly distributed as a three-dimensional crystal lattice. (See figure 10.) As light energy is absorbed by the grain, negative electrons are released from some of the bromide ions and transfer themselves through the crystal lattice. The bromide ions thus become bromine atoms due to the loss of one electron. The liberated electrons are unable to combine with the positive silver ions (at this stage) because there is insufficient space within the crystal lattice for the formation of such a large atom.

If the structure of the crystal were perfect the free-roaming electrons would probably recombine with the bromine atoms to recreate the original bromide ions. However, in reality, the crystal lattice is never flawless and may either contain (foreign) atomic impurities (termed 'electron traps') and/or the crystal may have small defects on its surface (known as 'sensitivity specks').

In fact modern research has shown that certain 'impurities' actually increase the sensitivity of the silver halide. For example trace elements of sulphur ions, silver atoms, and even gold ions all help to manufacture electron traps or structural defects in the silver halide crystal. (Kowaliski, 1972:359-61.) The free electrons begin to accumulate at the traps

and/or sensitivity specks and collectively build up a strong negative charge. This electric field then attracts a number of the small positive silver ions, which in turn combine with the free electrons creating neutral metallic silver atoms. If the action of light is allowed to continue unabated, subsequent numbers of liberated electrons are in turn trapped by these newly created silver atoms and the whole process is repeated. (Langford, 1974:163-5.)

#### 5.1.5 The negative image

All images formed on surfaces prepared with light-sensitive chemicals are the 'negative' of the object being photographed. (*ie* an image on a piece of sensitized paper will appear light in those areas that correspond to the dark tones of the original subject and opaque in those areas that correspond to the lighter tones of the original.) Therefore, in order to produce a positive image, (one which corresponds with the appearance of the original subject), it is necessary to rephotograph the negative image.

#### 5.1.6 Fixing of photographic images

As already briefly mentioned, the latent image present in the light-sensitive emulsion is normally made visible by the actions of a suitable chemical developer. In modern photography, this developer continues to act upon the light sensitive emulsion until it (the developer) is either physically removed and/or neutralized. Thus, the photographer allows

the developer to act upon the emulsion only for a limited time (depending on the photographer's needs). Once satisfied with the quality of the developed image the photographer places the negative print in a bath of water or very weak acetic acid to remove and neutralize all surplus developer in the emulsion.

However, before this image may be brought out of the darkroom into the light of day the photographer needs to remove those elements of the light sensitive emulsion that have not been exposed to sunlight. For example, with silver halide emulsions, some of the silver halide is still unexposed and unreduced. If the negative image were to be placed in the light at this time these unreduced areas would immediately be affected and the image would be lost. Therefore, to make the negative print chemically stable in the presence of sunlight, the image has to be 'fixed'. In the case of silver halide emulsions, the silver halide is normally dissolved in the solution of a substance that can form soluble silver salts. Mannheim, (1982:624) states:

A wide range of substances is available ranging from cyanides, and thiocynates, which act quickly, to sulphite and a strong solution of potassium bromide, which are slowest in action. For general purposes sodium thiosulphate (hypo) is the most effective agent.

Once fixed, the image may be safely exhibited outside the darkroom.

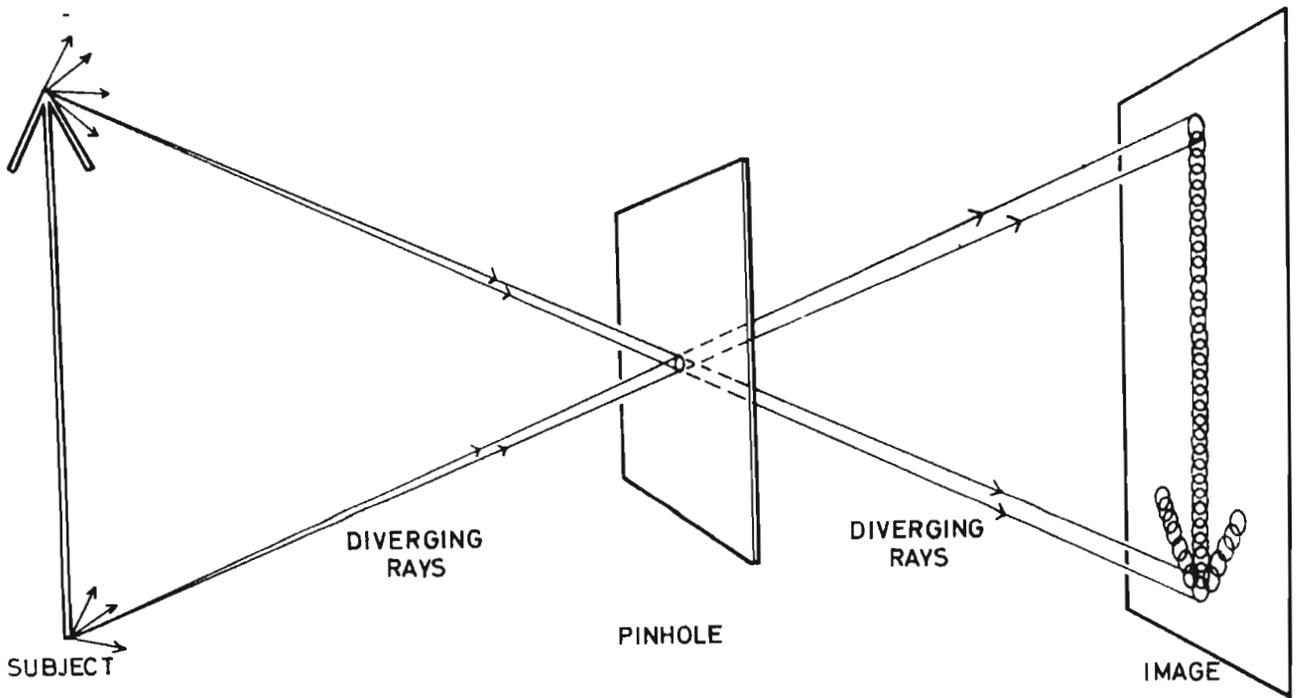


FIGURE 6

A diagram showing image formation on the surface opposite the aperture. Note that the image is a composite of the pinhole diameter, which causes a 'soft-focus' appearance.

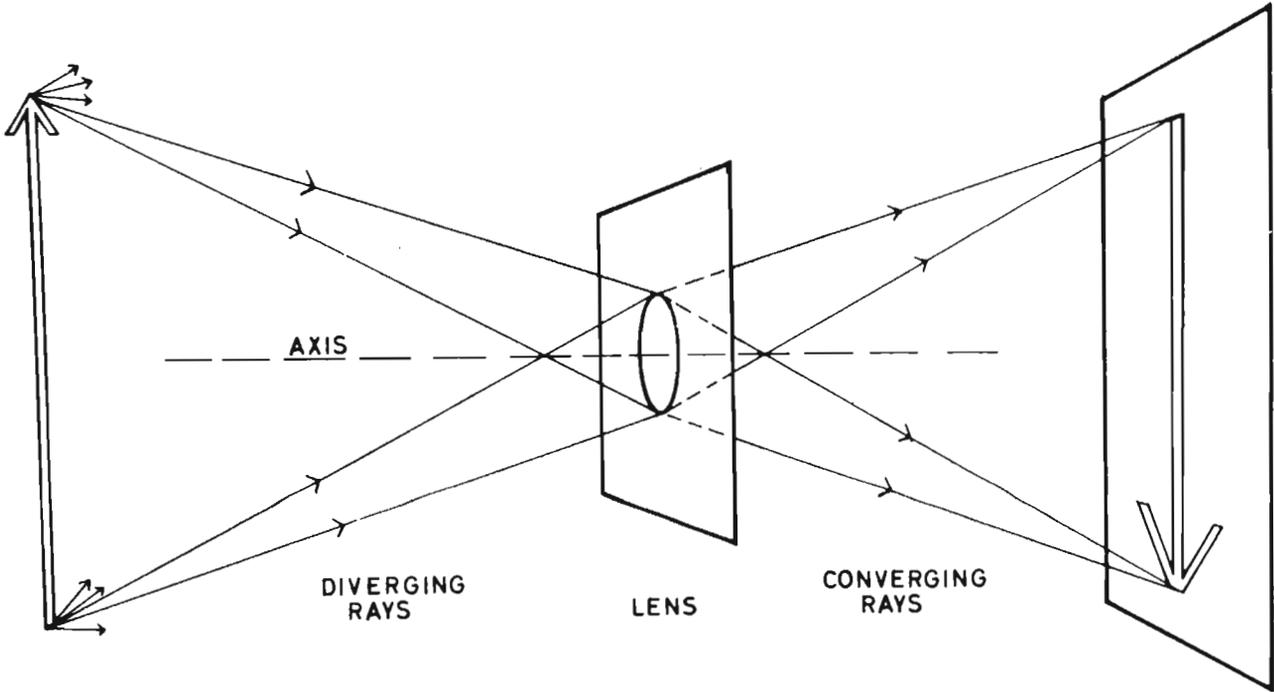


FIGURE 7

A diagram showing the effect of a simple bi-convex lens.

The larger aperture allows more light into the chamber

and the lens produces a 'sharp-focussed' image.

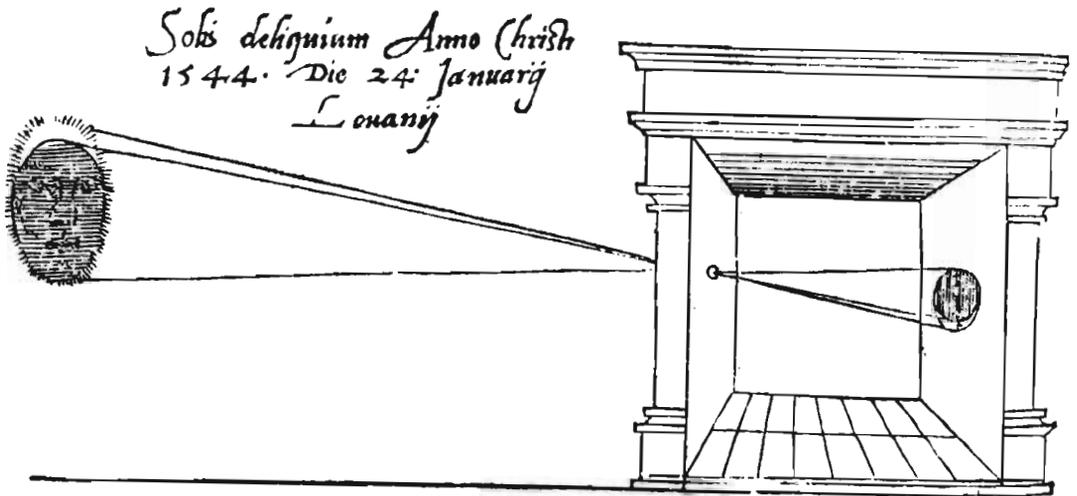


PLATE 31 Photograph produced with a pinhole camera. Note that regardless of their distance from the aperture, all objects are equally 'soft-focussed'.



PLATE 32 Photograph produced with a lens. Note that only near objects are in focus while more distant objects are blurred.

illum in tabula per radios Solis, quàm in cœlo contingit: hoc est, si in cœlo superior pars deliquiū patiatur, in radiis apparebit inferior deficere, vt ratio exigit optica.



Sic nos exactè Anno .1544. Louanii eclipsim Solis obseruauimus, inuenimusq; deficere paulò plus q̄ dex-

PLATE 33

The first recorded illustration of a  
*camera obscura*, built by  
R. Gemma Frisius, c 1545 AD.

(Gernsheim, 1981:9.)

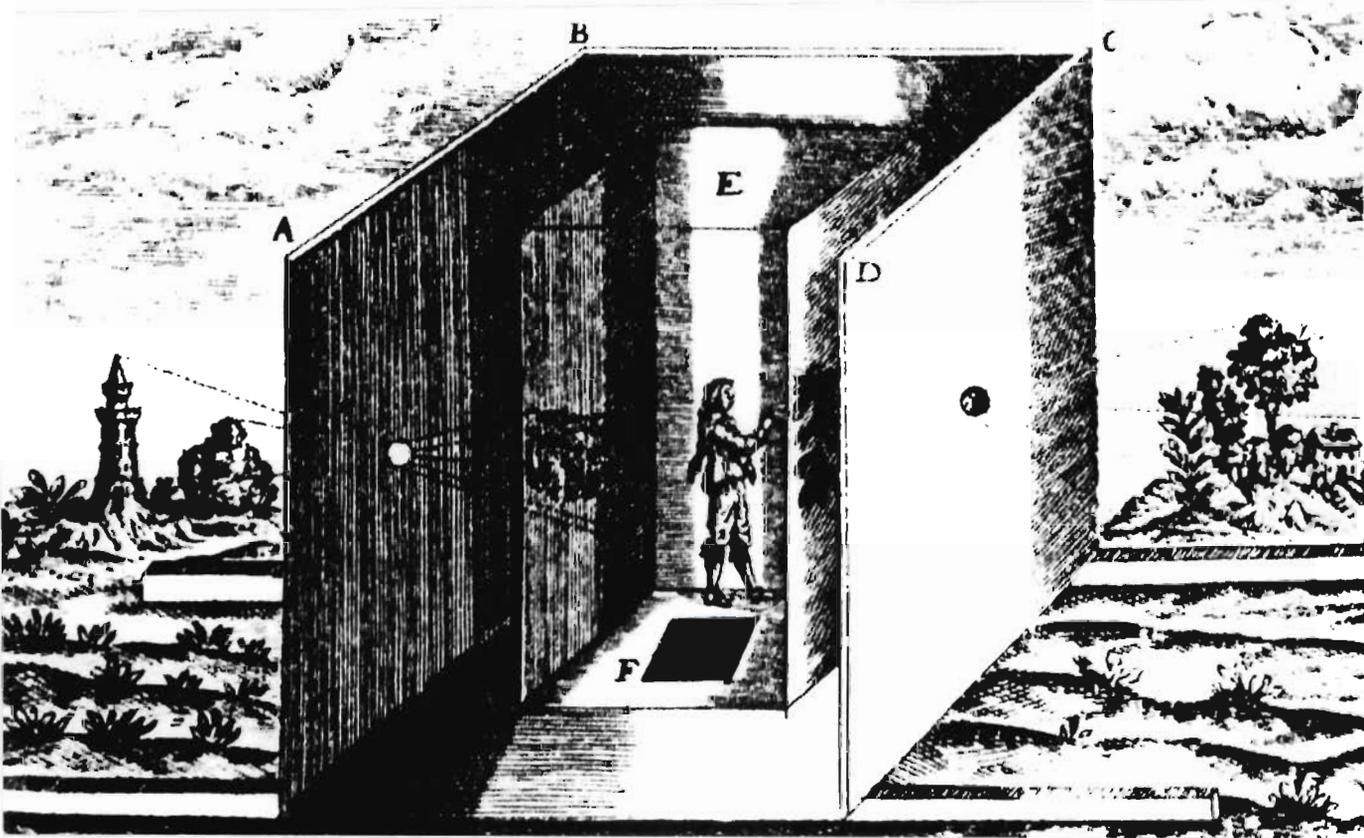


PLATE 34

A portable *camera obscura*  
built by A. Kirchner, c 1646 AD.  
(Gernsheim, 1981:9.)

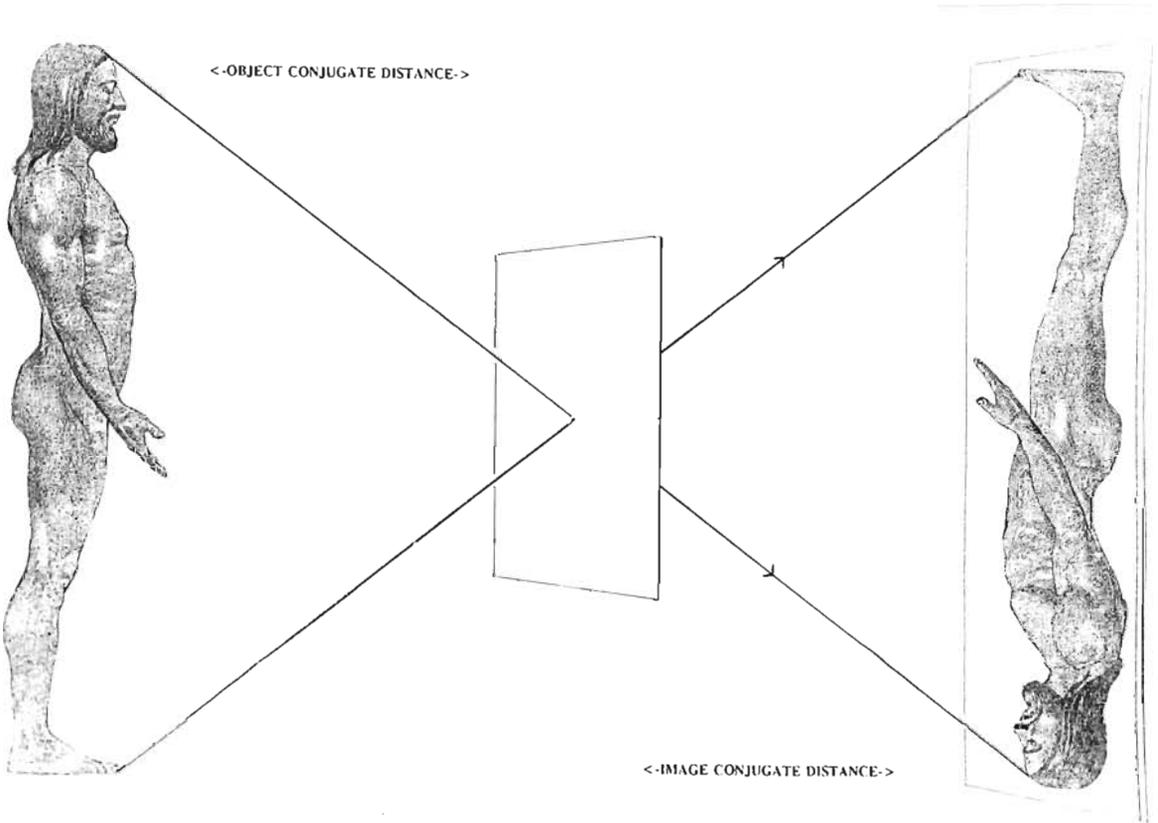


FIGURE 8

Diagram showing the effect of using an aperture with a small diameter. Note that the image is acceptably focussed but the light levels within the camera are correspondingly compromised.

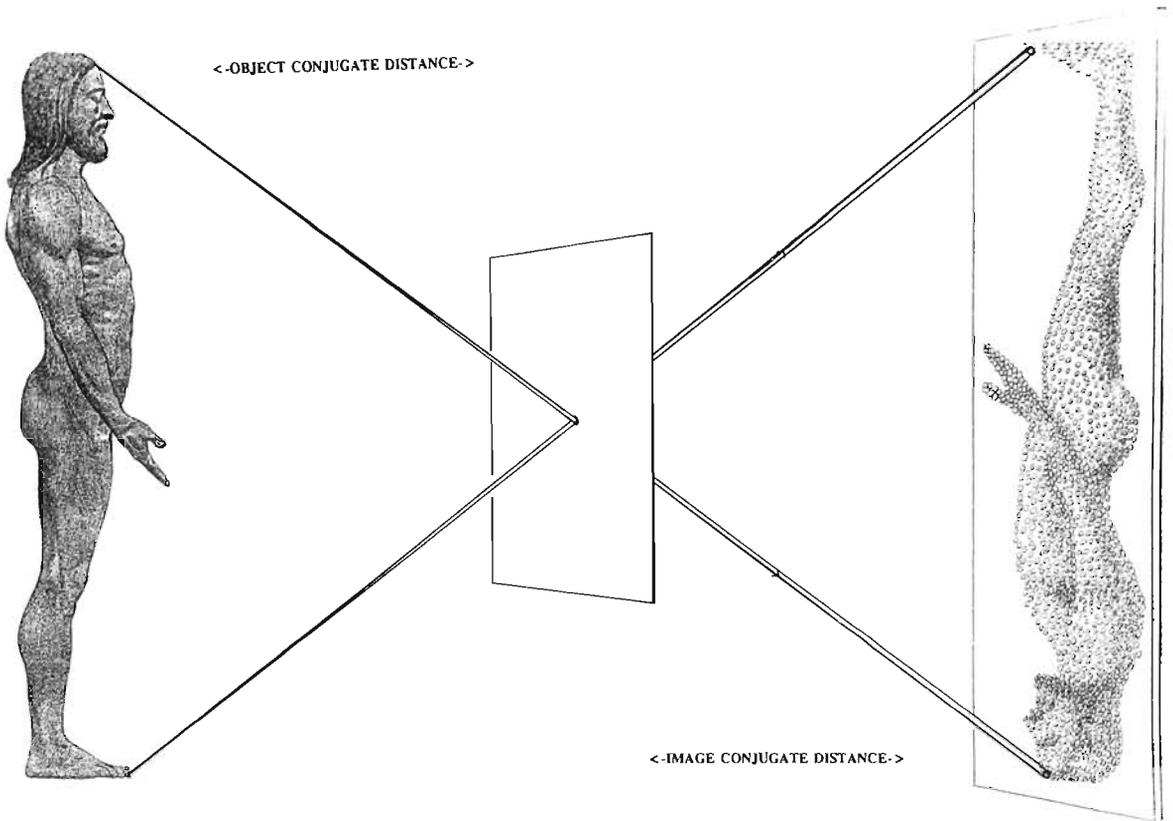


FIGURE 9

Diagram showing the effect of using an aperture with a large diameter (over 5mm). Note that although the image is much brighter, the image is more obviously a composite of the aperture diameter and thus appears to be out-of-focus.

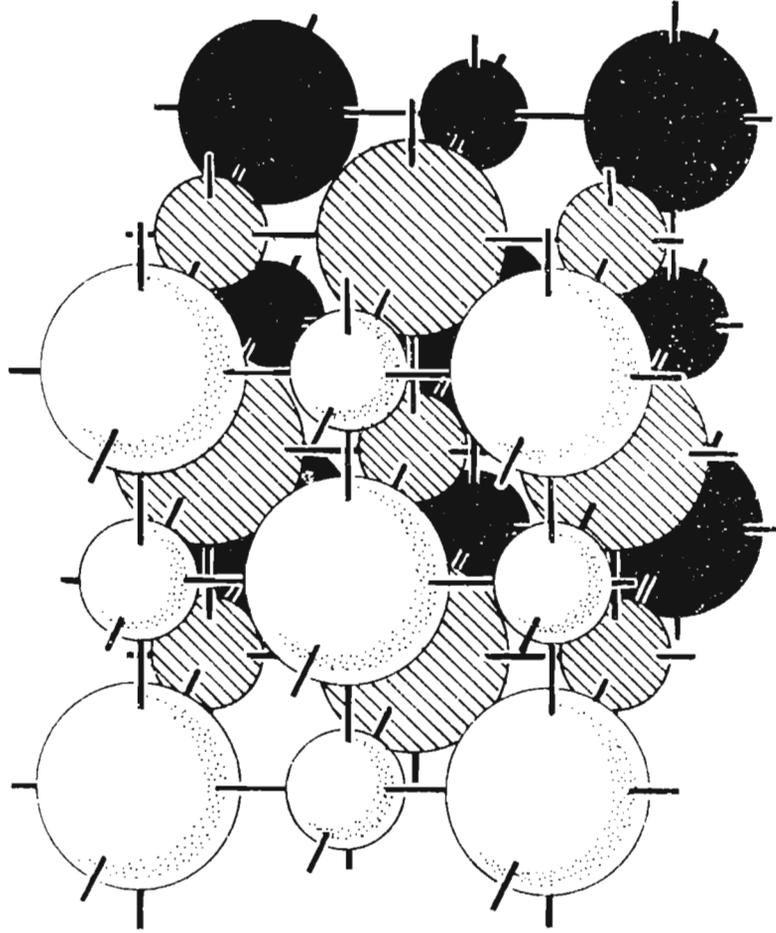


FIGURE 10

Schematic depiction of the three-dimensional crystal lattice formed of small silver ions and larger halide ions. *eg* silver chloride and silver bromide (Walls, 1977:95.)

## 5.2 THE POSSIBILITY OF THE SHROUD OF TURIN BEING A PHOTOGRAPH

At the outset it is important to realize that if the image on the *Shroud* was indeed produced 'photographically', its mode of production would have differed (in certain respects) from the way modern photographic images are normally produced.

This was true even of the first products by (what are presently considered to be) the pioneers of photography. For example, Thomas Wedgwood (1771-1805) and Sir Humphry Davy (1778-1829) (who are well known for their publication entitled: *Account of a method of copying paintings upon glass and of making profiles by the agency of light upon nitrate of silver* [1802]), first produced images, in the form of silhouettes and negative images of botanical specimens (*ie* contact copies of leaves) on both white paper and leather moistened with a silver nitrate solution. However they could not fix their images, which had to be kept in a dark room and could only be viewed by candle light.

William Henry Fox Talbot (1800 -1877) like the other early pioneers of photography, first employed silver nitrate as a suitable light-sensitive chemical for his investigations. At first his products were simple negative images, but he went on to perfect a negative-positive process and is consequently accredited with being the discoverer of photography.

Similarly, the *Shroud* displays a number of features that would necessarily classify it as a very primitive form of photography.

### 5.2.1 The negative image on the *Shroud of Turin*

If the image on the *Shroud* is photographic then originally the linen cloth must have been prepared with an (as yet) unspecified light-sensitive emulsion/solution. This in turn was placed in a *camera obscura* on a two-dimensional surface opposite the aperture. The subject (a crucified man) was suspended vertically (by one of a number of possible means), outside the *camera obscura* opposite the aperture. The distance between the aperture and the man (object conjugate distance) would most probably have been identical to the distance between the aperture and the light-sensitive emulsion (image conjugate distance). (See figure 8 and 9 and plate 35.) This latter point concurs with the criteria for image quality as specified by Mannheim (1982:1125), thus:

The definition produced by the pinhole camera is determined by the size of the image patch corresponding to a point object. The diameter of the image patch formed by rays of light from a point source is given by

$$D = \frac{d(u+v)}{u}$$

where  $D$  = diameter of the image patch,  $d$  = diameter of the pinhole where  $u$  = distance of the object from the pinhole,  $v$  = distance of the image from the pinhole.

Thus it can be seen that for an image to be the same size as the subject, both subject and image patch must be equidistant from the aperture. In addition, the  $f$  value (see 5.1.2) is found by measuring the actual distance from the aperture to the prepared light sensitive surface (image conjugate distance) and dividing this by the diameter of the aperture.

(Jordan, 1976:55.)

Of course the hypothetical medieval 'photographers' would have needed as much light as possible to make an impression on the *Shroud*. Thus for a life-sized image to be produced they would have wanted the smallest object conjugate distance and image conjugate distance possible. This would have been about 1830 cm (or six feet).

On exposure, the emulsion would have formed (after a few minutes) a latent image (which the medieval 'photographers' are hardly likely to have known about and indeed did not need to know about). After many hours, (possibly days) a visible discolouration (image) would have been recorded. It is hardly likely that a living subject could have endured this process. It is quite certain that the subject was the corpse of man who had suffered death by crucifixion. The image obtained would have been negative (as the image of the *Shroud* is). This image would have formed only on the emulsion coated fibrils closest to the aperture. In other words, only the top fibrils of the linen cloth would have been affected and the image would not be visible on the underside of the cloth. This feature is present in the *Shroud*. It would not have been necessary for this negative image to be rephotographed in order to produce a positive image (as is done in modern photography). It is quite possible that the hypothetical persons responsible for producing the image did not have the expertise and/or the technology to take this process further than they had in fact done. However, whether or not they had known of the possibility of positive images, the *Shroud's* creators may have been more than satisfied with

the faint negative impression they had already achieved, because it gave the appearance of sweat that had been deposited on the *Shroud* as if a human body had actually touched the linen cloth. A positive image would not have helped this desired interpretation.

### 5.2.2 The exposure

As has already been alluded to, it is also possible that the exposure was made over a very long period (upward of eight hours). This exposure was maintained until a visible discolouration appeared on the *Shroud* (see 5.1.3).

This latter possibility is far more plausible than its alternative, *viz*:

- \* A latent (invisible) image was developed (enhanced) by employing a suitable chemical substance.

This would, of course, rule out the need for the hypothetical medieval ‘photographers’ to have known about developers. In addition they are hardly likely to have known about latent images, or indeed to have ‘discovered’ them by accidentally employing the correct chemical compound.

These assumptions are supported by the nature of the image on the *Shroud* itself, *viz*:

- \* The image is extremely faint and subtle, needing modern photographic enhancement to bring out many of its details;
  
- \* The image is slightly blurred or soft-focussed. This latter feature is typical of pinhole images in general and may also suggest a slight movement of the subject (wind) over a prolonged period of time. In this connection it is interesting to note that when observing a large image inside a *camera obscura* one is struck by the fact that the image is visually coherent only at a distance of two to three metres from the image patch. As one approaches the image it becomes increasingly unrecognizable. This characteristic of a *camera obscura*'s image corresponds closely with the characteristics of the *Shroud*'s image;
  
- \* The image is not a like a modern day 'snap-shot' because there is no obvious single light source in the image, only a general impression of being top-lit. Certain features that are closest to the spectator, such as the bridge of the nose, eyebrows, cheeks, beard, fingers, knees *etc.* are more exposed than those areas which are further away, such as ankles, neck, *etc.*;

If a human subject was to be suspended in strong sunlight for an extended period of time, no shadows would be evident on the photographic record of the event (see plates 6,7 and 8).

For example, in the morning the left side of the suspended body would be illuminated directly from the sun above. As noon approached the top of the head, the nose, the cheeks, the beard *etc.* would be directly illuminated. During the afternoon it would be the turn of the right side of the body to receive direct sunlight. (See plate 36.) Thus, certain features such as the tip of the nose, the bridge of the nose, the cheeks *etc.* would always be in direct sunlight. Other areas such as the sides of the nose would receive substantially less sunlight during the course of the same day. The resulting (combined) photographic record of such an exposure would be remarkably similar to the *Shroud's* image in that it would be ideal for three-dimensional enhancement (see 3.4.1). Thus, if the photographic hypothesis is valid, then in effect the *Shroud* image is not one exposure (a snap-shot) of a particular time of day but may be understood as being a series of photographs overlapping each other. Each 'separate' exposure would (in a sense) be a record of a particular moment in time, but taken together they would represent the passing of many hours or even days.

### 5.2.3 The double image

The *Shroud* shows two negative images: one dorsal and one frontal. Assuming that these images originated from one human subject, then they had to be made at separate times, but under similar lighting conditions.

If for example, each exposure took only one day, and the frontal image was made on the

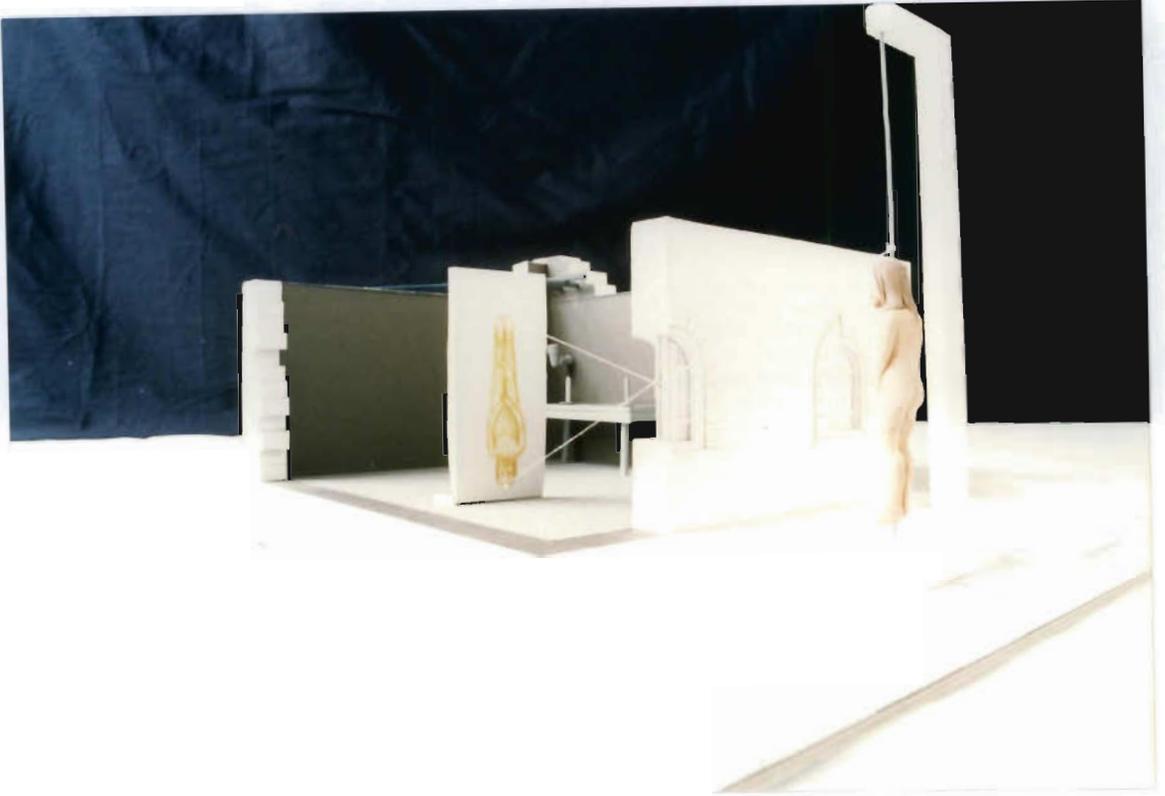


PLATE 35

Suggested reconstruction of how a medieval  
'photographer' could have produced the image on  
the *Shroud of Turin*, c 1200 - c 1357.

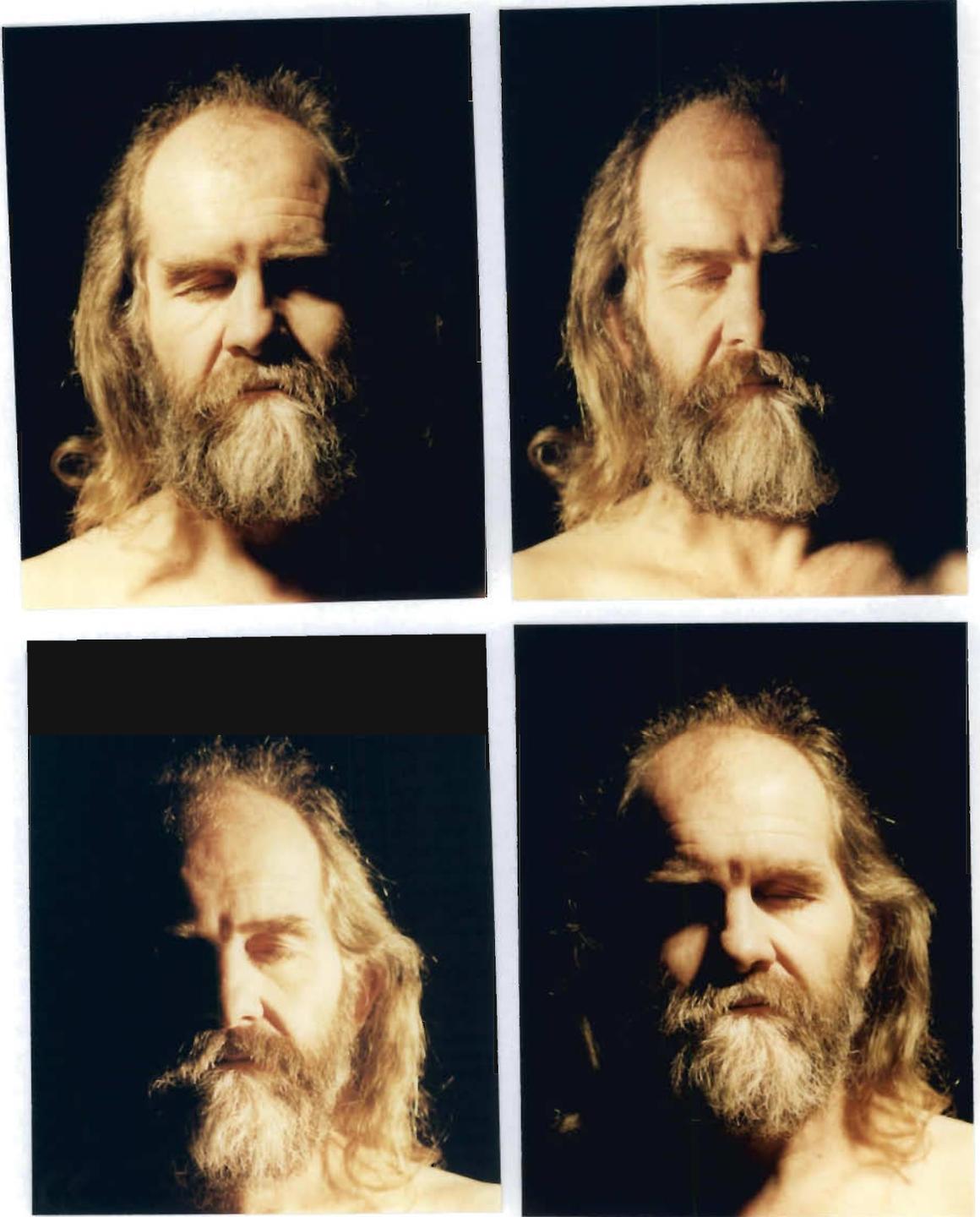


PLATE 36 Sequence of photographs simulating the illumination of the human face over an eight hour period. Note that the bridge of the nose and cheeks receive more light than such areas as the side of the nose and under the chin.

first day, then it would have been necessary to roll up and protect that area of the *Shroud* destined for the exposure of the dorsal image on the following day. Once the frontal image had been obtained, it would have been necessary to protect it from further exposure to sunlight. Therefore, it too would have to be rolled up and protected. On the second day the unexposed portion of the *Shroud* would have been unrolled and set up in preparation for its exposure. The body would then have been turned so that the dorsal view was illuminated by the sun and the whole process repeated as for the first exposure.

#### 5.2.4 Fixing the image

Before the *Shroud* could be brought out of the *camera obscura* its images had to be 'fixed'. This process would have depended on the nature of the (as yet) unspecified light-sensitive emulsion employed. In this regard the following possibilities exist, viz:

- \* The chemicals that produced the faint image may have been neutralized by an (as yet) unspecified chemical treatment; or
  
- \* The discolouration caused by the action of light on the emulsion may have also affected the fibrils of the linen themselves (see 3.4.3). This latter possibility means that after exposure, the *Shroud* may have been leached of all chemicals present in order to prevent further discolouration by the action of sunlight. Thus, the linen fibrils themselves, would have contained the photographic information as a chemical

discolouration or burn.

### 5.2.5 **The stigmata**

Once the image of Christ had been successfully achieved all wounds would have been enhanced by the addition of blood. In this regard human blood would have been used to create the marks of the Passion. Blood would be carefully applied by brush to the wounds in the feet, wrist and side. Blood would be trickled freely along the forearms, the feet and across the small of the back. Blood would also be used for the scourge wounds and the thorn wounds. After this blood had dried the *Shroud* would be given a cursory soak in water and then dried. The blood would remain trapped in the fibrils of the linen cloth and dried. Over time, this excess dried blood would be slowly eroded away. (See 3.4.3.)

### 5.2.6 **The photographic hypothesis**

It is certain that the photographic hypothesis seems almost tailor-made to resolving the *Shroud* mystery in the sense that it neatly explains each and every one of the image's characteristics. Indeed, the only real hurdle in the way to accepting such an obvious conclusion is that photography was apparently only developed in the early 1820s - a full five hundred years after the *Shroud* first came to light. The obvious fact that the *Shroud's* image is photographic is not in itself considered proof enough (by other researchers) that our perceptions concerning the history and development of photography are seriously

flawed. Sindonologists simply ignore this option and doggedly continue to search for a solution which does not compromise their comfortable paradigm. Surely, after one hundred years of wasted time, money and effort it is time to do a little lateral thinking.

It will have to be accepted that *if* the photographic hypothesis has any merit it will surely require us to rethink our present interpretations concerning the abilities and technological capabilities of the thirteenth and fourteenth centuries. Thus, the problem in effect shifts from the *Shroud* itself to the issue of verifying the following possibilities, viz:

- 5.2.6.1            Is there any historical evidence of persons knowing about the *camera obscura* before *c* 1357; and also understanding the nature and cause of pinhole images?
  
- 5.2.6.2            Is there any historical evidence of persons knowing about light-sensitive chemicals before *c* 1357; and also having the technology to arrest the sensitivity of these hypothetical chemicals to light (*ie* is it plausible that they could have ‘fixed’ their image)?
  
- 5.2.6.3            Is there any historical evidence of a medieval society or persons having a working knowledge of crucifixion before *c* 1357 AD?

Only if each of these three questions/factors are verified is there a possibility of the *Shroud*

being a form of photograph. In addition, the verification of the following factor (subject to the verification of the above mentioned three factors) would also be supportive of the main hypothesis:

5.2.6.4 Is there any historical evidence of persons having practically experimented with either magnifying glasses, plano-convex lenses or concave mirrors before *c* 1357; and also understanding the relationship of these lenses to an aperture and its effect on the image patch?

Finally, through practical experimentation it would be necessary to do the following, *viz*:

5.2.6.5 To produce a negative image on linen cloth which duplicates the characteristics of the image on the *Shroud of Turin*. This image would have to be produced employing only those substances and equipment that were known to have existed in a medieval society before *c* 1357; and whose natural characteristics were known to have been reasonably well understood before *c* 1357.

## CHAPTER SIX

### THE HISTORICAL EVIDENCE FOR MIEVEAL PHOTOGRAPHIC TECHNOLOGY

#### 6.1 THE CAMERA OBSCURA

##### 6.1.1 The *Camera Obscura* in recorded history

The earliest known, published illustration of a *camera obscura* was produced by R. Gemma Frisius in the *De radio astronomico et geometrico liber* in 1545 (cf plate 33). This device is recorded as having been built specifically for observing the solar eclipse of 24 January, 1544. (The Oxford Companion to Art, 1970:193-4.)

In 1550 a description was given by Girolamo Cardano of Milan, of a *camera obscura* and a bi-convex lens (made of crown glass) fitted in its aperture. In 1568 Daniel Barbaro not only recommended a lens but also that the aperture be made in a diaphragm, thus enabling him to cut a very sharp-edged hole for producing sharper images. (Mannheim, 1982:135; 151.)

Although Leonardo da Vinci (1452-1519) described the functioning of the *camera obscura*

quite fully and was also the first person to compare the *camera obscura* to the workings of the human eye, it is Giovanni Battista Della Porta who is more generally considered its real inventor. Della Porta's account (in which he gives the first detailed description of the pinhole camera and its employment) appears in the first edition of the *Magia Naturalis sive de Miraculis Rerum Naturalium*, in four books (1558: lib. iv, cap.2). He used no lens with his version of the device but mentions the utilization of a concave mirror (*speculum*) in front of the aperture. With the aid of this mirror he was able to both enlarge and reverse the image, thus enabling the spectator to see the image patch the correct way round. (Cohen, 1953:659.) All of these above accounts are undisputed references to the device known as a *camera obscura* (this latter term being coined by Johannes Kepler in his *Ad Vitellionem paralipomena* in 1604). However, it is quite certain that the principle of the camera was known prior to this time.

For example, although no documented evidence exists (or more correctly, survives), it is generally accepted that the ancient Greeks for one, would have known about this device. (Cohen, 1953:658.) In addition, many accounts have come down to us that were written (in some cases, literally millennia) before the more well known sixteenth century descriptions. All of these texts, point to the existence of an unnamed device which seems to fit the description of the *camera obscura*. However, bearing this possibility in mind, we would do well to heed the words of Krasna-Krausz (Mannheim, 1982:453), who states that,

Knowledge of the camera or, at least, of its principle has been ascribed to Mo Tzu in China of twenty-five centuries ago, the Greek philosopher Aristotle (384-322 B.C.), the learned Arab Ibn al-Haitham (965-1038), the English friar

Roger Bacon (1214-94), the hebrew scholar Levi ben Gershon (1288-1344) and others. But some of these assumptions are based on imaginative readings of barely more than sketchy remarks.

It would be advisable, therefore, to examine more closely some of these 'sketchy remarks' and ascertain their probity and merit.

#### 6.1.2 Evidence for the *camera obscura* before 1357 AD

Before reviewing the documented evidence for both the existence of and/or knowledge of the *camera obscura* and/or its theory before the middle of the fourteenth century it is important that the following point be borne in mind, *viz*: it is assumed that a person can practically employ a device such as a *camera obscura* without necessarily having to have an 'accurate' understanding of its theoretical working. For example, many modern photographers are quite capable of producing photographs utilizing highly complex cameras and photographic films without a 'full' understanding of either modern chemistry, physics or optics.

In the same way it could never be claimed that any of the medieval natural scientists under review in this chapter, ever had a complete understanding of the various principles pertinent to the formation of pinhole images.

Related to this, researchers of the science of optics such as Lindberg, who are generally more interested in analysing the development of and influence of specific optical theories

in the history of science make a distinction between those medieval natural scientists who have concerned themselves with the theory of apertures which are truly 'pinholes' and those who deal more with the problems of light passing through large, geometrically shaped apertures. In this connection, Lindberg (1968:157) explains that

historically, finite and point apertures have constituted two distinct cases. Many of the historical figures associated with the camera obscura dealt with only one or the other or, if they dealt with both cases, did so in separate works. Moreover, there is very little resemblance between the respective theories. If the aperture may be regarded as a point, the entire theory consists of two statements: (1) light is propagated in straight lines, and (2) light rays intersecting in the aperture do not mingle....By contrast, if the aperture is regarded as having dimensions of significant size, the question of shape enters the problem, and difficult questions are posed: If the aperture is square, why is the image round? Or, to take account of the phenomena in more detail, why does the image have the shape of the aperture directly behind the aperture and the shape of the luminous object far behind the aperture?

Although these points raised by Lindberg are important, what is even more relevant to this investigation is not so much the theory of pinhole images *per se* (we know this already), or when specific theories were actually developed and by whom, but rather, is there sufficient evidence to prove that any person/s in existence (c 1200-1357 AD) could have (practically) produced an image opposite an aperture (pinhole or otherwise) in a darkened chamber, box or tent. It is well known for example, that there was a particularly great interest in the subject of optics between 1250-1350. This undisputed fact is borne out by the number of important natural scientists and philosophers of both the Latin Christian West and the Muslim East who concerned themselves with optical issues. For example we have the Latin works of Albert the Great (Albertus magnus) (c 1193/1207-1280), Roger

Bacon (c 1210/20 - c 1294), Raymund Lulli (c 1235-1315), John Pecham (Peckham) of Canterbury, Witelo, John of Paris (1225-1306), Dietrich of Freiberg; the Arabic works of Ahmed ibn Idris al-Qarafi, Qutb al-din al Shirazi, Kamal al-din al Farasi; and the Hebrew writings of Levi ben Gerson (Gershon) (1288-1344). (Sarton, 1947:141-2; Lindberg 1968:154-76.)

Most authorities agree that this interest was due to the singular influence of the *Kitab al-manazir* of Ibn al-Haytham. This publication was known in the West as early as the thirteenth century as the *Perspectiva* or *De aspectibus*. This was later published by Friedrich Risner along with Witelo's *Perspectiva* as the *Opticae thesaurus Alhazeni Arabis libri septem* in 1572. Sarton (1947:141) asks

How shall we account for such ubiquitous and simultaneous efflorescence? The explanation is that all these scholars were drinking from the same source, which became available to them (or which they were ready to use) at about the same time. That source was the *Kitab al-manazir*.

#### 6.1.2.1 Ibn al-Haytham and his influence

Abu 'Ali al-Hasan ibn al-Hasan ibn al-Haytham (known as Alhazen or Alhacen in the Latin west) lived in Arabia c 965 - c 1039 AD and not only produced the *Kitab al-manazir* but numerous other texts which covered such subjects as optical illusions, the height of the atmosphere, the apparent increase of the size of the moon near the horizon and atmospheric refraction, perspective, binocular vision, shadows and colours. In addition he produced a

treatise on burning mirrors (translated into Latin as the *De speculis comburentibus*).

More importantly, he also wrote on a number of topics more directly related to this investigation, viz: the structure of the human eye and the *camera obscura*. In particular, he formulated a detailed and fairly accurate analysis of pinhole images. Of particular importance is his description of an experiment wherein a number of candles are placed opposite the aperture of a darkened chamber. In this regard at least, there is no doubt that al-Haytham was referring to what was to become known as a *camera obscura*. al-Haytham makes the following comments:

The evidence that lights and colours are not intermingled in air or in transparent bodies is that when a number of candles are in one place, [although] in various and distinct positions, and all are opposite an aperture that passes through to a dark place and in the dark place opposite the aperture is a wall or an opaque body, the lights of those candles appear on the [opaque] body or the wall distinctly according to the number of candles; and each of them appears opposite one candle along a [straight] line passing through the aperture. If one candle is covered, only the light opposite [that] one candle is extinguished; and if the cover is removed, the light returns...Therefore, lights are not intermingled in air, but each of them is extended along straight lines (Lindberg, 1968:154).

al-Haytham does not specify the dimensions of the aperture, but considering that he wanted to prove that light does not mingle, it would most assuredly have been as small as possible (if not actually being a pinhole). This assertion is also supported by practically duplicating this experiment. (See 6.1.1.2.)

However, it is important to realise that as far as al-Haytham was concerned, the main emphasis of this specific experiment was not to produce images (although from other texts it is obvious he was more than aware of this possible application), but to prove to his readers that separate light rays emanating from specific sources do not mingle and produce a common ray. In this sense at least, the documented experiment with the aperture was considered useful only in so far as it proved this latter point.

Historically, al-Haytham is a most significant figure in the history of the science of optics. In particular he refuted the very popular extramission theory of vision (as propounded by such writers as Euclid, Galen and Plato) and proposed his own original intromission theory of vision. Briefly stated, the extramission theory (which was still popular in Bacon's time), supported the idea that rays emanated from a spectator's eyes, which in turn grasped the object under observation and returned with the visual information to the eyes. In opposition to this, al-Haytham proposed that light reflects from objects and enters our eyes. Specifically he showed that every point on a body (in space) radiates in infinite directions. al-Haytham (Lindberg, 1976:73) states that:

from each point of every coloured body, illuminated by any light, issue light and colour along every straight line that can be drawn from that point.

al-Haytham is here applying the principle of punctiform analysis to nonluminous bodies. In other words he is aware that light is reflected from all parts (or points) of a body and

is received by the eye. This discovery is especially pertinent to this investigation and shows a radical departure from the previous intromission theories of the atomists and Aristotle, who believed that 'atomic' particles stream off of objects and then enter the eye. In addition, al-Haytham was probably one of the first recorded natural scientists to realise that images, produced by the aid of an aperture (finite or geometric) were in fact composite. In other words, he fully realised that the image is formed by the superimposition of an incalculable number of image patches, each in the shape of the aperture and each radiated from every point of the object. These overlapped images give the soft-focus appearance of the original object and not the shape of the aperture. This of course explains why a pinhole image is more focussed in appearance than an image produced with the aid of a larger aperture. Hence, an image in a *camera obscura* can only be discerned at some distance and often is unrecognizable at close range. (See 4.1.1.)

Figure 11 explains the main features of al-Haytham's theory. Circle ABCD represents the visible portion of the sun to a spectator on earth. From all points on the sun's surface rays are projected towards the triangular aperture. For the purposes of clarity, only the rays from points A and C are shown in the diagram. The rays from point A illuminate an area at A'. Similarly the rays from point C illuminate an area at C'.

Now if all points from the sun were depicted it is evident that a composite image of the sun's area (ABCD) would be illuminated in the corresponding area A'B'C'D'. If either the dimensions of the aperture be decreased or the distance between the aperture and the sun

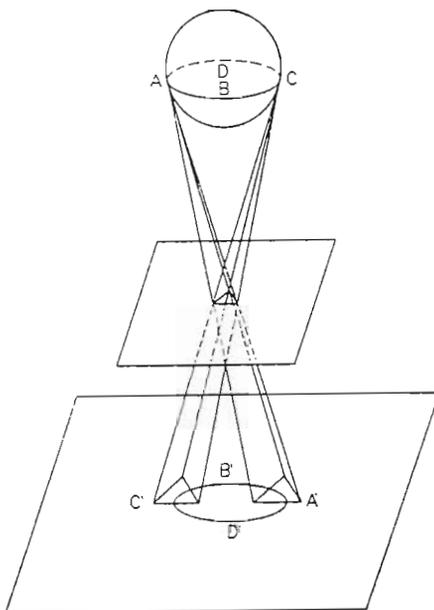


FIGURE 11

Diagram showing al-Haytham's theory  
of pinhole images, eleventh century.

(Lindberg, 1968:155.)

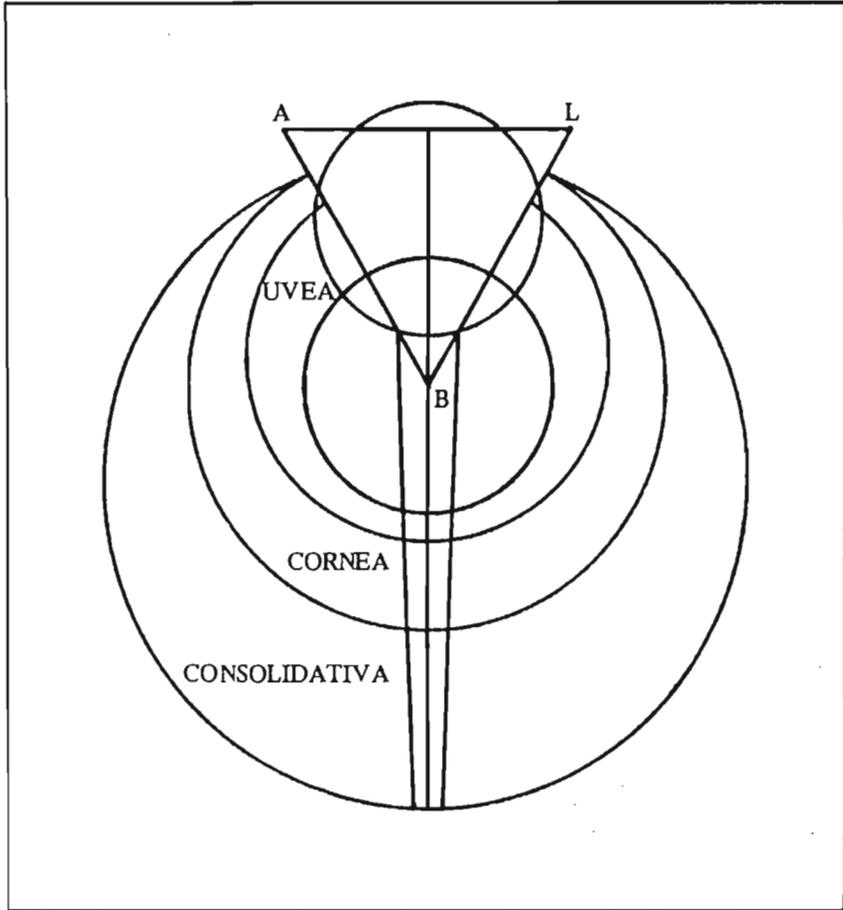


FIGURE 12

The path of radiation through the eye  
according to Roger Bacon, thirteenth century.

(Bacon, 1928a:442.)

be increased it follows that the triangular patches of illumination would also become correspondingly smaller. This action would have the effect of sharpening the image.

It should be especially noted that in many ways al-Haytham seems to have had a greater understanding of pinhole images than many of the philosophers who succeeded him in the west. In this regard at least, here is proof that certain scientific ideas and discoveries are not necessarily improved upon with subsequent development. Moreover, the Latin translations of the *Kitab al-manazir* only directly influenced the west from about 1250 onwards. Of course there always exists the possibility that during the period of the Crusades, (c 1060-1291 AD) certain Christian ecclesiastics and scholars living in Christian occupied territories such as the County of Antioch, or the Kingdom of Jerusalem (or even Sicily and Spain for that matter), could have come into direct contact with Alhazen's Arabic writings concerning the *camera obscura*. After all, there is much evidence for cross-fertilization of ideas between 'Saracen' and 'Frank', especially during the many periods of truce and there are many accounts of 'Saracens' being employed by religious military orders such as the *Knights Templar*, for their skill in carving, masonry, metalwork, textiles and even interpretation, because their expertise in these areas was far in advance of the Latin west: 'They lack our faith: we lack their works' (Simon, 1959:56-9). However, this interaction between the two cultures did not always include the reading of Arabic literature. Arabic (and other Semitic tongues) was quite alien to the western Europeans. In this regard, Simon, (1959:59) explains that because of Arabic's 'literally infinite' vocabulary and its extreme flexibility, it was 'too taxing for the type of

memory trained in putting a limited verbal raw material with a comparatively rigid grammar through every permutation of concept and expression’.

Even Bacon, it seems, was not unaware of these problems at the time and dealt at length with the question of cross-cultural communication. In part three of his *Opus majus*. He (Bacon, 1928a:109-10), states that

a knowledge of languages is very necessary for directing the commonwealth of the Latins for three reasons. One is the sharing in utilities necessary in commerce and in business, without which the Latins cannot exist, because medicines and all precious things are received from other nations...A second reason is the securing of justice. For countless injuries are done the Latins by the people of other nations...The third reason is the securing of peace among the princes of other nations and among the Latins that wars may cease. For when formal messages along with letters and documents are drawn up in the respective languages of both sides, very often matters which have been set on foot with great labour and expense come to naught owing to ignorance of a foreign tongue. And not only is it harmful, but very embarrassing when among all the learned men of the Latins prelates and princes do not find a single one who knows how to interpret a letter of Arabic or Greek nor to reply to a message.

It is also interesting to note the case of the natural philosopher, Adelard of Bath (*fl* 1116-42 AD). Adelard travelled throughout Europe and the Middle East, learned Arabic and even translated into Latin a number of Arabic treatises on subjects such as mathematics and astronomy. He produced an encyclopedia of natural philosophy entitled the *Questiones naturales*, which, he claimed, presented new knowledge as a result of his study of Arabic learning. However, in this document he only managed to produce a theory of vision that owed far more to the Encyclopedic tradition of the west than the Muslim east. (Lindberg

1976:93.)

Of course, there is no reason to doubt that Muslim scholars at least, through the work of Ibn al-Haytham, knew of the workings of both the *camera obscura* and the nature of pinhole images before the middle of the eleventh century. Finally, it should be pointed out that Ibn al-Haytham himself mentions that he did not discover the device we call a *camera obscura*, ‘*Et nos non invenimus ita...*’ (Cohen, 1953:658) and thus implies that it was quite common knowledge even in his own time (*ie* late 10th and early 11th centuries).

#### 6.1.2.2            **Roger Bacon (c 1210/20-1294 AD)**

In part five of the *Opus majus*, Bacon, drawing heavily from the work of Aristotle, Galen, Avicenna, Constantinus and especially Alhazen (al-Haytham) lays down what must have been the most comprehensive outline concerning optical science for its time. (*ie* c 1250-70 AD) However, in this and his other works, he never once makes a direct comment or observation concerning the phenomenon of light as observed in a darkened chamber. There are however a number of tantalizing remarks made by Bacon which can only make sense if one acknowledges his awareness of this device. To understand this context more fully, it is necessary to review briefly the *modus operandi* of the fifth part of the *Opus majus*, *viz: Optical Science*. This treatise is divided into three parts. Part one is divided into twelve distinctions as follows:

- \* The first distinction, which deals mostly with those topics that relate to the more or less psychological and philosophical aspects of vision and its relationship to the human mind;
- \* The second distinction, which deals with the optical nerves and the structures of the eye;
- \* The third distinction, which deals largely with Bacon's attempt to make the parts of the human eye conform to more mathematically ideal proportions;
- \* The fourth distinction, which deals with the qualities and properties of the various parts of the eye;
- \* The fifth distinction, which attempts to understand the causes for vision;
- \* The sixth distinction, which deals with those observations which were not easily explained in terms of the paradigms of thirteenth century science;
- \* The seventh distinction, which deals with the extramission and intromission theories of vision;
- \* The eighth, ninth and tenth distinctions, which deal specifically with the prerequisites

for human vision.

In the third distinction, Bacon correctly identifies the structures that make up the human eye, and perhaps more importantly, clearly understands how light enters through the aperture of the eye (pupil) and is refracted by the convexity and density of the lens and finally 'focussed' onto the optic nerve. (See figure 12.)

Although his ray diagrams do not agree exactly with more modern ray diagrams, and his depiction of the eye is distorted to allow each part of the eye to be described by a perfect circle, his general understanding of the form and function of the parts that make up the eye, viz: pupil, lens and optic nerve are fairly accurate.

It is well known that the workings of the human eye and the *camera obscura* are (for all intents and purposes) identical but it was not until the fifteenth century that scientists such as Da Vinci actually wrote down this analogy. However, Bacon makes mention of some of the properties of the eye that support the suspicions one may have of his knowledge concerning not only the workings of the human eye but also darkened chambers. In his fourth distinction, chapter one, Bacon (1928b:444) states the following:

The coats and humors, according to Alhazen, have their admirable qualities, from which follow the benefits of vision, as he himself shows. The first function of the cornea is the closing of the opening in the uvea, preventing the escape of the humour albugineus (Bacon's term for aqueous humour. N.P.L.A.); it is, moreover, transparent, so that the impressions [species] of light and colour may pass through it, as was verified before...The uvea is

usually black, in order that the humour albugineus and the glacialis (Bacon's term for the lens. N.P.L.A.) may be obscured, so that feeble impressions of light and colour may appear in it, since feeble light is very apparent in dark places, and is concealed in places full of light.

This is very good evidence for assuming that Bacon not only had some experience in observing images in darkened chambers but was applying its phenomenon to the workings of the eye. Anyone who has tried to observe the faint pinhole images that are produced inside a *camera obscura* will know that it takes the human eye quite some time to become accustomed to the reduced light levels. In this regard it also becomes impossible to detect these faint images if even the slightest amount of light enters the chamber (through a secondary aperture for example). Only someone with this experience could have stated 'feeble light is very apparent in dark places, and is concealed in places full of light'.

This assumption is further strengthened by Bacon's referral to Alhazen's experiment with candles and an aperture (see 6.1.2.1).

In the sixth distinction, chapter six, Bacon simultaneously attempts to show that light travels in straight lines as well as supporting his theory that different rays of light can mix together as one. This latter point (which disagrees with Alhazen's (al-Haytham's) account), need not concern us too greatly, for what is relevant to this investigation is his comment that

when three candles are placed opposite an opening; for then the lights appear

distinct beyond the opening, and therefore also in the opening...since light travels along a straight path, while it is being multiplied in the same medium (*ie* air. N.P.L.A.), therefore the light of each candle, just as it passed along different straight lines before the opening, so must it continue to do beyond the opening as regards the principal multiplication, and therefore the primary and principal paths are divided beyond the opening just as they were before it (1928b:466).

To undertake this experiment, it is necessary that the candles are the only source of light in the room. In other words, only a darkened room or *camera obscura* will serve as an adequate venue in which this experiment may be carried out. Indeed, the candle flames are very dim and have to be quite close to the pinhole to be discerned. In addition, the flames (as they appear in the image patch) are clearly upside down indicating to the observer that the rays from the candle to the image patch are straight. Further evidence exists that Bacon fully understood the principle behind the phenomenon of pinhole images and the cause of their inversion. For example, in the seventh distinction, Bacon attempts to explain why the images received by the eye are not inverted! (obviously because common sense told him that the world as viewed by human sight appeared the correct way round!) Here, he has the difficult task of trying to explain to his reader (Pope Clement IV) how the more typical phenomenon of the inverted image patch has been modified by the effects of the different refracting properties of the various translucent mediums within the eye, *ie* the lens and the vitreous humour. To this end he describes how light would 'normally' enter the eye if no such refraction were to take place. He explains that:

For if the rays of the visual pyramid meet at the centre of the anterior glacialis (*ie* when the rays emanating from the object converge on the lens. N.P.L.A.), they must be mutually divided, and what was right would become left and the

reverse, and what is above would be below, and thus the whole arrangement of the visible object will be changed... (1928b:466).

### 6.1.2.3 Concluding remarks

As can be ascertained from the literary evidence alone, both practical and theoretical knowledge pertaining to pinhole images was available in the Muslim east before 1039 *AD* — a full three centuries before the *Shroud of Lirey* came to light. In addition, it would be fair to state that at the very least, some practical understanding of pinhole images was evident in the Latin west before 1270 *AD*.

## 6.2 LIGHT SENSITIVE CHEMICALS

### 6.2.1 Light sensitive chemicals in recorded history

There exist a number of very simple chemical compounds that are more or less sensitive to light. The most obvious being silver chloride and silver nitrate.

Silver chloride, which is a solid (often produced by precipitation), is not soluble in water and whether in liquid suspension or dry powder form is extremely sensitive to the action of sunlight. Mellor (1922:390), informs us that in nature, silver nitrate occurs in veins of clay slate together with other silver ores, and is known as

*horn silver, chlorargyrite, ceragyrite, or keragyrite...*[t]here can be little doubt that silver chloride was known in the time of Pliny for in his *Historiae naturalis*...he refers to operations in which this compound must have been formed. Geber also, in his *Summa perfectionis magisterii*, describes its *color mirabilis*.

If used as a light sensitive emulsion/solution on a suitable two dimensional support it will form a latent image fairly rapidly. After some time a visible dark grey-brown discolouration will appear. By comparison, silver nitrate (in its liquid state) is more stable than silver chloride but, once dry, is also fairly sensitive to the action of sunlight, and after a prolonged time a visible dark blue-grey discolouration will also appear.

The first recorded experimentation which involved silver chloride and its ability to change colour (due to the action of light) was undertaken by C Gesner in the sixteenth century. He recorded in his *De omni rerum fossilium genere* (1565 AD) that *horn silver* darkens when exposed to light. (Mellor, 1922:408.)

Robert Boyle (1660 AD) believed that this compound (*horn silver*) darkened when exposed to air and not light. In fact it was not until 1725 that Johann Heinrich Schulze (without knowledge of Gesner's discovery), accidentally discovered that a suspension of chalk in silver nitrate was transformed by the action of light.

## 6.2.2 Silver Nitrate before 1357 AD

There is much evidence for the existence of silver nitrate in both medieval Christian and Muslim societies. The prerequisite for this compound is simply silver and nitric acid. For example, Geber described how silver nitrate may be prepared by dissolving silver in nitric acid in his *De inventione ventatis* (12th or 13th century AD). More specifically, he showed how silver nitrate is prepared by crystallization from a solution of silver in diluted nitric acid. (Mellor, 1922:459.) Because of man's need to refine both gold and silver deposits, nitric acid (because of its ability to dissolve silver) became an invaluable chemical for separating silver from gold and silver alloys (electrum).

To produce this chemical it was necessary for nitre to be collected and transformed into nitric acid. The silver was then ground and dissolved in the acid. However, there is a seeming disparity between the various historical accounts concerning the supposed origins of this compound.

### 6.2.2.1 Nitric acid

In his *Studies in ancient technology* vol. viii. Forbes states that late medieval metallurgists did not use nitric acid (specifically as a parting agent) before the time of Agricola (c 1490-1555).

Before this date he claims that gold-silver alloys were parted or refined by one of two main processes. Basically these are as follows:

- \* sulphur process, where the gold-silver alloy is heated with sulphur-compounds and charcoal. As a result of this action, the silver is transformed into silver sulphide whilst the gold remains as a residual (regulus); and
- \* salt process, where the gold-silver alloy is mixed with sodium chloride (salt) and heated slowly in a clay crucible. The salt attacks the silver, forming silver chloride (see 6.2.3), which is absorbed by the walls of the crucible.

Forbes (1964:176-7), describes a number of variants of this basic process and seems to support the view that the salt processes were known at least as early as the time of Agatharchides (181-146 *BC*) and Pliny (23-79 *AD*).

However, an account written by Albertus Magnus (*c* 1193-1280) does not corroborate Forbes' statements. It transpires that he not only knew about nitric acid but actually used it to separate gold from silver. His account for preparing silver nitrate (or *eau prime* as he called it) is as follows:

Prenez deux parties de vitriol romain, deux parties de nitre, et une partie d'alun calcine; soumettez ces matieres, bien pulverisees et melangees, a la distillation dans une cornue de verre. Il faut avoir soin de fermer exactement toutes les jointures, afin que les esprits ne s'echappent pas (*ne spiritus possint*

*evaporari*). On commence par chauffer d'abord lentement, puis de plus en plus fort. - Le liquide ainsi obtenu dissout l'argent (*est dissolutiva lunae*), separe l'or de l'argent, et transforme le mercure et le fer en chaux (oxydes) (*Aurum ab argento separat, mercurium et martem calcinat, convertit in calces.*) (Hofer, 1866:388.)

Of course, this implies that Albertus Magnus must have also produced silver nitrate. Although he doesn't actually give his version of this reagent a name, he does mention that the dissolved silver and eau prime '*tingit cutem hominis nigro colore et difficulter mobili*' (Hofer, 1986:389).

The fact that Albertus Magnus mentions this phenomenon is not at all surprising. Indeed, even if there existed no documented evidence of his discovery of silver nitrate's ability to change colour, it is certain that he would have known about it. In this regard, it is common knowledge amongst photographers and other persons who have had occasion to handle this seemingly innocent, colourless solution that silver nitrate (in solution) causes extremely severe skin stains. These normally occur on the fingers and take weeks to be eroded away. It is interesting to note that photographers in the nineteenth century (because they prepared their own light sensitive emulsions) were identified by the public-at-large by the state of their brown and yellow stained hands. Once the lesson has been learned, persons who handle this chemical are very careful to don protective clothing and gloves. Considering the chances of someone not experienced in handling silver nitrate (*eg* Albertus Magnus) not getting his hands stained, taken together with Albertus Magnus's written description of the staining powers of the chemical he produced (*c* 1250 AD), it is quite certain that Albertus

Magnus both produced silver nitrate and understood its ability to change colour well before 1300 *AD*. Indeed, it can be safely stated that anyone who discovered silver nitrate would have discovered its staining power at the very same time. However, no evidence exists that Albertus Magnus or indeed any other alchemist or metallurgist (before the sixteenth century) knew exactly *why* silver nitrate changed colour. Even so, given the early occurrence of this reagent in western history, it would be safe to assume that silver nitrate would be a worthwhile reagent to include in the practical experiments related to this investigation.

The other light sensitive reagent (which is fairly well documented) is silver chloride, and (as will be seen) could have contributed equally as well to the hypothetical medieval 'photographers' solution to the problem of recording an image in their *camera obscura*.

### 6.2.3 Silver chloride

There is an apocryphal account which tells how a stained glass worker lost his silver button in a crucible of molten glass and accidentally created a yellow stain on glass. (Lee, Seddon and Stephens, 1989:84; Coe, 1980:9.) From this 'discovery' a silver stain was apparently developed and introduced to the art of stained glass by the French by the beginning of the fourteenth century. This stain produced a full range of tones from lemon yellow right through to orange. Previously, workers in the glass medium had relied on a mixture of iron oxide and powdered glass to achieve a monochrome brown. (Singer, 1957:240-3.) In

addition, before the discovery of silver stains, pieces of glass destined to be stained yellow (and indeed any other colour) had to be produced separately. Thus the new techniques of silver staining allowed the artisan to mix certain colours on the same piece of glass. For example it was now possible to take a piece of red glass and highlight it orange by simply painting on a layer of silver stain to the appropriate area. Brisac (1985:176) explains that

This remarkable technical accomplishment freed the glazier from the constraints of leading: silver oxide allowed a piece of white glass to be coloured with yellow without any cutting, and it modified the tonality of glass so that two shades could be set together without the addition of a lead. The oxide, usually placed on the outside of the glass, fused into the glass during firing; when used on the inside of the glass, it was handled like paint. Stained glass was consequently renewed, enriched and even made simpler by this process.

It should be pointed out that modern glass-stainers can employ a variety of silver based stains to achieve their yellow hues, and in this respect silver chloride, silver nitrate, and even silver oxide will colour glass yellow. However, most popular writers cite any one of the above mentioned silver based solutions as being the constituent of the original silver stain discovered *c* 1310 *AD*. For example, Brisac (quoted above) mention silver oxide as being the stain employed, whereas in fact, the actual chemical employed in France in the early fourteenth century was chloride of silver or silver chloride (Singer, 1957:240-3; Osborne, 1970:46).

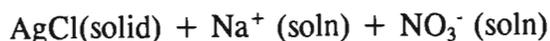
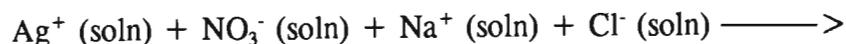
To prepare this stain it was necessary to dissolve about an ounce (32 grams) of pure silver in an equal amount of pure nitric acid. (The silver being finely ground before-hand to

speed up the process.) Boiling water was then added to this silver nitrate solution. Once the silver had completely dissolved it was saturated with sodium chloride (common salt). The resulting precipitate was allowed to settle and any excess water was poured off. This sludge was then mixed with fresh water and allowed to stand until the sediment settled and the excess water could be carefully poured off. After about six of these 'washings' with fresh water, a residue of relatively pure chloride of silver remained. (Duthie, 1982:79-81; Suffling, 1902:84-6.)

In modern parlance, this is simply a description of a typical 'no-electron-transfer' reaction (precipitation) which occurs when a solution of sodium chloride is mixed with a solution of silver nitrate. (Plane, 1966:85.)

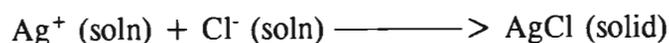
A solution of sodium chloride contains sodium ions and chloride ions whereas a solution of silver nitrate contains silver ions and nitrate ions. If these two solutions are mixed together a chemical reaction occurs which results in the formation of a white silver chloride precipitate. This happens because silver chloride is not soluble in water whereas sodium and nitrate ions are. Therefore, if the precipitate is washed regularly the sodium and nitrate ions are eventually removed leaving the relatively pure silver chloride precipitate behind.

The reaction can be expressed as follows:



where (soln) indicates that the ion is in solution and (solid) indicates that AgCl is a solid.

The deleted formulae indicate those ions that do not change during the course of the reaction. The result of which is:



The ability to produce silver salt (as described above) constituted a major advancement during the 'decorated' period in the history of stained glass (*c* 1280- *c* 1380 *AD*). During which period many other colours were also added to the palette of the stained-glass artist.

It is interesting to note that pieces of stained glass which are thicker than five or more millimetres often do not allow enough light through to produce a clear and bright colour. Because of this problem, glass-stainers developed what are normally referred to as 'flash' colours. In this technique, a piece of clear glass is coated with a coloured oxide and heated to *c* 600 degrees Celsius. At this temperature the oxide fuses with the surface of the glass. This thin veneer of pigment allows more light through and contributes to a clearer colour.

In the same way, glass-stainers applied silver chloride to the surface of a piece of glass and heated it in a kiln to the requisite temperature. Thus, the resulting yellow colour is no more than a surface stain on clear glass. As in the case of silver nitrate, there is no doubt that persons handling silver chloride would have soon learned of its ability to stain not only glass, but also fingers and clothing as well. Silver chloride is highly unstable in light, and even modern chemical suppliers do not (as a rule) keep stocks of this very expensive chemical because of the problems of long term storage. In this connection, silver chloride is normally produced only when it is actually required and is then stored in powder form (precipitate) in a light-proof and damp-proof environment at a controlled room temperature. As with silver nitrate there is no documented evidence, before the eighteenth century, that glass-stainers or anybody else connected silver chloride's instability with the action of sunlight. However, glass-stainers (c 1310) obviously did realize that it was the action of heat which produced the lemon yellows and oranges in the kiln and there is no reason to doubt that being involved with the subject of light and its ability to illuminate coloured glass, a glass-stainer might have suspected light as being the cause of silver chloride's rapid discolouration.

Finally, it is worth mentioning that the Egyptians knew of silver salt's ability to produce yellow stains (due to the action of heat) by at least the sixth century *AD*. In this connection the stains were used in the ceramic industry.

## 6.3 LENSES

### 6.3.1 Lenses in recorded history

Until quite recently, most authorities believed that the die-sinking and gem-cutting tasks of ancient times were undertaken by persons who were very short sighted. (Beck, 1928:327.) Such persons, (according to this scenario) would have been much sought after since they would have possessed (in effect) a pair of magnifying glasses permanently attached to their eyes. Beck (1928:327), states that

This idea is so prevalent that when ancient magnifying glasses are found, scholars go to the trouble of trying to find some other use to which they could be put, the favourite suggestion being that they must have been ornaments.

In fact the invention of glass and the subsequent manufacture of lenses may be traced back to Predynastic Egypt, the Ancient Near East and the Aegean. In this regard, a large piece of blue glass was found at Abu Shahrein in Mesopotamia which dates from *c* 3000 *BC*.

It is accepted that two separate traditions of glass manufacture coexisted in ancient times: the one centred in Egypt; and the other in the Aegean. In general, the Egyptian glass may be coloured whereas the Aegean examples are either transparent or more normally colourless. However, magnifying glasses were not always made from glass and many have been found which are made from crystal (optical quality quartz). This latter point is important, since it implies that the discovery of the lens does not necessarily depend on the

manufacture of glass *per se*. In this context it is interesting to note that in the British Museum there exists a mechanically ground quartz lens (which was found in a tomb from Helwan (Van Daniken, 1975:171).

Beck also informs us, that in the British Museum there are housed two Egyptian magnifying glasses. They are now tarnished through age, but originally would have been quite able to focus the Sun's rays. Both lenses, are about two and a half inches diameter (55 mm) and three and a half inches focus (80 mm), which would mean they could magnify about three diameters. Both of these examples are ground glass lenses and are not cast. One of these lenses was found at Tanis and has been dated to 150 AD.

Similar lenses have been found at Carthage (*c* 300-500 BC) and from Crete (*c* 1600-1200 BC) The latter site revealed one lens which is eight-tenths of an inch diameter (20 mm) and has a focus of about one inch (22.5 mm). This would give this lens an effective magnification of ten diameters. In addition, most of the natural philosophers (both western and eastern) knew of the burning lens (made normally by filling a round blown glass container with water). In this regard Roger Bacon not only fully describes the working of the burning lens and its manufacture but also undertook a series of experiments employing plano-convex lenses (*c* 1270 AD).

CHAPTER SEVEN  
PRACTICAL EXPERIMENTS EMPLOYING  
MEDIEVAL TECHNOLOGY

7.1 GENERAL OBSERVATIONS

It is important to emphasize that for the purposes of impartiality and historical accuracy, only those relevant examples of technical expertise, chemicals and equipment that were known to have existed *c* 1200-1357 were included in the practical investigation of the hypothesis (as stated in chapter six).

However, this strategy (as it stands) has two serious drawbacks:

- \* Firstly, it is assumed that many important medieval technological discoveries have not come down to us and therefore, even if these technologies are suspected to have existed, they cannot (for the sake of objectivity) be employed; and
- \* secondly, it is assumed that it would be impossible for a twentieth century researcher to completely divorce himself from his own socio-technological paradigm and successfully embrace a medieval world-view.

Therefore, in an attempt to overcome this impasse, it must be accepted that the

photographic hypothesis (as stated in chapter six) must be supported or refuted by the employment of known medieval technology and/or a technology that is conceivable in a medieval context, so long as it can be irrefutably supported by the physical evidence of the *Shroud of Turin* itself.

## 7.2 THE PRELIMINARY EXPERIMENTS

### 7.2.1 The objectives

To ascertain the suitability of certain light sensitive reagents (available before *c* 1357) as regards their respective abilities to produce an image as found on the *Shroud of Turin*.

### 7.2.2 Equipment

#### \* The construction of a *camera obscura*

For the purposes of initiating the practical investigation a suitable venue was converted into a functioning *camera obscura*. Technically speaking a *camera obscura* employs a pinhole (or small aperture), but for the purposes of experimentation this room had to have an aperture which could also house single and double-lens arrangements. The room employed for this purpose measured 450 x 350 x 300 cm. All windows and doorways in the room

were boarded up and sealed. An aperture was cut in a sheet of tempered hardboard and fitted into one of the frames of the south facing window. It should perhaps be pointed out that this *camera obscura* was intended to operate during the South African spring/summer season (November to February).

\* **The lenses**

Because (at this early stage), the primary objective of the preliminary investigation was to ascertain the suitability of selected light sensitive reagents (available before 1357), the question of whether or not it would be necessary to employ a lens of some kind was of secondary importance. Bearing this point in mind, two plano-convex lenses (made of optical glass) were employed in the initial experiments. These were originally part of a condenser for a photographic enlarger and were reassembled in a simple telescopic, metal tube, in such a way as to allow for easy adjustment of focus (*cf* plate 37). In this regard a number of plano-convex lens arrangements had been previously experimented with, and regardless of the size or the power of the lenses employed a more or less similar result could be obtained in most cases. Although plano-convex lenses were available between 1200-1375 and natural scientists such as Roger Bacon had experimented with multiple arrangements of lenses during this period (*cf* Bacon, 1928a; 1928b), there is no certainty that this particular piece of apparatus (*ie* a double-lens arrangement) was known of at that time. Equally, there is no reason to doubt that it couldn't have been made. In the text that follows this piece of apparatus will be referred to as the double-lens.

\* **The image patch quality**

Thus prepared, it was possible to experiment with either a straight forward aperture (to create a pinhole effect) or to focus the image with the double-lens. This latter device produced a sharp and bright focussed image. However, it is interesting to note that although the double-lens allowed more light onto the image patch area it also restricted the area that could be exposed because of a lack of lens covering power, (*ie* image fall-off). In other words, the small aperture (without any lenses), gave the best results (in terms of producing an acceptable, focussed, life-sized image of a human subject). Despite this fact, however, the small aperture did not allow sufficient levels of light into the chamber to affect the light sensitive chemicals within a short time-span (*eg* two or three days).

\* **The screen**

In order to support the light sensitive linen material at the correct angle and distance (image conjugate distance) from the aperture, a large mobile screen was constructed. This piece of apparatus measures 280 x 122 cm and is made of mild steel and tempered hardboard. This screen (plate 38), is fitted with wheels and may be moved as and when the need arises. (In the text that follows, this piece of apparatus will be referred to as the screen).

\* **The box camera**

For smaller tests, a heavy duty cardboard box measuring 340 mm x 450 mm was fitted out with an aperture which could also accommodate the double-lens. This smaller version of the *camera obscura* will be referred to (in the text), as the box camera.

\* **The plaster head**

For a suitable subject to 'photograph' it was necessary to manufacture a plaster-of-paris head and shoulders. This item was cast from life and then coated with a fine layer of acrylic paint in order to simulate human flesh (see plate 39).

\* **The linen cloth**

It is obviously not easy to obtain hand-woven linen today, but a good substitute in the form of machine-woven Irish linen was employed. A large roll was purchased from which a number of small pieces were cut measuring approximately 10 x 20 cm each. These were used for testing all light sensitive reagents during the investigation.

The linen was first machine washed with soap and very hot water (90 C) and repeatedly rinsed with clean water. This was done to ensure that the cloth contained no traces of starch or size.

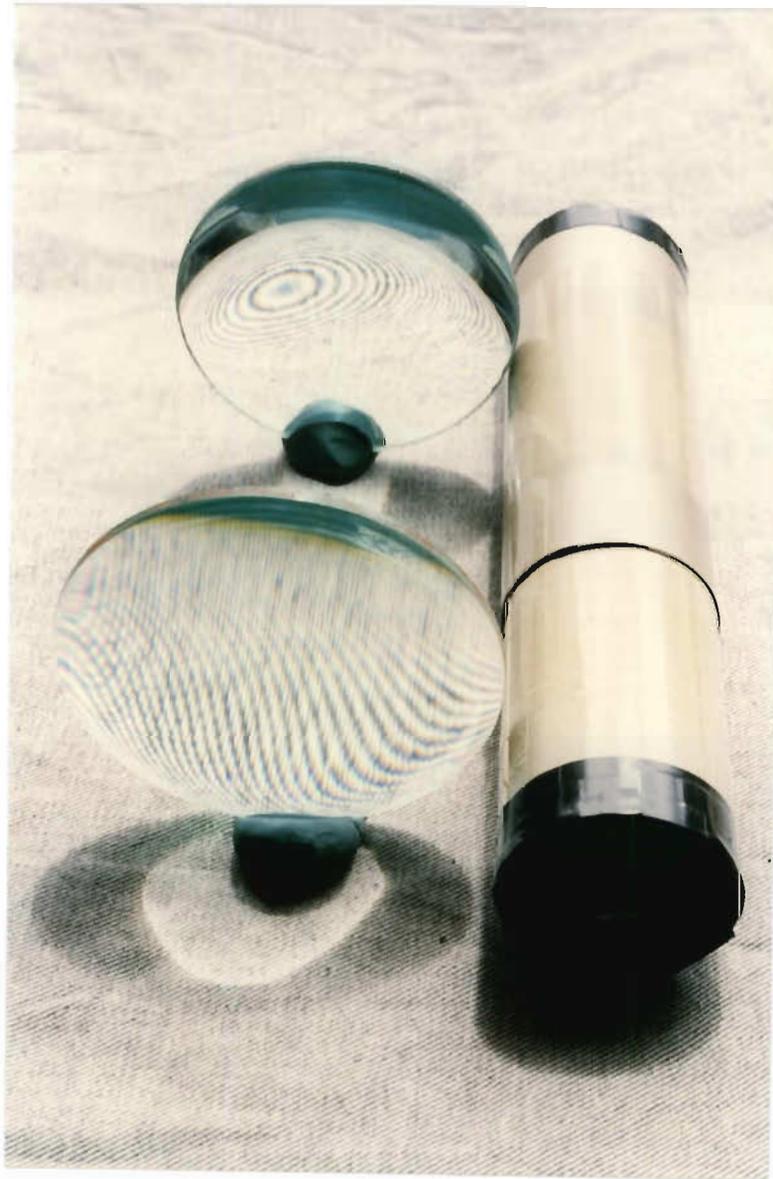


PLATE 37

Apparatus consisting of a pair of  
movable plano-convex lenses.



PLATE 38

Photograph of the mobile screen.



PLATE 39

Photograph of the plaster head. It should be noted that in the preliminary tests the head did not possess a beard and was painted in flesh tones.



PLATE 40

Photograph of a test strip of linen prepared with reagent D, showing tonal ranges possible in a 30 minute period.



PLATE 41

Photograph of the negative image  
of a pair of scissors on linen cloth  
prepared with reagent D.

### 7.3 THE PRACTICAL INVESTIGATION (PHASE ONE)

#### 7.3.1 The objectives of phase one

- \* To formulate the optimum mix of silver chloride and/or silver nitrate to distilled water in order to obtain (after exposure to sunlight) a good tonal range of reduced silver on a linen support.
  
- \* To ascertain if any chemicals available in medieval times (such as ammonia, ascorbic acid, borax, sodium chloride *etc.*) could serve as developers and/or fixers. (Hoefer 1866; Testi, 1950; Thorndike, 1923a; 1923b; 1934a; 1934b; Singer, 1956.)

In this connection phase one of the investigation sought to answer the following questions, *viz*:

- \* How long did it take a specific light sensitive sample to discolour when exposed to direct sunlight?
  
- \* What was the darkest tone that a sample could obtain?
  
- \* How much of the discolouration would remain in the linen after soaking in distilled water?

- \* What affect would certain chemicals, (available in medieval times) *viz*: ammonia, borax, sodium chloride *etc.* have on the exposed samples and would they fix the discolouration?
  
- \* Was it even possible to capture a negative image of a three-dimensional subject with the aid of such primitive light sensitive reagents?

### 7.3.2 Methodology (phase one)

The following methodology was applied, *viz*:

- \* At the commencement of this experimentation it was envisaged that four sets of cloth samples would be prepared with light sensitive reagents (*ie* two employing silver nitrate and two employing silver chloride).

Based on the visual results of these tests it was assumed that a decision could be made as to the formulation of a more accurate recipe. In this regard, any result would be compared with the data from the *Shroud* as regards to colour, tonal range and effect on the linen fibres (as examined under a microscope).

A number of modern recipes exist which give precise measurements for certain photographic emulsions, however, as no information was available to the author

concerning photographic solutions/suspensions/emulsions which only employed silver chloride (or silver nitrate) and distilled water, the initial recipes were based on common sense. It must be understood that a decision had to be made concerning a range of trial reagents, which by the process of trial and error could be gradually refined. In this sense, the author attempted to look at the problem from a medieval perspective.

The four (albeit arbitrary) recipes decided upon for these first experimental samples were as follows:

- \* **Reagent A:** silver chloride (5% solution);
- \* **Reagent B:** silver chloride (2% solution);
- \* **Reagent C:** silver nitrate (5% solution);
- \* **Reagent D:** silver nitrate (2% solution);

However, almost immediately, this proposed scenario had to be altered. This was due to the fact that silver chloride (which is a precipitate) cannot form a solution in distilled water. However, silver chloride can be dissolved in ammonia, but it was found that this formula was only partially sensitive to light. The silver nitrate, on the other hand, was easily dissolved in distilled water. Four pieces of linen cloth were stretched on a wooden support and painted by brush with Reagent C. This action was repeated for Reagent D. The four pieces painted with Reagent C were termed C1, C2, C3 and C4. The four pieces

painted with Reagent D were termed D1, D2, D3 and D4.

C1 and D1 were placed in direct sunlight and timed as to any general discolouration. Sample C1 turned a dark mauve-brown within 10 minutes. After 24 hours C1 was a deep chocolate brown. The fibres were discoloured far more strongly on the side facing the direct sunlight. Sample D1 took 30 minutes to discolour to a pale burnt sienna. This discolouration did not alter significantly after 24 hours. As with C1, only one side of the linen cloth was seriously affected by the action of sunlight.

It was obvious from this test that reagent D exhibited very similar characteristics to the image on the *Shroud of Turin* (both in terms of coloration and the condition of the fibre), and it was decided to only continue testing with reagent D.

D2 was placed in direct sunlight but was covered by a light proof piece of card. Every five minutes this card was moved across the face of the linen sample to test for gradation of tone. After 30 minutes it was confirmed that a wide range of tonal variation could be achieved from pale yellow-brown to a pale burnt-sienna (the latter tone appearing exactly like a scorch mark). D2 was placed in a bath of ammonia (5% solution) and then after one minute, was rinsed under running water. The tonal range became fainter, but still clearly discernable (plate 40). In addition this 'image' became 'fixed' in the sense that it did not alter after further exposure to sunlight. This result was extremely important (and almost too easy to obtain) because right from the beginning of these experiments it was confirmed

that ammonia can 'fix' the discolouration of silver nitrate on linen cloth. To date, no previous record of this phenomenon has been verified. At the time it was not fully understood what was actually taking place (at a chemical level), and indeed, since the tests were being conducted within the parameters of a medieval context, tangible results were sought rather than technical explanation. In addition, it was felt that at a later stage one would perhaps submit the cloth for a more thorough scientific evaluation, in order to determine what precisely was happening at a molecular level. Indeed, it is now understood that the straw-yellow stain that remains after washing with ammonia (which incidently removes all superfluous silver nitrate from the linen cloth), is possibly the result of a combination of two factors:

Firstly, (and least likely), it is known that ammonia dissolves lignin and perhaps trace elements of reduced silver may bond with the lignin during this period of contact with the ammonia. After reconstitution, the lignin is both physically altered at a molecular level (damaged) and combined with minute traces of reduced silver. The effect for all intents and purposes is akin to the fixing process employed in modern photography, because although the image is visually weaker (due to the loss of exposed silver nitrate) it (the now permanent image) remains unaltered if placed in direct sunlight.

Secondly, it is known that the reduced silver nitrate produces free radicals (ions) which quite possibly cleave the bonds found in cellulose and hemicellulose polymers which make up the linen fibre. In short, the linen is possibly oxidised as a result of the effects of UV

radiation on the silver nitrate. After the majority of silver has been removed by the ammonia the linen is left with an encoded image which is caused by the structurally altered cellulose. This oxidised cellulose will appear identical to cellulose which has been scorched or aged.

D3 was placed in direct sunlight with an object on top (*ie* a pair of scissors), after ten minutes this cloth was placed in a bath of ammonia (5% solution). After one minute the cloth sample was washed in running water and then slowly dried in the dark room. This negative image of a pair of scissors is now permanent (plate 41). D4 was placed on the screen in the *camera obscura* and exposed to the image of the plaster head. The image was focussed by the employment of the double-lens apparatus. The image conjugate distance and object conjugate distance totalled 3000 mm. The day was a mild one with scattered cloud. It was assumed that if a negative image could be achieved on such a moderate day then a hot, clear day would produce even better results. After eight hours there was no perceptible change to the sample. It was decided to repeat the above test on a hot, clear day and with a reduced image conjugate distance - thus bringing the sample closer to the light source. This of course has the effect of making the image smaller than life-size. In addition, it was decided to employ the services of the box camera for this type of test. This initiated phase two of the practical investigation.

## 7.4 THE PRACTICAL INVESTIGATION (PHASE TWO)

### 7.4.1 The objectives of phase two

- \* To produce a naturalistic, negative image of the plaster head on a sample of linen cloth impregnated with reagent D.

In this connection phase two of the investigation sought to answer the following question, viz:

- \* Was silver nitrate (2% solution) sufficiently sensitive to record the tonal variation of a focussed image of a three-dimensional object on a hot clear day?

### 7.4.2 Methodology

A fresh piece of linen cloth (10 x 20 mm) was prepared 24 hours before each test with reagent D.

The image of the plaster head was focussed (by means of the double lens) onto the rear wall of the box camera. Because of the reduced image conjugate distance only a half life-size image could be produced of the head.

After eight hours of exposure there was no perceptible change to the linen sample. In addition, it was not possible to develop any hypothetical latent image by using either borax or ascorbic acid. In fact, the admixture of ascorbic acid (1% solution) to the sample caused the entire cloth to turn dark orange-brown almost immediately.

#### 7.4.3 Initial findings

It was realised at this stage that the following factors applied to the use of silver nitrate (2% solution) which had been painted onto linen material and allowed to dry slowly in a darkroom before exposure, viz:

- \* silver nitrate (reagent D) impregnated linen samples changed colour within two minutes of exposure to direct sunlight.
- \* these silver nitrate samples could produce a good tonal range equal to and better than the image on the *Shroud of Turin*.
- \* the silver nitrate samples displayed (visually) the same characteristics (in terms of coloration and the condition of the linen fibres) as found on the *Shroud of Turin*.
- \* the silver nitrate samples could not record an image that was focussed with the double-lens construction, regardless of the weather conditions, the length of exposure

in one day, or the distance of the sensitised cloth from the lens.

It was realised that there was only one possible explanation to this latter problem, viz: the double-lens apparatus was blocking out part of the spectrum necessary to effect a change to the silver nitrate solution (reagent D).

Considering that the samples could change colour rapidly on even overcast days but not inside the house or at night under normal tungsten light it was believed that the glass lenses were the sole cause of the problem and that some information was needed concerning such details as the refractive indices of different types of glass, their respective UV transmission limits and the nature of the ultraviolet spectrum itself.

## 7.5 ULTRAVIOLET SPECTRUM

As was briefly covered in chapter five, human vision (and most modern photography) is limited to the visible spectrum. More specifically, the extent of human vision is limited by the sensitivity of the eye's cone receptors to wavelengths from about 380-700 nm.

However, this range may be extended under special circumstances. For example some individuals can perceive wavelengths below 350 nm and if confronted by a strong infrared source, the human eye may detect wavelengths in excess of 900 nm. (Arnold, 1971:113-4.)

The ultraviolet spectrum extends from 1 nm to 380 nm and below 350 nm is for all intents and purposes invisible to human perception. However, this narrow band of the electromagnetic spectrum accounts for 10% of the sun's radiation which due to the absorption of the earth's ozone layer and atmosphere, is cut to less than 4% by the time it reaches sea-level as UV. This amount is also subject to the conditions of the atmosphere and seasonal changes.

In addition, as was deduced from the initial experiments undertaken to produce a negative image with silver nitrate, it seems that only the violet and ultra violet spectrum has any immediate affect on a silver nitrate solution. Unfortunately, all optical materials, *eg* glass, air, water *etc.* have strong absorption bands in the UV region and apart from quartz and calcium fluoride (fluorite) make poor transmission lenses or mediums.

The ultraviolet spectrum may be split up into a number of sub-divisions. The following divisions are adequate for the purposes of this investigation (*cf* Arnold, 1971:257), *viz*:

- \* Near UV or 'black light': 320-380 nm.
- \* Middle UV: 200-320 nm.
- \* Vacuum UV (VUV): 1-200 nm.

This latter division contains the so-called 'Schumann region': 120-200 nm.

If one looks at the table showing the UV transmission limits of some selected optical materials (figure 13), it will be seen that quartz cannot transmit UV below about 185 nm. This should not be seen as a problem because even oxygen cannot cope below about 190 nm.

Indeed, the gelatin that constitutes most modern photographic emulsions has a transmission limit of as high as 250 nm which leaves very little of the UV spectrum available for most photographic work.

However, it was never necessary to use gelatin for these tests, thus the employment of a quartz lens extended the electromagnetic spectrum by an additional 130 nm, (*ie* 320-190 nm) - the only area of the spectrum that could in fact make an impression on the silver nitrate solution in a short time-span. Indeed, it was discovered that optical glass will only allow the light spectrum range 320-380 nm and that only quartz is capable of allowing penetration by the spectrum between 180 - 250 nm. Below this point ultra violet rays cannot penetrate even oxygen or water. Thus, it was apparent that silver nitrate responds to that part of the spectrum which glass cannot cope with *ie* middle ultra violet spectrum.

## UV TRANSMISSION LIMITS OF VARIOUS OPTICAL MATERIALS

MATERIALS	APPROXIMATE TRANSMISSION LIMIT
WINDOW GLASS (VARIOUS)	320 - 340 NM
OPTICAL GLASS (VARIOUS)	320 - 380 NM
CANADA BALSAM	300 NM
ATMOSPHERIC OZONE	295 NM
GELATIN	250 NM
SPECIAL HIGH-SILICA GLASS	220 NM
FUSED SILICA	200 NM
OXYGEN	190 NM
<b>QUARTZ</b>	<b>185 NM</b>
WATER	170 NM
FLUORITE	120 NM
LITHIUM FLUORIDE	110 NM

FIGURE 13

Table showing suitability of various optical materials to UV transmission.

If one considers that due to the protection of the earth's atmosphere only 4% of the Sun's total UV output actually reaches sea level, then it becomes clear why the exposure time had been so slow (in comparison to more modern emulsions).

It also became clear that silver nitrate could be prepared without the necessity of a darkroom, in fact the solutions could be mixed at night under normal tungsten lights, or even by day as long as the curtains were drawn.

### 7.5.1 The quartz lens

It was necessary at this stage to produce a quartz lens. To this end a number of tests were made with glass lenses of either bi-convex or plano-convex structure. These tests were undertaken in order to ascertain the correct specifications for any proposed manufacture of a quartz lens.

In this regard, it was found that a single lens of .75 power (plano-convex) was able to produce a focussed image of a human head (in the case of the box camera) with no apparent image fall-off problems. The lens eventually chosen as a model for the envisaged quartz lens was only 2 mm thick and had a diameter of 50 mm.

Its dimensions and power of magnification compared favourably with the level of technology available millennia before the medieval period. A number of attempts were

made to produce a lens from rock crystal but it was found to be extremely difficult to acquire a large enough example that was both optically clear and flawless. In addition, professional lens makers found that the quartz cracked very easily if too much heat was generated during the grinding and polishing stages of production. These factors threatened to undermine any further attempts at conducting experiments with the silver nitrate solution.

Fortunately, due to the kindness of Mr D van Staaden of the Council for Scientific and Industrial Research (CSIR) in Pretoria, a synthetic quartz, plano-convex lens was made available for testing. This borrowed lens was far from ideal, having a thickness of 4 mm and a diopetre of 2. Even so, this lens was able to focus a three-quarter size image of the original subject and was certainly able to be used for any testing with UV radiation (see plate 42).

## 7.6 THE PRACTICAL INVESTIGATION (PHASE THREE)

### 7.6.1 The objectives of phase three

It was necessary to produce a negative naturalistic image of the plaster head employing the (CSIR) quartz plano-convex lens and linen cloth prepared with reagent D.

### 7.6.2 Methodology

A piece of linen material prepared with reagent D was placed in the box camera. The synthetic quartz lens was inserted into the aperture and the plaster head was set up opposite the lens. The area behind the head was blocked off with a screen which in turn was covered with a non reflective black cloth. An attempt was made to give the linen cloth eight hours of exposure on a hot, clear day.

It must be noted that the box camera was set up in such a manner as to ensure an equal amount of sunlight in the morning as in the afternoon, *ie* the exposure was set to commence at 08:00 and to end at 16:00. The subject was the plaster head. The image was three-quarters life size.

### 7.6.3 Initial findings

It was discovered that after eight hours of exposure a faint negative image of the subject was obtained. However, on fixing this image in ammonia (5% solution) the image virtually disappeared leaving only a trace of its former intensity.

It was realised at this point that UV was indeed responsible for the image on the linen cloth (impregnated with reagent D) but that after only eight hours of exposure the material which composes the linen fibrils (*ie* cellulose, hemicellulose, lignin, pectin *etc.*) had not been

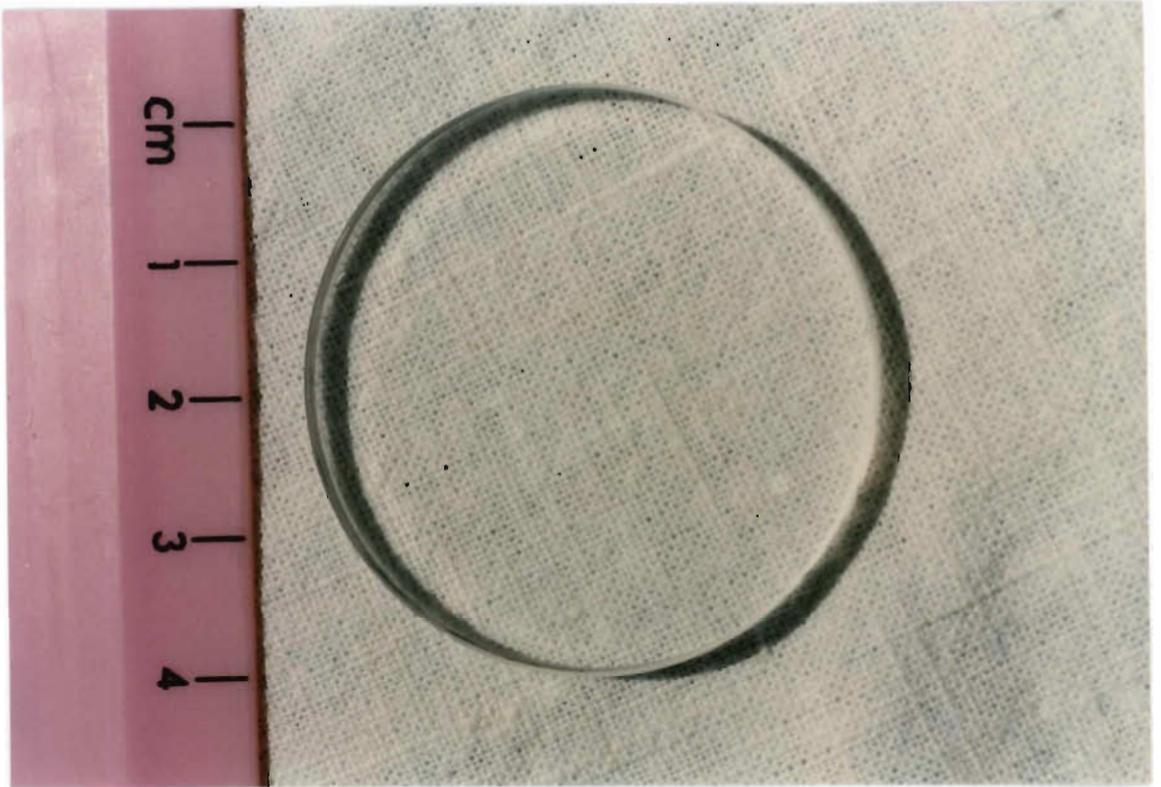


PLATE 42

Synthetic quartz lens employed in phases three, four, five, six and seven of the practical investigation.

adequately bonded with the reduced silver. Indeed all that was happening was that the vast majority of the silver nitrate solution (reduced and unreduced) was being washed out during the fixing process.

Of course, one could have mixed the solution with gum arabic or some other binder in an attempt to better adhere the reduced silver to the linen fibrils. This action, however, would have contradicted the physical evidence as found on the *Shroud of Turin* (see chapter four). It was decided therefore, to find a solution to this problem which did not employ binders of any description.

## 7.7 THE PRACTICAL INVESTIGATION (PHASE FOUR)

### 7.7.1 The objectives of phase four

It was necessary to produce a negative naturalistic image of the plaster head employing the CSIR quartz plano-convex lens and linen cloth prepared with reagent D.

### 7.7.2 Methodology

A piece of linen material prepared with reagent D was placed in the box camera. The synthetic quartz lens was inserted into the aperture and the plaster head was set up opposite

the lens as for phase three. An attempt was made to give the linen cloth 24 hours of exposure on three successive, hot, clear days. At night the aperture was masked to protect the cloth from any possible background radiation.

### 7.7.3 Initial findings

It was discovered that after 24 hours of exposure that the entire surface of the cloth (containing both the image and the background areas) was discoloured to such an extent that no clear image was discernable. It was realised that the reagent was turning brown on its own accord (*ie* independent of the action of UV) at a constant rate. This discolouration had a different appearance to the discolouration caused by the action of UV radiation. It was therefore necessary to desensitise the silver nitrate solution in order to minimise the natural discolouration process and give the cloth adequate time to record the reduced silver image as caused by UV radiation.

## 7.8 THE PRACTICAL INVESTIGATION (PHASE FIVE)

### 7.8.1 The objectives of phase five

It was necessary to produce a negative naturalistic image of the plaster head employing a quartz plano-convex lens and linen cloth prepared with a reagent which was less sensitive

than reagent D.

### 7.8.2 Methodology

A very small quantity of silver nitrate (.06 mg) was dissolved in 125 ml of distilled water. This considerably weaker solution (0.5%) will be referred to as reagent E. To this end a piece of linen material prepared with reagent E was placed in the box camera. The synthetic quartz lens was inserted into the aperture and the plaster head was set up opposite the lens as for phases three and four. An attempt was made to give the linen cloth 24 hours of exposure in strong sunlight.

### 7.8.3 Initial findings

An excellent negative image of the plaster head was achieved after three days of exposure. However, the weather had not been ideal during this three day period (a factor which made this positive result all the more surprising).

The image displayed a good tonal range and also a three-dimensional quality similar to that when observing the inside of a plaster-of-paris mould. In addition, it was observed that the recorded image of the white linen head covering (which had been wrapped around the plaster head to simulate hair), was more detailed than the negative image of the face. It was realised that the head covering (because it was made of white linen) had reflected more UV

radiation than the flesh coloured areas of the plaster head. In other words, it was fairly obvious that not only highlights such as cheeks, forehead, nasal ridge, chin *etc.* but also, more reflective (whitened) areas were contributing to the formation of the negative image on the prepared linen cloth.

It was also noticed that no perceptible discolouration had occurred elsewhere on the linen cloth, only those areas subjected to UV radiation were noticeably affected. This latter point is most important, because it implies that under normal conditions such a piece of prepared cloth will not become discoloured if it is not displayed in direct sunlight. This means that the cloth (without fixing) may be left uncovered indoors for a long period (two to three days) even on bright and sunny days. In addition such a cloth may be transported outside for short periods on heavily overcast days. In short, it is quite possible to impregnate a piece of linen cloth with reagent E outside of a darkroom, dry it in the shade and then 'load' it into the *camera obscura*.

On fixing (ammonia 5% by solution) the phase five image, a great percentage of the detail was lost, (see plate 43). However, that detail which remained, although extremely subtle, is quite visible under certain lighting conditions. An enhanced negative photograph of the image (see plate 44) reveals a fairly good image of the plaster head in positive. It was decided at this stage to increase the length of exposure and to increase the reflectivity of the plaster head in a further series of tests.



PLATE 43



PLATE 44

Positive and negative photographs of the image  
produced in phase five, (after fixing).



PLATE 45

Photograph showing how the tests were undertaken during the practical investigation. Note that the area behind the plaster head is marked off with a non-reflective screen, in order to minimise any impression on the sensitized linen cloth in the camera.

## 7.9 THE PRACTICAL INVESTIGATION (PHASE SIX)

### 7.9.1 The objectives of phase six

It was necessary to produce a negative naturalistic image of the plaster head employing a quartz plano-convex lens and linen cloth prepared with reagent E.

It was also desired to achieve an image which could be more easily compared to the image on the *Shroud of Turin*.

### 7.9.2 Methodology

A very small quantity of silver nitrate (.06 mg) was dissolved in 125 ml of distilled water (reagent E). To make the plaster head more Christ-like, a beard and moustache (based on the *Shroud of Turin* image) were added. In addition, in order to increase reflectivity, the head and beard were painted white (see plate 39).

The prepared linen cloth was placed in the box camera. The synthetic quartz lens was inserted into the aperture and the 'improved' plaster head was set up opposite the lens as for phases three, four and five, (see plate 45). An attempt was made to give the linen cloth 24 hours of exposure over a three day period.

### 7.9.3 Initial findings

A series of rain storms interrupted the exposure. Because of this factor the exposure time was erratic in the sense that it received more morning light than afternoon light over a six day period. It was calculated that (excluding the periods the box camera was under cover from the rain), the cloth was exposed for a total of 20 hours.

The image produced on this occasion (despite the bad weather and reduced exposure time) was much better than the one produced in phase five. This was obviously due to the fact that the 'improved' head was more reflective than before. (See plate 46.)

The image was fixed with ammonia as before and although much of the detail was lost the remaining image was much clearer than for phase five. (See plate 47.)

It should be further noted that this image was only fixed eight days after it was removed from the box camera (or 14 days after its original preparation). In all this time the cloth had not become discoloured in any area other than that exposed to UV radiation.

Although this test (phase six), had been ruined by the weather it had confirmed many of the assumptions that had been made up until this time and it was now possible to repeat this test with more confidence.



PLATE 46



PLATE 47

Photograph of the image produced in phase six. On the left is the the image before fixing, on the right is the same image after fixing.

Note the loss of detail caused by the fixing process.

## 7.10 THE PRACTICAL INVESTIGATION (PHASE SEVEN)

### 7.10.1 The objectives of phase seven

It was necessary to produce a negative naturalistic image of the plaster head employing a quartz plano-convex lens and linen cloth prepared with reagent E.

It was also desired to achieve an image which could be more easily compared to the image on the *Shroud of Turin*.

### 7.10.2 Methodology

A very small quantity of silver nitrate (.06 mg) was dissolved in 125 ml of distilled water (reagent E). The plaster head was set up exactly as it had been in phase six. (See plate 45.) The prepared linen cloth was placed in the box camera. The synthetic quartz lens was inserted into the aperture and the 'improved' plaster head was set up opposite the lens as for all previous tests. An attempt was made to give the cloth a six day exposure in good weather.

### 7.10.3 Initial findings

The cloth was exposed for seven consecutive days. Two days had been cloudy. The image

that was achieved on this occasion was outstanding, as can be immediately seen by observing plate 48. This image was fixed in ammonia (5% solution) and the results recorded. (See plates 49 and 50.)

One will notice that in the 'fixed' version of the phase seven image, the subtle, yellowed image of the bearded head on the linen cloth is almost identical to the image on the *Shroud of Turin*. The highlights such as the bridge of the nose show (even after fixing) a delicate gradation of tone. The eyes appear owlish, the moustache is clearly demarcated. The image only appears on the surface of the fibrils and no image is visible on the reverse of the linen cloth. It was clear at this stage that only a lens of sufficient diameter, could allow through sufficient amounts of light to affect the prepared linen cloth. In this regard, although a recognisable image may be formed by the employment of a pinhole, the small level of radiation which actually enters the camera has little or no effect on the silver nitrate. This is especially true of larger images - those which require an image conjugate distance of over one metre.



PLATE 48

Photograph of the image produced in phase seven before the image was fixed. Compare this image to plate 49.



PLATE 49



PLATE 50

Positive and negative photographs of the image  
produced in phase seven, (after fixing).

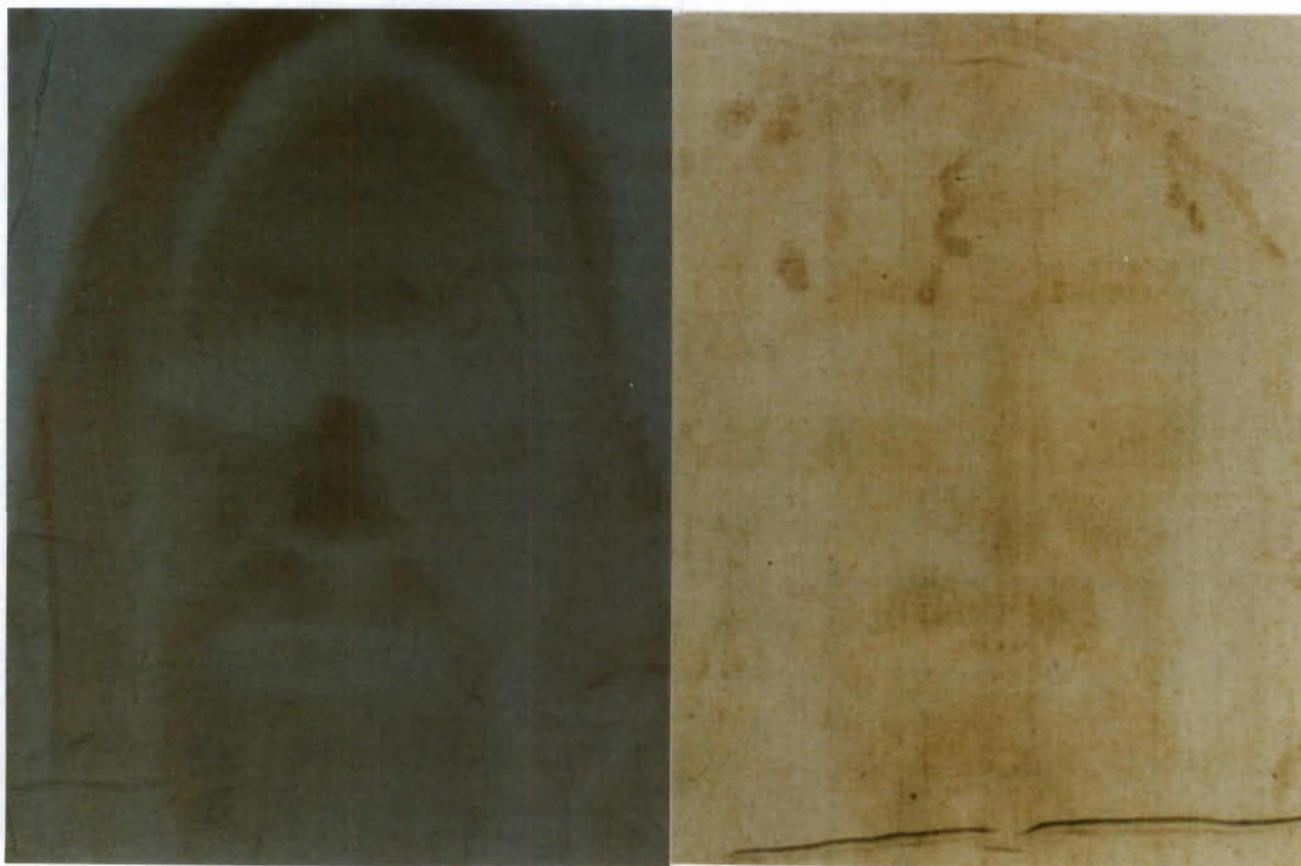


PLATE 51

A comparison of the negative image produced in phase seven  
(plate 49) with the negative image as found on the  
*Shroud of Turin* (plate 5).

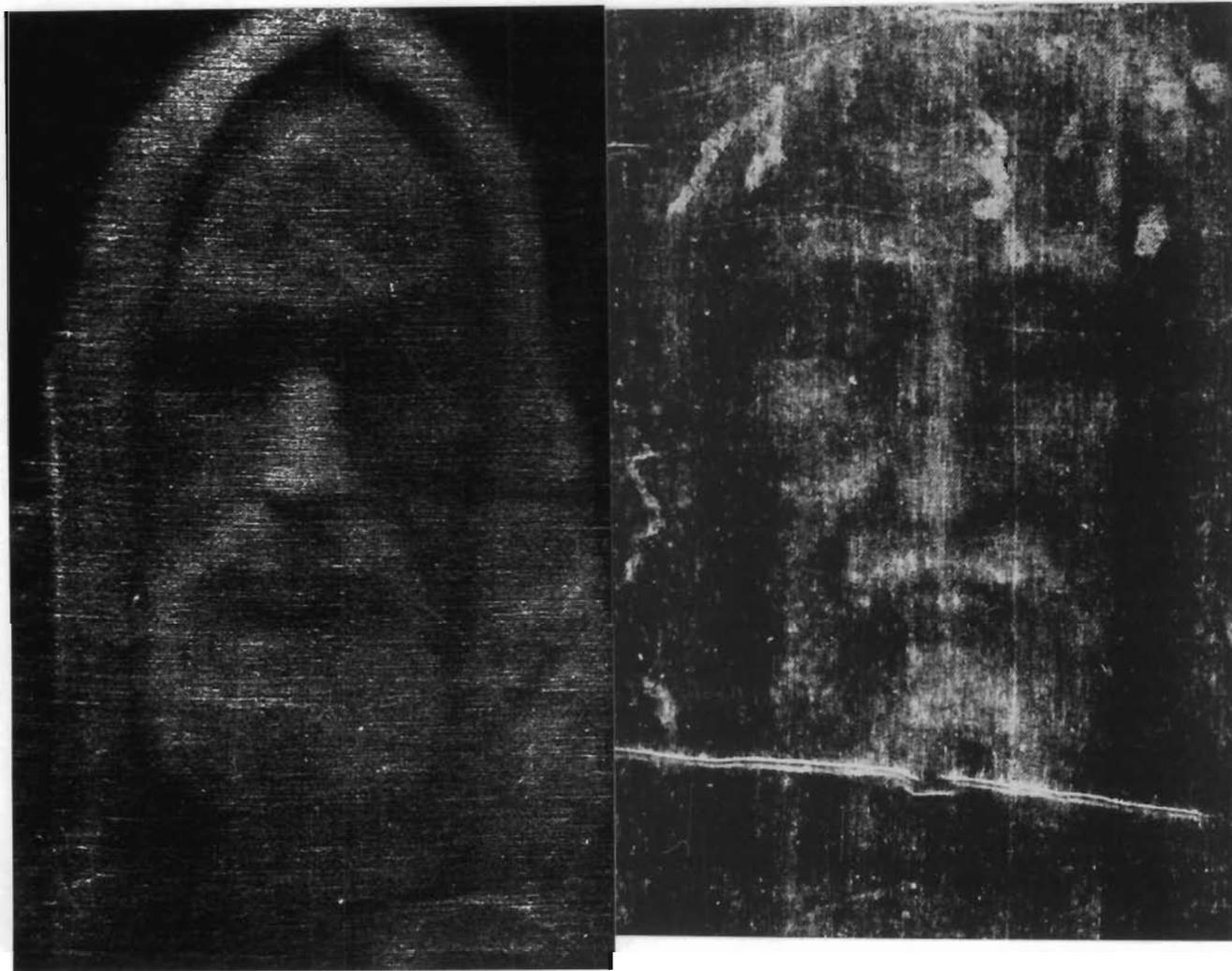


PLATE 52

A comparison of the positive image produced in phase seven  
(plate 50) with the positive image as found on the  
*Shroud of Turin* (plate 9).

## CHAPTER EIGHT

### CONCLUSION

#### 8.1 GENERAL OBSERVATIONS

It has been the main contention of this thesis that if one approaches the *Shroud of Turin* from a phenomenological perspective it will be possible to ratiocinate the process by which it came into being.

In other words, regardless of its original context and irrespective of the specific period in human history that it comes from, if the *Shroud* was made by human-beings, then it will be possible to reconstruct its mode of production. Similarly, even if part or all of this process were due to natural causes (*ie* made according to the laws of nature and without direct human involvement) it will still be possible to deduce the cause of the *Shroud of Turin's* manufacture /creation.

#### 8.2 THE EVIDENCE IN SUPPORT OF THE PHOTOGRAPHIC HYPOTHESIS

In terms of the delimitations of this particular piece of research it would be fair to say that a number of positive conclusions may be made concerning the plausability of someone having had the practical knowledge and equipment necessary to produce a photographic

negative image before 1357 AD, viz:

From the documented evidence that has been reviewed thus far, the following factors are of particular importance:

- \* the *Shroud* has been carbon dated by the radiocarbon laboratories of Oxford, Tucson and Zurich to the precise period in time (*ie* 1260-1357 AD) when there was a particularly great interest in the subject of optics throughout both the Christian and Moslem world, viz: 1250-1350 AD. This factor (in the light of supporting evidence) cannot be considered a coincidence.
- \* the arabic natural philosopher, al-Haytham was perfectly aware (both theoretically and practically) of the principles of the *camera obscura*, the nature and cause of pinhole images and the action of light well before 1039 AD (see 6.1.2.1). Indeed it would seem that most of the knowledge relating to optics which was available in the Christian west for the three centuries after this date was heavily dependant on moslem scholarship. In addition many of the theoretical insights into the subject of optics (largely attributable to al-Haytham) had often been compromised by certain western natural philosophers, notably Bacon. (See 6.1.2.2.)
- \* both the writer Geber and the natural philosopher/chemist Albertus Magnus knew (practically) how to manufacture what we now term silver nitrate (in solution) before

1280 *AD*. In addition Albertus Magnus was aware of the ‘staining’ effect that this substance had once exposed to the environment. However, there is no real evidence that Geber or Albertus Magnus understood what caused silver nitrate solution to discolour. (See 6.2.2.1.)

- \* both natural and synthetic quartz are extremely brittle and hard materials and one would perhaps want to believe that a medieval artisan would not have had the proficiency to produce such technologically advanced pieces of apparatus as rock-crystal, bi-convex lenses. However, the evidence clearly shows that a bi-convex lens had been produced in glass by at least 1200 *BC*. In addition, it is known that magnifying glasses were produced in both glass and optical quality rock-crystal (quartz) well before the second century *AD*. (See 6.3.1.) One is also reminded here, that the 10th and 11th century Mohammedans (of Fatimid Egypt), managed to produce hollow, pear-shaped, cut rock-crystal ewers (Huyghe, 1974:133). One of these lapidary masterpieces (from Cairo) measures a full 18cm in height, is not only hollowed and decorated in relief but includes the inscribed name of the caliph al-Azis Billah (975-96 *AD*) (Meyers, 1987:285).
  
- \* quartz would have been an obvious material for a hypothetical lens-maker to choose, due to its natural optical qualities. It is certain that a 14th century ‘photographer’ would not have known about the UV content of light. However, there is no reason to doubt that he attributed certain ‘magical’ qualities to the quartz material itself. For

example, quartz is a symbol of purity and translucence of thought and may have been employed due to its symbolic reference to the Virgin and the tenets of the Immaculate Conception (Allen, 1994).

- \* there can be no question that the *Shroud of Turin* contains a wealth of information which could never have been discerned by a person living before 1898 (when Pia made the first positive images of this relic). In other words, it is inconceivable that an artist (living in the late thirteenth or early fourteenth centuries) would have gone to such impossible lengths (*ie* torturing and crucifying a man and then painting/dying/staining/printing the totality of this visual information in the negative according to the principles of modern photographic theory). Coupled to this is the fact that the visual information contained in the image largely contradicts both Holy Scripture and Roman Catholic tradition. In this regard the ill advised comment by Professor Edward Hall that ‘There was a multi-million pound business in making forgeries during the fourteenth century. Someone just got a bit of linen, faked it up and flogged it’ (Wilson, 1991:12) is totally inadequate as an explanation.
  
- \* from the documented evidence of the early pioneers of modern photography (*cf* Newhall, 1980:13-35), it transpires that in *all* cases, silver nitrate was the natural choice for the first experiments involving light-sensitive chemicals. In addition, the first recorded attempts by all of these pioneers to ‘capture’ the images of nature were in the negative.

- \* it is possible to produce and stabilize (fix) a negative image comparable to the image on the *Shroud of Turin* employing only four substances/chemicals all of which (collectively) were known to have been available well before 1280 AD, viz: quartz, linen, silver nitrate, and ammonia (urine). In addition a person can produce this image without having knowledge of modern chemistry or physics.

### 8.3 CONCLUSIONS

After considering all the documented evidence relating to the phenomenon of the *Shroud of Turin* and having successfully duplicated the characteristics of the image with technology known to have existed (at the very least) by 1280 AD, there can be no doubt that the image that occurs on this relic was produced by means of a photographically related technique - one which would have been very similar to the hypothetical account given in Chapter Five and of which more will be said later. This particular photographic process (although similar to modern photography) is not able to make instant images of a particular moment in time. Rather, it is a very primitive process which records (in the negative only) the sunlight (particularly UV radiation) which has been reflected from a subject over a period of many days. For this reason it would be suggested that this process be termed solargraphy rather than photography in order that a distinction could be made.

It is also quite certain that even the most skilled realist painter of our own time (armed

with the knowledge of the principles of photographic science and technology) could not manually duplicate (with pigment or dye) the image as it appears on the *Shroud*. This fact alone should convince anyone that the *Shroud* is not 'simply' a painted/dyed/stained/printed product. There is no other alternative but to accept the fact that someone (before the age of modern photography) used some primitive photographic related technique to produce this image.

The following is a categorization (given in chronological order), of the methods and techniques which would have been needed to produce the image as it appears on the *Shroud of Turin*, viz:

- \* as the image was made in the northern hemisphere, during the summer season, the *camera obscura*'s aperture would have faced northwards. The lens employed was made of ground rock-crystal (quartz). The lens would have been bi-convex (converging lens) in form and could not have been much smaller than 80 mm in diameter and 7 mm across its axis. It would have had a focal depth of between 2.2 to 4 meters.
  
- \* inside this fairly large *camera obscura*, the linen cloth (originally measuring over four meters in length) was affixed to a vertical screen (two meters high) in such a manner that two meters of its length were rolled up on the floor and two meters were attached to the screen (figure 14).

#### CONCLUSION

- \* the two meter length of cloth which was attached to the screen was painted with a very dilute silver nitrate solution.
  
- \* the subject (corpse) was positioned outside the *camera obscura* (opposite the aperture). The subject was faced towards the aperture and it was illuminated by the sun for at least three days (*eg* the left side of the body received the morning sun and the right side of the body received the afternoon sun).
  
- \* After this period of exposure a faint purple-brown negative image formed on the uppermost fibrils of the linen sheet. The aperture was closed off and (by the light of candles or torches) the sheet was removed from the screen. The sheet was turned around so that the unexposed section was attached to the screen and the exposed portion of the sheet (which now contained the frontal image) was rolled up. The unexposed section was now painted with a dilute silver nitrate solution.
  
- \* the subject (corpse) positioned outside the *camera obscura* was now faced away from the aperture and it (in turn) was illuminated by the sun for at least three consecutive days (*eg* the left side of the body received the morning sun and the right side of the body received the afternoon sun).
  
- \* After this second period of exposure a faint purple-brown negative image formed on the uppermost fibrils of the linen sheet. The aperture was closed off and (by the light

of candles or torches) the sheet was removed once more from the screen. The sheet now contained the dorsal and frontal images of the corpse. The linen cloth was saturated with ammonia and left for a few minutes after which it was repeatedly washed in water. The image was largely indiscernible at this stage, but as it dried became more straw-coloured in appearance. (See figure 15.)

- \* After drying the cloth in the sun, scourge marks (consisting predominantly of slightly diluted blood) were applied by hand to the image. These were applied by the use of at least two stamps (which ensured a regular tripartite pattern).
  
- \* After the application of scourge marks, undiluted blood (with or without an iron based binder) was literally trickled along the arms and across the small of the back. A paint brush was more than likely used for the blood flows in the hair, the inverted '3' blood clot, the wound in the side, and the *stigmata*.
  
- \* The *Shroud* may have been given an additional cursory soak after this and then left to dry. Regardless, after centuries of handling, the blood has abraded off the cloth and all that remains today are a few particles which are trapped in the

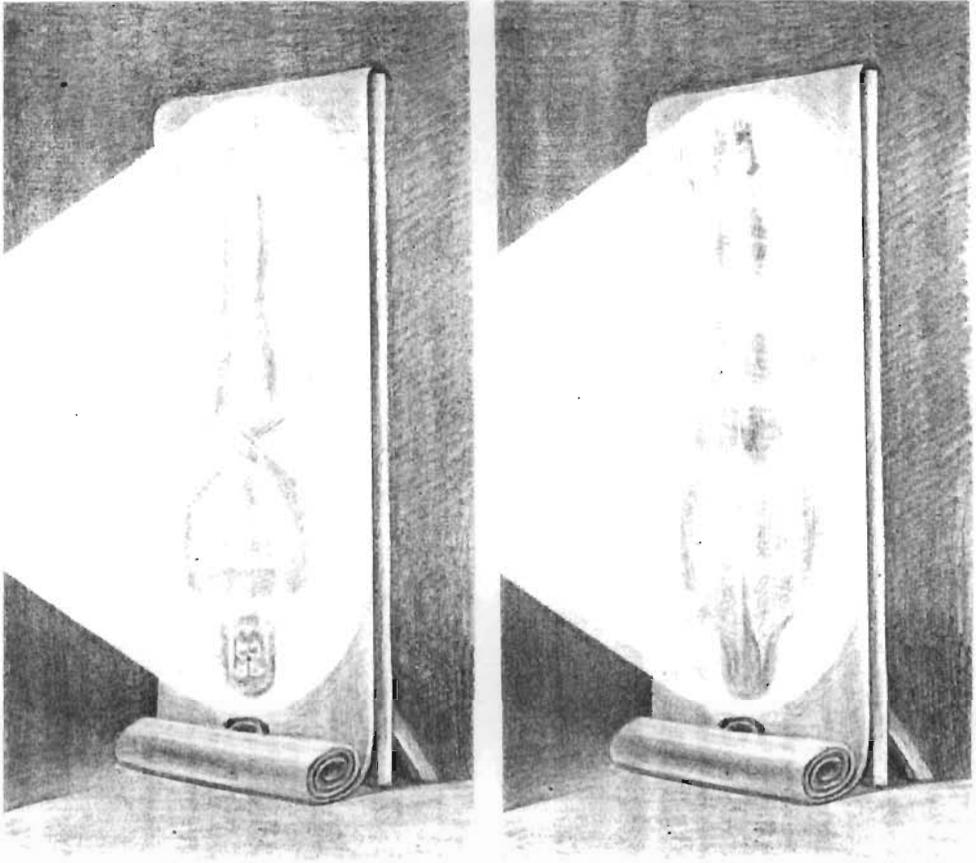


FIGURE 14

FIGURE 15

Diagram showing how the *Shroud* was affixed to the screen during the exposure for the frontal and the dorsal image.

fibrils. The *Shroud* may have originally been trimmed around its border to disguise those areas at the extremities of the cloth that did not come into contact with silver nitrate. Indeed, impregnated areas that do not actually receive an image are still slightly darker in tone than pristine sections. This may be readily observed in plate 49.

### 8.3.1 Speculations

Obviously, apart from the *Shroud*, there exists no other document that can single-handedly support the photographic hypothesis. In addition, there still exist a number of unanswered questions concerning the *Shroud's* origins and the possible reasons why it was produced the way it was.

In this regard one can only speculate, but there do exist a number of pieces of evidence which if viewed together seem to offer at the very least some circumstantial evidence for the *Shroud's* production.

The creators of this relic employed photography rather than more traditional approaches for at least four reasons, *viz*:

- \* it was faster:
  
- \* it was more economical:

#### CONCLUSION

- \* it did not necessarily require the services of an artist;
- \* it automatically guaranteed a naturalistic (humanistic) image of the highest order;

But, although it is possible that the image as it appeared in the late thirteenth and early fourteenth centuries would have appealed to both Roman Catholic and Greek Orthodox Christians alike, it also contains details which contradict orthodox mores (*ie* wounds in the place of Destot, nakedness *etc.*). These unorthodox details are present because the body of a crucified man was actually used.

In addition to and as result of this factor, the *Shroud* is unique in the history of art, in that it has characteristics which make it difficult to categorise as definitively Byzantine or Gothic.

There can be no doubt that (originally) it was intended by its creators (for whatever purpose/s) to be viewed as the physical imprint of Christ - an imprint made with His Sweat and Blood. This would have been viewed by the faithful as *the* actual Blood which was shed at Calvary for the sake of all humanity.

The following excerpt from a prayer in preparation for Holy Mass sums up the feelings of a believer in this spiritual context:

Hail, noble and precious Blood, flowing from the wounds of my crucified Lord Jesus Christ, and washing away the sins of the whole world. Be mindful, O Lord, of thy creature whom thou hast redeemed with thy Blood. I am grieved because I have sinned, I desire to make amends for what I have done. Take away from me therefore, O most merciful Father, all my iniquities and sins; that, being cleansed both in body and soul, I may worthily taste of the Holy of holies. Grant that this holy feeding on thy Body and Blood, of which, though unworthy, I purpose to partake, may obtain the remission of my sins, the perfect cleansing of my offences... (Cabrol, 1931:16).

It has already been noted (see 3.3) that the Eucharist was enjoying a privileged position in Christian worship from about the twelfth century onwards and that the transubstantiated bread and wine were taking precedence over all other relics. However, the *Shroud* would surely have maintained its hegemony as the most important relic for any medieval Christian (Latin or Greek) (had it been known of before 1357 AD). Indeed, for Greek and Latin alike, to be in the presence of the *Shroud* would have been considered the next best thing to being in the physical presence of Christ Himself.

Thus it would seem that (apart from the overtly unorthodox and naturalistic details) the *Shroud* would both satisfy the predominantly materialistic western world's growing preoccupation with relics and the need for tangible (physical) remains of sacred personages as well as appealing to the Greek Orthodox Christians who in turn would have been able to view the image on the *Shroud* in much the same way as they would an icon. Indeed, without the benefit of having seen the image reversed (*ie* as a positive image), the *Shroud* appears flat and two-dimensional, the eyes look larger than life and the feet point downwards, defying gravity as indeed is peculiar to much Byzantine symbolic

depictions of divine and sacred persons.

Thus, the *Shroud* is both Holy image and Holy relic and seems to bear testimony to a period of communication or dialogue between West and East, Latin and Greek.

Some researchers such as Harris, have jumped to the conclusion that the *Shroud* was simply 'a fake conceived by popes to impress the laity and the clergy' (Smullen, 1988:112). There are a number of very good reasons to refute this allegation, viz:

- \* the linen fabric of the *Shroud* is intermingled with a specific species of cotton only found in the Middle East (see 4.1.1). This means that the original fabric employed for this relic could only have been obtained from the following states that existed c 1200-1357 AD viz: the Middle Byzantine Empire (1025-1204 AD), the Byzantine (Latin) Empire (1204-61 AD), the Nicaean Empire (1204-82 AD), the Late Byzantine Empire (1261-1453 AD), the Sultanate of the Rum Seljuks (c1100-1360 AD), the Ottoman Empire (1301-1683 AD), the Kingdom of Cyprus (1192-1489 AD), the Ayyubid Empire (1171-1250 AD), the Earldom of Tripolis (1102-1289 AD), the Kingdom of Armenia Minor (1198-1375 AD), the Principality of Antioch (1098-1268 AD), and the Mameluk Empire (1250-1517 AD). It is highly unlikely that someone in the west would import a piece of linen from the middle east in order to make a one-off image (regardless of the technique employed).

- \* the image depicts a naked Christ whose wounds do not conform (in all cases) to accepted Roman Catholic tradition. If the *Shroud* was produced in the west and dates from around 1250-1350 AD, it (and its creators) would have had been in grave danger of falling foul of the Inquisition.
- \* representatives of the Roman Catholic church were very quick to try and stop the *Shroud's* veneration as the actual burial cloth of Christ when it was first put on exhibition by Jeanne de Vergy in 1357 AD. (See Stevenson, 1981:129-34). Indeed it was not until 1471 AD that Pope Sixtus IV accepted the *Shroud* as an important relic of the passion of Christ (see 2.2.2). The Church is hardly likely to have tried to prohibit the veneration of a relic that they had gone to so much trouble to produce in the first place.

Having reviewed the facts concerning this relic there are strong reasons to believe that the *Shroud* was originally made (not for the *plebs Christi* but) for a particular client (or perhaps a closed community), one who was particularly adept (for medieval times) at distinguishing between obvious fakes and genuine relics of the Christian faith. This client would have been an orthodox Roman Catholic and would have been particularly well versed in the symbolism of the Passion of Jesus Christ. In this regard, the *Shroud* would have been seen as proof that Christ (as God incarnate) had died a physical death, and that he rose again (in accordance with accepted orthodox beliefs and in opposition to the teachings of the Cathars and other heretical groups in existence at this time). It is assumed

that this client would have had to have been in a particularly exalted position to have even dared to risk an accusation of heresy from the Holy See and its representatives (in particular the Dominican order and the Inquisition).

The degree of realism found in the *Shroud's* image points to the fact that the creators of this relic went to a great deal of trouble to guarantee that their client would be satisfied with its claim to authenticity. The crucified man whose image now appears in the *Shroud* was specifically chosen for his appearance (*ie* age group, stature, racial features *etc*). In this regard, the detail of the man's pigtail is particularly important as this is a good indication that the man was a Jew and even possibly a rabbi. If one considers the wholesale slaughter of the Jews in many of the cities of the Rhine and Danube which occurred regularly after the preaching of a Crusade (Trevor-Roper, 1966:106-8; Johnson, 1976:245), the many pogroms directed against Jews and such events as 'striking the Jew' which were common place in the thirteenth and fourteenth centuries, then the death of a single Jew by Frank or Greek would have been considered a small matter. Of course this still does not rule out the possibility that the unfortunate man who was employed for this image was a Moslem or even an acquiescent Christian ascetic - one who willingly played the role of Christ for the purposes of producing this relic.

The account given in Chapter Five and in this section deals with a plausible account of the basic methods employed in order to produce the image as it now appears on the *Shroud*. However, it should be pointed out that it will never be possible to recreate the exact details

of what occurred when the *Shroud* was originally produced (c 1280-90?), and a number of issues (which unfortunately must remain forever speculative) should be noted.

Firstly, it is possible that a life-cast was made from a human subject (exactly as was used by this author for the purposes of experimentation), and that this model and not an actual corpse was used as the subject. If this was, in fact done, the period of exposure could have been extended considerably (without fear of decomposition to the subject), and a pinhole could have served equally well as a quartz lens. However, from the evidence of the *Shroud's* image itself (including such details as the swelling of the face and the dislocation of the shoulder), and the fact that without a quartz lens, it may take many months to produce a visually coherent record on a silver nitrate impregnated linen sheet, it seems far more likely that both a corpse and a lens were in fact employed.

Secondly, if a corpse was suspended by a rope or beam it would not appear exactly as is (perhaps more idealistically) depicted in plate 35. Indeed, to ensure that the corpse did not move about for the minimum period of six days exposure to the sun, the hands and feet would have had to have been bound. In this regard, it is quite possible that the final painting (with blood) of the *stigmata* on the image of the wrists on the actual *Shroud* served a double purpose, viz: to depict the nail wounds; and to disguise the image of the binding rope. This notion is supported by the strange blood flows which run across the small of the man's back. Perhaps these were placed there in order to disguise the recorded image of a rope or similar binding which was originally evident.

The corpse itself could have been suspended in many ways. One possibility, is that a metal spike or bolt was driven into the man's skull. This was attached to either a rope or a thin beam (made of wood or metal), and which was in turn attached to a gibbet or frame some distance above the level of the head (see plate 35). This rope or supporting beam would have been painted matt black in order to eliminate its reflectivity.

Alternatively, the corpse may have been suspended by a rope that was attached to a metal bolt or hook, which had first been driven into the back of the torso. This rope would have run up the spine and would have been supported by a gibbet (as in the previous example). In this scenario it would have been necessary for a binding to have been tied around both the neck and the supporting rope. This action would have ensured that the head of the victim did not roll forward and that it maintained an upright posture. In this case the 'pigtail' (visible on the dorsal image) would in fact be the image of this supporting rope (see plate 3 and 7).

Again, it is equally possible that the corpse was attached (vertically) to a board (painted matt-black), by means of either metal nails or pins and/or ropes. In all of the above mentioned scenarios it is quite possible that the corpse was painted matt white. This action would have increased the reflectivity of the surface which not only would have sped up the exposure time but would also have helped to inhibit the decomposition of the corpse.

Finally, a note should be made concerning the two 'missing' sections (of image) which run

vertically on either side of the man's head and which have (up until now) been interpreted as a chin-binding (designed to close the jaw at death) (see plates 5, 8 and 9). In fact, these may be evidence that the silver nitrate solution was painted on during the actual period of exposure. In other words, the cloth (in an unprepared state) was suspended on a screen, the image was focussed onto the cloth and then the silver nitrate solution was applied by a brush in vertical strokes. This solution takes some time to dry, but still darkens on exposure to the sun. As the image developed (over the course of three days) those areas on either side of the head (possibly by virtue of the fact that they were in relative shadow and had reflected less radiant energy) were not completely dry at the time the *Shroud* was submerged in ammonia. These areas simply did not receive the same concentrations of silver nitrate solution and the little that did adhere to the linen was washed away in the ammonia bath.

#### 8.4 THE NEED FOR FURTHER RESEARCH:

It would be imperative that suitably qualified persons conduct a series of non-destructive tests which dealt specifically with the *Shroud's* photographic (solargraphic) qualities. In this context it should be possible to verify that silver nitrate was the specific light-sensitive chemical employed and further it would be possible to calculate the characteristics of the lens or lenses used for this exposure based on the minor distortion that seems to exist in the image (*ie* the head and feet are smaller in scale than the centre of the body).

The *Shroud of Turin*, far from deserving our condemnation as a 'fake' should be viewed as an outstanding example of medieval ingenuity. Until now the *Shroud of Turin* has been venerated as one of Christendom's greatest relics, a miraculous production 'made without human hand'. Time will show that in fact it is both an important embodiment of the religious and socio-political environment of the thirteenth century as well as being amongst the greatest technological marvels ever produced for its time. Indeed the *Shroud of Lirey-Chambéry-Turin* heralds the dawn of the scientific age and may still claim to be 'made without human hand'.

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## ABSTRACT

The main objective of the inquiry is to deduce the methods and techniques that were employed in the manufacture of the historically unique *Shroud of Turin*. By taking a more or less phenomenologically based stance, it is argued that this image could only have been produced by employing a photographically related technique. To this end, an examination is made of both the nature of the image, as well as all relevant documented evidence which supports the above stated hypothesis. In addition, practical experiments are conducted which employ the kinds of technology and apparatus known to have existed *c* 1250-1357 *AD*. The results of this investigation strongly support the notion that persons living *c* 1250-1357 *AD* did in fact have the necessary technology to manufacture what could be termed a negative solargraphic image of a human subject.

VIABLE IMAGE FORMATION THEORIES

IMAGE CHARACTERISTICS	IMAGE FORMATION THEORIES				
	PAINT, DYE OR PIGMENT	DIRECT CONTACT	VAPOUR	DIRECT CONTACT AND VAPOUR	HEAT OR LIGHT
SUPERFICIALITY:	NO	NO	NO	NO	YES
DETAILED:	NO	NO	NO	POSSIBLE	POSSIBLE
THERMALLY STABLE:	NO	POSSIBLE	NO	POSSIBLE	YES
NO PIGMENT:	NO	POSSIBLE	YES	YES	YES
THREE-DIMENSIONAL:	NO	NO	NO	NO	YES
NEGATIVE:	YES	POSSIBLE	POSSIBLE	POSSIBLE	YES
DIRECTIONLESS:	NO	POSSIBLE	YES	YES	YES
CHEMICALLY STABLE:	POSSIBLE	POSSIBLE	NO	NO	YES
WATER STABLE:	POSSIBLE	POSSIBLE	NO	NO	YES

Table showing the probity of the various image formation theories as compared to the specific characteristics of the *Shroud's* image.

(after Stevenson, 1981.)