



**A REVIEW OF FIVE INTERNATIONAL FORENSIC REPORTS: FINGERPRINT
EVIDENCE LESSONS FOR SOUTH AFRICAN LAWYERS**

A Dissertation Submitted in Fulfillment of the Requirements for the Degree of

MASTER OF LAWS

By

MERCY CHIWARA (201205884)

at the **Nelson R Mandela School of Law, University of Fort Hare**

Supervisor: Professor Lirieka Meintjes-van der Walt

DECLARATION

I declare that, except for the references as well as any other assistance duly indicated and acknowledged, this dissertation, “A Review of Five International Forensic Reports: Fingerprint Evidence Lessons for South African Lawyers” is my own work that has never been previously submitted in part or in its entirety at any institution for degree purposes or otherwise.

Signed at East London on

.....

Mercy Chiwara

ACKNOWLEDGEMENTS

I would like to thank God Almighty for His love, mercies, provision, protection and grace upon my life during the period of my study. My sincere gratitude also goes to my pastors (Pastor Patrick and Pastor Mrs. Thembi Agbomere) for supporting me spiritually.

I am especially indebted to my Supervisor Professor Lirieka Meintjes–van der Walt who regardless of her busy and tight schedule provided me with extensive guidance throughout this research. Her patience, motivation, enthusiasm, and immense knowledge helped me in all the time of research and writing of this dissertation. Over and above she has taught me more than I could ever give her credit for here. She has shown me, by her example, what a good academic researcher and person should be. I could not have imagined having a better supervisor and mentor for my Masters study.

This work would not have been possible without the financial support of the Zimbabwean Presidential Scholarship and the Govan Mbeki Research and Development Centre, I am so grateful.

Nobody has been more important to me in the pursuit of this research than the members of my family. I would like to thank my mother, Lydia Mandove, whose love and guidance is with me in whatever I pursue. She is my ultimate role model. Most importantly, I wish to thank my loving and supportive friends, Charisma M Ncube, Advocate Zizipho Ncontsa, Emily Murahwa, Talkmore Nyakudya Chidede, Tinashe Wazvaremhaka, Beatrice Pedzisa, Shelton Motamakore, Vongai Chimeri, Pumeza Zinto, Mrs B. Opperman, Mr Nasholan Chetty, Rangarirai Musingafi and Edwin Rukovo who provide unending inspiration.

DEDICATION

I dedicate this work to the Lord Almighty and to Lydia Mandove (mother).

ABBREVIATIONS AND ACRONYMS

(B)	Bophuthatswana Supreme Court
(C)	Cape Provincial Division
(D)	Durban & Coast Local Division
(E)	Eastern Cape Division
(N)	Natal Provincial Division
(NC)	Northern Cape Division
(O)	Provincial Division
(SR)	Southern Rhodesia
(SWA)	South – West Africa
(T)	Transvaal Provincial Division
(W)	Witwatersrand Local Division
10 th Cir	Tenth Circuit
3d Cir	Third Circuit
4 th Cir	Fourth Circuit
AAAS	American Association for the Advancement of Science
AC	Appeal Court
ACE	Analysis, Comparison and Evaluation
ACE-V	Analysis, Comparison, Evaluation and Verification
AFIS	Automated Fingerprint Identification System
ALJ	American Law Journal

ALR	Arizona Law Review
Am Crim L Rev	American Criminal Law Review
CC	Constitutional Court
CPA	Criminal Procedure Act 51 of 1977
CPEA	Civil Proceedings Evidence Act 25 of 1965
CRC	Criminal Record Centre
Crim L Rev	Criminal Law Review
D Mass	District of Massachusetts
D Md	District of Maryland
D C Cir	District Circuit
DNA	Deoxyribonucleic Acid
DNM	District of New Mexico
E D Va	Eastern District of Virginia
ECM	Transkei High Court - Eastern Cape High Court, Mthatha
ED Pa	Eastern District of Pennsylvania
FBI	Federal Bureau of Investigation
FIPS	Fingerprint Identification Profile System.
Fordham Int'l Law Journal	Fordham International Law Journal
Harv L Rev	Harvard Law review
IAFIS	Integrated Automated Fingerprint Identification System
J Af L	Journal of African Law
J Crim L & Criminology	The Journal of Criminal Law and Criminology
J Int'l Crim Just	Journal of International Criminal Justice

J L & Soc’y	Journal of Law and Society
LAPD	Los Angeles Police Department
Law & Soc’y Rev	Law and Society Review
LCRC	Local Criminal Record Centre
LFP	Latent Fingerprint
NAE	National Academy of Engineering
NAS	National Academy of Sciences
ND Ind	Northern District of Indiana
NIFS	National Institute of Forensic Science
NIST	National Institute of Standards and Technology
NRC	National Research Council
NSY	New Scotland Yard
NYCSC	New York Civil Service Commission
NYSPS	New York State Penitentiary System
OIG	Office of the Inspector General
PCAST	President’s Council of Advisors on Science and Technology
SACB	South African Criminal Bureau
SAJCJ	South African Journal of Criminal Justice
SALJ	South African Law Journal
SAPS	South African Police Services
SCA	Supreme Court of Appeal
SCRO	Scottish Criminal Records Office
SD Ind	Southern District of Indiana

SFI	Scottish Fingerprint Inquiry
SNP	Spanish National police
SOP	Standard Operating Procedures
SPSA	Scottish Police Services Authority
SWGFAST	Scientific, Working Group on Friction Ridge Analysis, Study and Technology
US	United States Supreme Court
USA	United States of America
WCC	Cape Provincial Division - Western Cape High Court, Cape Town

Table of Contents

DECLARATION	ii
ACKNOWLEDGEMENTS	iii
DEDICATION	iv
ABBREVIATIONS AND ACRONYMS	v
ABSTRACT.....	xv
CHAPTER ONE	1
INTRODUCTION AND OVERVIEW OF THE STUDY	1
1 1 INTRODUCTION	1
1 1 1 Background to the study	1
1 2 THE RATIONALE FOR THIS INVESTIGATION.....	3
1 2 1 Definition of fingerprints and the types of fingerprints	3
1 2 2 The nature of the opinion rule in South Africa and other jurisdictions.....	4
1 2 3 The importance of reliable expert opinion evidence for judicial decision making	8
1 2 4 Specific issues pertaining to expert opinion evidence in general and fingerprint evidence in particular	11
1 3 THE RESEARCH PROBLEM ADDRESSED IN THIS STUDY	14
1 4 THE AIMS AND OBJECTIVES OF THIS RESEARCH PROJECT	15
1 5 THE PURPOSE AND SIGNIFICANCE OF THIS RESEARCH PROJECT	15
1 6 RESEARCH QUESTIONS.....	15
1 7 DELIMITATION.....	15
1 8 NEXUS STUDY	16
1 9 LITERATURE REVIEW	16
1 10 THE RESEARCH METHODOLOGY	22
1 11 ETHICAL IMPLICATIONS OF THIS STUDY	23

1 12 CHAPTER OUTLINE	23
1 13 REFERENCING STYLE.....	24
THE HISTORY AND UNDERLYING PRINCIPLES OF FINGERPRINT EVIDENCE	24
2 1 INTRODUCTION	24
2 2 THE HISTORICAL EVOLUTION OF FINGERPRINT EVIDENCE	25
2 3 THE FORMATION, NATURE, TYPES AND METHODS OF COLLECTION OF FINGERPRINTS	30
2 3 1 Formation and nature of fingerprints	30
2 3 2 Types of fingerprints and their methods of collection	33
2 3 3 Classification of Fingerprints.....	35
2 4 FINGERPRINT COMPARISON METHODOLOGY	42
2 4 1 Analysis.....	43
2 4 2 Comparison	44
2 4 3 Evaluation	44
2 4 4 Verification	46
2 5 CONCLUSION.....	46
CHAPTER 3	48
ANALYSIS OF THE FIVE INTERNATIONAL REPORTS	48
3 1 INTRODUCTION	48
3 2 OFFICE OF THE INSPECTOR GENERAL, UNITED STATES DEPARTMENT OF JUSTICE: A REVIEW OF THE FBI'S HANDLING OF THE BRANDON MAYFIELD CASE REPORT (THE MAYFIELD REPORT)	50
3 2 1 The factual background of the Brandon Mayfield case	50
3 2 2 The purpose of the report	51
3 2 3 The causes of the misidentification as explored in the report	52
3 2 4 A summary of the recommendations	56

3 3 THE NAS REPORT	57
3 3 1 The purpose of the NAS Report.....	58
3 3 2 Challenges to the forensic science field in general according to the NAS Report.....	59
3 3 3 Criticisms against fingerprints evidence in particular.....	59
3 3 4 A summary of the recommendations	66
3 3 5 The effect of the NAS Report on case law.....	67
3 4 THE SCOTTISH FINGERPRINT INQUIRY REPORT.....	69
3 4 1 The factual background of <i>HM Advocate v Mckie</i> (1999)	70
3 4 2 The purpose of the report	71
3 4 3 Causes of the misidentification of latent fingerprints Y7 and Q12.....	71
3 4 5 Limitations of fingerprint evidence in general.....	73
3 4 6 A summary of the recommendations	75
3 5 THE NIST REPORT.....	79
3 5 1 The purpose of the report	79
3 5 2 Challenges against fingerprint evidence as explored in the report.....	80
3 5 3 A summary of the analysis of human factors and errors as given in the report.....	82
3 5 4 Recommendations provided for in the report.....	83
3 6 THE PRESIDENT’S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY (PCAST) REPORT	87
3 6 1 The purpose of the report	87
3 6 2 Challenges raised against fingerprint evidence.....	88
3 6 3 A summary of the recommendations	89
3 7 CONCLUSION.....	90
3 7 1 The accuracy and reliability of the uniqueness and permanence of friction ridges	91
3 7 2 Bias	91
3 7 3 Error rate	91

3 7 4 Training, education, certification and accreditation.....	92
3 7 5 Reporting results and testifying in courts.....	92
3 7 6 Documentation.....	92
3 7 7 The subjective nature of fingerprint evidence.....	93
3 7 8 Codes of ethics.....	93
3 7 9 IAFIS.....	93
CHAPTER 4	94
THE RELIABILITY OF FINGERPRINT EVIDENCE.....	94
4 1 INTRODUCTION	94
4 2 THE DIFFERENCE BETWEEN THE ADMISSIBILITY AND THE WEIGHT OF EXPERT EVIDENCE.....	95
4 3 FACTORS THAT COULD RELIABLY DETERMINE THE WEIGHT OF FINGERPRINT EVIDENCE IN SOUTH AFRICAN COURTS.....	97
4 3 1 The Daubert criteria	97
4 3 2 Testability	98
4 3 3 Peer review and publication.....	100
4 3 4 Objective standards.....	102
4 3 5 Known or potential error rate.....	102
4 3 6 General acceptance	106
4 4 OTHER FACTORS THAT CAN IMPACT ON THE RELIABILITY OF FINGERPRINT EVIDENCE IN SOUTH AFRICA	107
4 4 1 Training and Education.....	107
4 4 2The independence of a fingerprint laboratory.....	108
4 4 3 Points of similarity and the existence of dissimilarity	111
4 4 5 Verification	113
4 4 6 Scrutiny of the evidence.....	115

4 4 7 A Lack of cross-examination by the defence.....	116
4 5 CROSS-EXAMINATION QUESTIONS TO TEST FINGERPRINT EVIDENCE	122
4 5 1 Relevance.....	122
4 5 2 Validation.....	123
4 5 3 Limitations and errors	126
4 5 4 Bias	137
4 5 5 Verification and peer review	139
4 5 6 Expressions of opinion and the presentation of evidence in reports and in court.....	141
4 5 7 Personal proficiency.....	144
4 5 8 Education, training, accreditation and certification	144
4 6 CONCLUSION.....	145
CHAPTER FIVE	148
CONCLUSIONS AND RECOMMENDATIONS	148
5 1 INTRODUCTION	148
5 2 RECAPITULATION	149
5 3 THE MAIN FINDINGS OF THIS INVESTIGATION.....	151
5 3 1 Uniqueness and permanence premises.....	152
5 3 2 Proficiency testing	152
5 3 3 Unknown or potential error rate.....	153
5 3 4 A Lack objective standards	154
5 3 5 The presentation of fingerprint evidence in courts and reports.....	154
5 3 6 Bias	155
5 3 7 Training, education and funding	156
5 3 8 IAFIS search	157
5 3 9 Codes of ethics.....	158
5 3 10 Admissibility and weight of fingerprint evidence in South African courts	158

5 4 RECOMMENDATIONS	159
5 4 1 Education	159
5 4 2 The establishment of an independent fingerprint institute	160
5 4 3 Presentation of fingerprint evidence in reports and courts.....	161
5 4 4 The need for blind verification by a second independent examiner	161
5 5 CONCLUDING REMARKS	162
BIBLIOGRAPHY	164
Books	164
Book Chapters.....	166
Journal Articles	167
Legislation:	175
South Africa.....	175
Case Law:.....	175
Canada	175
England and Wales	175
United States of America	175
Scotland	176
South Africa.....	177
Reports:	179
United States of America	179
Scotland	179
Internet sources and newspaper articles	179
Theses	187

ABSTRACT

For more than a century fingerprint evidence has been used as a tool for the forensic identification of offenders, and has generally been accepted without being tested, challenged or scrutinized because the courts were convinced that no prints look alike or are the same. Fingerprint evidence has been used and accepted on the basis that each person's friction ridges are unique, that the ridges are permanent and can be transferred to a surface. However, the transferability of the uniqueness raises issues that are very significant in relation to the reliability of fingerprint evidence because only a partial impression is typically transferred. Furthermore, the print can be distorted as a result of pressure and this inevitably affects the impression.

Nevertheless, in recent and authoritative Reports from the United States and Scotland, criticisms are being raised against fingerprint evidence. These challenges include the fact that to date there has not been a study to validate the reliability of fingerprint individualisation, the fact that there is no specific requirement with regard as to how much constant or uniform detail between latent print and known print suffices to reach a decision of identification and the fact that there are no objective standards coupled with the problem that there is a lack of scientific validity of the method used for comparisons. This study reviews the law relating to fingerprint evidence in the light of the reports produced by the Office of the Inspector General, United States Department of Justice, Reviewing the Mayfield Case (US) in 2006, the National Academy of Sciences (US) Report in 2009, the Fingerprint Inquiry Report by Lord Campbell in Scotland in 2011, the National Institute of Standards and Technology and National Institute of Justice (US) Report in 2012, and the President's Council of Advisors on Science and Technology Report (US) in 2016, so as to establish lessons for South African lawyers in as far as reliability, weight and admissibility of fingerprint evidence is concerned. Finally, this study concludes that South Africa's norm of accepting fingerprint evidence as unquestionable is problematic in law and in science and that there is a need for reform regarding the manner in which fingerprint evidence is evaluated by the courts.

CHAPTER ONE

INTRODUCTION AND OVERVIEW OF THE STUDY

1 1 INTRODUCTION

1 1 1 Background to the study

Crime is increasing in South Africa, and has become one of the major challenges that many countries face each and every day.¹ When a criminal incident is investigated, the first questions to be asked are who committed the crime, and where, why and when the crime was committed. The prosecution has to prove the facts regarding these questions so as to secure a conviction. In order for law enforcement agents to provide answers to these questions, they embark on a process of gathering information and are required to find means and ways in which perpetrators can be brought before court. The identification of an offender is necessary in every criminal trial and this helps in protecting innocent individuals from wrongful convictions.² The means and ways utilised to bring perpetrators before court, include the use of scientific methods or by bringing witnesses to testify before court or a combination of the two methods could be employed.

Methods that can be used, include forensic investigations³ to gather evidence, which include fingerprinting, which is a means of identification of a perpetrator. Proof that a crime has been committed entails satisfying certain elements of that specific crime. These include unlawfulness, wrongfulness, causation, fault, and conduct.⁴

¹ Crime is defined as an unlawful, blameworthy conduct punishable by the state. See Snyman *Criminal Law* 5ed (2008) 3. Also see Horswell *The Practice of Crime Scene Investigation* (2004) 3. Further, it was stated that “crime does not occur in a vacuum. It is essentially a social phenomenon. Circumstances affecting the wider South African society will thus naturally also have impact on the incidence of crime. Negative developments in the socio-economic sphere have an impact on the growing rate of criminal activities.”

² Lord Thomas of Cwmgiedd (Lord Chief Justice of England and Wales) “Expert Evidence: The Future of Forensic Science in Criminal Trials”; The 2014 Criminal Bar Association Lecture (14 October 2014) 2.

³ Krishnamoorthy *Fingerprint Recognition for Forensic Applications* (LLD Thesis Universidad Autonoma de Madrid May 2015) 31. He contends that forensic evidence constitutes all the means by which any alleged fact whose truth is investigated at a judicial trial is proved or disproved.

⁴ It must be proved beyond reasonable doubt that the accused committed some wrongful act and at the time he was aware of his actions and the consequences thereof. Wrongfulness requires conduct in the form of an act or omission which is voluntary and is wrongful/unlawful. Unlawfulness is the requirement which is excluded when what one does is justified. Causation is also required for consequence crimes. Fault is also a requirement that should be satisfied for the conduct to be a crime. Fault can either be intentional or negligence. See Snyman *Criminal Law* 5ed (2008) 71.

Fingerprint evidence was the first forensic method that caught the public's imagination and also provided a valuable tool for police and criminal investigators.⁵ The matching of images of fingerprints has been used for the forensic identification of perpetrators and fingerprint evidence has been accepted as a tool for the identification of a perpetrator or offender. Fingerprint evidence is based on three assumptions. They are the following: 1) the uniqueness of each person's friction ridges; 2) the permanence of those ridges throughout the person's entire life and 3) the transferability of that uniqueness to a surface.⁶ However, the transferability of the uniqueness raises issues that are very significant in relation to the reliability of fingerprint evidence because only a partial impression is typically transferred. Furthermore, the print can be distorted as a result of pressure and this inevitably affects the impression.

Fingerprint evidence has been used for more than 100 years and has generally been accepted without being tested, challenged or scrutinized because the courts were convinced that no prints look alike or are the same.⁷ However, recently fingerprint evidence has seen an increasing number of challenges and concerns raised by academic writers, scientists, jurists, and analysts etc. as to whether it is reliable enough to be put to court.⁸ These challenges include the fact that to date there has not been a study to validate the reliability of fingerprint individualisation.⁹ Furthermore there is no specific requirement with regard as to how much constant or uniform detail between latent print and known print suffice to reach a decision of identification.¹⁰ Other challenges with regard

⁵ Gabel "Realizing Reliability in Forensic Science from the Ground Up" 2014 *Journal of Criminal Law and Criminology* 291.

⁶ Cooper "Challenges to Fingerprint Identification Evidence: Why the Courts Need a New Approach to Finality" 2016 *Mitchell Hamline Law Review* 756-757.

⁷ Cole "More than Zero: Accounting for Error in Latent Fingerprint Identification" 2005 *Journal of Criminal Law & Criminology* 987.

⁸ De Villiers "Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the last number of years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?" 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016). See also Koehler and Saks "Individualization Claims in Forensic: Still Unwarranted" 2010 *Brooklyn Law Review* 1187-1208. See also Cole "Individualization is Dead, Long Live Individualization! Reforms of Reporting Practices for Fingerprint Analysis in the United States" 2014 *Law, Probability and Risk* 117-150.

⁹ Committee on Identifying the Needs of the Forensic Science Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (2009) 144. See also Edmond "Expert Evidence in Reports and Courts" 2014 *Australian Journal of Forensic Sciences* 3.

¹⁰ Haber and Haber "Scientific Validation of Fingerprint Evidence under *Daubert*" 2008 *Law, Probability and Risk* 101-102.

to fingerprint evidence, is the fact that there are no objective standards coupled with the problem that there is a lack of scientific validity of the method used for comparisons.¹¹

1 2 THE RATIONALE FOR THIS INVESTIGATION

1 2 1 Definition of fingerprints and the types of fingerprints

A fingerprint may be defined as the mark that is made by pressing the tip of the finger on a surface or it can be made in ink for the purpose of identifying a person or an object.¹² Normally each and every person has unique traits such as fingerprints that can be used to identify that individual and which usually cannot be altered.¹³ Fingerprints differ from person to person; even identical twins are claimed to have different prints and these do not vary over time.¹⁴ As a result of this, a fingerprint is considered as an effective way of identifying a person and helping to prove guilt or innocence so that innocent persons are not convicted and the perpetrators of crimes are brought to justice.¹⁵ If an unknown fingerprint matches a known fingerprint, the suspect can be convicted.¹⁶

Fingerprints identified at crime scenes fall into three categories, namely patent, latent and impressed.¹⁷ Patent fingerprints are defined as those prints that are clearly visible to the naked eye and are normally made because the individuals have had their fingers in some sort of liquid or powder for example blood, ink, or oil and generally a photograph will suffice in recording them.¹⁸ Latent fingerprints are prints that are not visible to the naked eye but are visible under certain conditions.¹⁹ These prints can be made visible or certainly more identifiable by introducing them to a powder or chemical agent.²⁰ One of the most common methods for discovering and collecting

¹¹ Committee on Identifying the Needs of the Forensic Science Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (2009) 139. See also Cole "More than Zero: Accounting for Error in Latent Fingerprint Identification" 2005 *Journal of Criminal Law & Criminology* 993-998.

¹² Sarokin "What is patent fingerprint" <http://yourbusiness.azcentral.com/patent-fingerprint-20968.html> (accessed 25-03-2016).

¹³ Lawson "Can Finger Prints Lie? Re-weighing Fingerprint Evidence in Criminal Jury Trials" 2003 *American Journal of Criminal Law* 8-9.

¹⁴ Mathews "Crime Scene Forensics" www.crimescene-forensics.com (accessed 19-03-2016).

¹⁵ Cooper "Challenges to Fingerprint Identification Evidence: Why the Courts Need a New Approach to Finality" 2016 *Mitchell Hamline Law Review* 756-757.

¹⁶ Fingerprint evidence is used to identify suspects because it is regarded as part of forensic evidence and is accepted as opinion evidence which is considered to assist in proving or disproving the facts in issue that is if the evidence.

¹⁷ Faigman *et al* *Modern Scientific Evidence: The Law and Science of Expert Testimony* (2012-2013) 407.

¹⁸ Sarokin "What is patent fingerprint" <http://yourbusiness.azcentral.com/patent-fingerprint-20968.html> (accessed 25-03-2016).

¹⁹ *Ibid.*

²⁰ *Ibid.*

latent fingerprints, is by dusting a smooth surface with fingerprint powder.²¹ This, however, can contaminate the evidence and ruin the opportunity to perform other techniques that could uncover a hidden print or additional information.²² Impressed fingerprints are prints that have been made in soft material or tissue by pressing down with the finger or hand.²³

Fingerprints can be classified into three different groups, based on the pattern of the ridges, namely the loop, the whorl and arches. Loops refer to those ridges that start on one side and rise towards the centre and return back to the side they started from.²⁴ Arches may be described as those ridges that slope upwards and then downwards, like narrow mountains²⁵. Whorls refer to those ridges that form a circular or spiral pattern.²⁶ Fingerprint examiners look at the arrangement, size, shape and number of lines in these fingerprint patterns, to differentiate one from another. They also analyse the *minutiae*, which cannot be seen with the naked eye in order to compare specific points on a suspect fingerprint with similar information in a known print.²⁷

1 2 2 The nature of the opinion rule in South Africa and other jurisdictions

Forensic science evidence plays a very important role in the justice system in solving crimes.²⁸ In South Africa, forensic science evidence falls under the category of expert opinion evidence and its admissibility is governed by the rules of the Law of Evidence. Expert opinion evidence can be defined as testimony relating to a professional, scientific, or technical subject.²⁹ Like eye witness

²¹ Faigman *et al* 414.

²² Senbeta *An Evaluation of the Techniques used to Collect Latent Prints from Documents: A Case Study of Addis Ababa* (Magister Technologiae University of South Africa October 2010) 43.

²³ Sarokin "What is a Patent Fingerprint" <http://yourbusiness.azcentral.com/patent-fingerprint-20968.html> (accessed 25-03-2016).

²⁴ Jackson and Jackson *Forensic Science* 3ed (2011) 110. It is stated that, "60% of all fingerprint patterns have loops. Loops can be radial or ulnar. Radial loops slope towards the thumb and ulnar slope towards the small finger. Also every loop has a core, single delta, and a minimum of one recurving ridge that flows between the delta and core and minimum ridge count of one."

²⁵ *Ibid.* 5% of all fingerprint patterns have arches. Usually a plain arch is regarded as the simplest fingerprint pattern while tended are considered as intermediate between arch and a loop.

²⁶ *Ibid.* 35% of all the fingerprint patterns have whorls.

²⁷ Margaret Rouse "*Minutiae*" <http://searchsecurity.techtarget.com/definition/minutiae>. (accessed on 26-06-2016) Minutiae are defined as specific points in a finger image. There are two main types, known as ridge endings and bifurcations

²⁸ Meintjes-van Der Walt "Science Friction: The Nature of Expert Evidence in General and Scientific Evidence in Particular" 2000 *South African Law Journal* 771. Forensic Science evidence constitutes a vital component of circumstantial evidence. If science is employed to recognize, collect, analyses and interpret physical evidence from primary and secondary scenes, solutions to who, when, why, what, where and how questions may be offered.

²⁹ BusinessDictionary.com www.businessdictionary.com/definition/expert-evidence.html (accessed 23-07-2016) Expert evidence is described as, "information based on formal and/or special study, training, or experience that imparts the competency to form an opinion upon matters related to the subject."

testimony, expert opinion evidence can be very useful when solving crimes and can be an important advantage in any criminal docket.³⁰ Expert opinion evidence is one of the exceptions to the general rule that evidence of opinion is inadmissible.³¹ Expert opinion evidence is admissible if it can provide the court with scientific information which is likely to fall outside the experience and knowledge of the court.³² Consequently expert opinion evidence can be admitted if it is relevant and if it can assist the court in a situation where the witness is better qualified than the court to form an opinion on matters that fall outside the ordinary human experience.³³ As envisaged in section 210 of the South African, Criminal Procedure Act³⁴, no evidence will be accepted if it is irrelevant and immaterial; only relevant evidence should be accepted. In the *Holtzhauzen v Roodt*, case it was held that the court has to determine whether the subject of the enquiry does raise issues calling for specialised skill and knowledge.³⁵ This is so because evidence of opinion on matters which do not call for expertise, is excluded.³⁶ In the Canadian jurisdiction, the Court of Appeal's judgment suggested that an expert's evidence is inadmissible if it is unnecessary.³⁷ To be admissible, an expert's evidence should be necessary. Dumani elaborated that, in its limited sense, the word "necessary" means expert evidence has to provide helpful information which is likely to be outside a judge or jury's knowledge.³⁸ In England and Wales, in

³⁰ Edmond "Expert Evidence in Reports and Courts" 2014 *Australian Journal of Forensic Sciences* 2-3.

³¹ In general expert opinion evidence is inadmissible because it is like hearsay evidence. Section 3 (1) (b) of the Law of Evidence Amendment Act 45 of 1988 stipulates that hearsay evidence is inadmissible because it is irrelevant. However, opinion evidence is accepted on the grounds that the expert witness who is better qualified and has expertise in the specific field came to testify to court.

³² Schwikkard and van Der Merwe *Principles of Evidence* 3ed (2009) 81. See *Nicholson Charlene v RAF* 2012, wherein Wepener J referred to the case of *National Justice Compania Naviera SA v Prudential Assurance Co Ltd* 1993 which dealt with the duties of an expert witness and it was said that, "An expert witness should provide independent assistance to the court by way of objective, unbiased opinion in relation to matters within his expertise". Also in the case of *S v Gouws* 1967 4 SA 527 (EC) 528D Kotze J (as he then was) said: "The prime function of an expert seems to me to be to guide the court to a correct decision on questions found within his specialized field. His own decision should not, however, displace that of the tribunal which has to determine the issue to tried."

³³ Stevens *The Role of Forensic Expert Evidence in Establishing the Defence of Criminal Incapacity* (Doctor Legum Thesis University of Pretoria February 2011)3. In this thesis Stevens also referred to what Zeffertt and Paizes said that "an opinion will be relevant if it can assist the court and if the witness is better qualified to form such opinion".

³⁴ Criminal Procedure Act 51 of 1977.

³⁵ *Holtzhauzen v Roodt* 1997 4 SA 766 (W).

³⁶ *Ibid.* Relevance generally relates to the probative potential of an item of information to support or negate the existence of a fact or consequence.

³⁷ The Law Commission "Expert Evidence in Criminal Proceedings in England and Wales" 2011 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/229043/0829.pdf (accessed 26-06-2016) 13.

³⁸ Dumani *Aspects of Expert Evidence in the Criminal Justice System* (Magister Legum Thesis Nelson Mandela Metropolitan University May 2005) 4.

the *R v Turner*³⁹ case, it was held that an expert's opinion is admissible to furnish the court with information which is likely to be outside the experience and knowledge of a judge or jury.

If, on the proven facts, a judge or jury can form their own conclusions without the help of an expert, then the opinion of an expert is unnecessary.⁴⁰ It should be noted that opinions that do not assist the court in reaching a proper and fair decision, may just waste the time and resources of the court and may create confusion in the end. Expert witnesses are not allowed to express an opinion on an ultimate issue.⁴¹ An ultimate issue includes the legal or general merits of the case which the court has to decide.⁴² However, as Annari Faurie, in her Master of Laws dissertation indicates, courts at times permit not only experts, but also lay witnesses to express an opinion on the very issue that the court has to decide.⁴³

Furthermore, the nature of expert evidence is not to further the case of a particular party, but to assist the court to make a proper decision on technical or scientific matters. The importance of forensic science lies in its ability to supply important information about how the crime was committed and by whom.⁴⁴ Ireland and Beaumont state that opinion evidence is admitted on the grounds that it meets the helpfulness test and assists decision makers on issues outside their

³⁹ *R v Turner* 1975 1 All ER 70.

⁴⁰ The Law Commission "Expert Evidence in Criminal Proceedings in England and Wales" 2011 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/229043/0829.pdf (accessed 26-06-2016) 22.

⁴¹ This position however has been attacked by some scholars who argue that, the ultimate-issue principle serves no purpose other than to "obfuscate the true principle", they argue that it is impossible for experts to usurp the function of the court because after the expert witness testifies, the court is free to reject the witness' evidence. Schwikkard and Van der Merwe criticize the ultimate-issue rule because it does not explain why courts at times permit not only experts but also lay witnesses to express opinion on the very issue that court has to decide. See Schwikkard and Van der Merwe *Principles of Evidence* (2010) 83. Moreover Meintjes-Van der Walt concur with Schwikkard and Van der Merwe, she argues that "even when a mental health professional adduces evidence that touches upon the ultimate-issue, it remains evidence to be weighed by the court". See Meintjes-Van der Walt "A Few Plain Rules? A Comparative Perspective on Exclusionary Rules of Expert Evidence in South Africa" 2001 *THRHR* 236-256. See also Stevens and Lubaale "Revisiting the Historical Context of Surrounding the Development of the Ultimate-Issue Rule to Inform its Future in South African Law of Evidence" 2016 *Fundamina* 96, 105.

⁴² South African case law shows that there is a change in a manner in which ultimate-issue rule is treated in that some courts have rejected the application of ultimate-issue rule, See *S v Laubscher* 1988 1 SA 163 (A) at 168 B-C; *S v Calitz* 1990 1 SACR 119 (A); *S v Lesch* 1983 1 SA 814 (EPD); *Genturico AG v Fireston SA (Pty) Ltd* 1972 1 SA 589 (A); *Godi v S* [2011] ZAWCHC 247. Nevertheless other courts are still of the view that ultimate-issue rule should be applicable, see *S v Harris* 1965 2 SA 340 (A) 365 B-C and *S v September* 1996 1 SACR 325 (A) *Holtzauzen v Roodt* 1997 4 SA 766 (W); *S v The State* [2011] ZASCA 214; *S v Engelbrecht* 2005 2 SACR 41 (W).

⁴³ Faurie *Admissibility and Evaluation of Scientific Evidence in Court* (LLM-Thesis, University of South Africa, 2000) 7.

⁴⁴ Meintjes-van Der Walt "Fingerprint Evidence: Probing Myth and Reality" 2006 *South African Law Journal* 153.

experience.⁴⁵ There are issues that cannot be decided without expert evidence; hence expert evidence is needed where its help would be useful to the fact finder.⁴⁶ However, Meintjes-van der Walt, states that “what is regarded as ordinary human experience is fairly wide”.⁴⁷ Ordinary experience may be described as having information that is available to the public or information that is not acquired by specialised skills. Thus, expert witnesses qualify to testify if they possess some specialised knowledge, skill, training or possible experience adequate to enable them to give evidence or an opinion not generally available to the average person.⁴⁸

In summary, expert opinion evidence is relevant when it can help or could be of assistance to the court to reach a proper and fair decision on issues that fall outside the court’s experience.⁴⁹ The opinion rule is that an opinion should not be given on issues that the court has to decide.⁵⁰ Instead, the opinion should be given by an impartial and objective expert witness on matters within his or her field of expertise and his or her opinion must satisfy the acceptable reliability requirement for it to be admitted.⁵¹ In *Schneider v AA*⁵² Davis J said that an expert comes to court to give the court the benefit of his expertise and it does not preclude the expert from providing the court with an objective and unbiased opinion as possible, based on his expertise. He further said “An expert does not give evidence that goes beyond the logic which is dictated by the scientific knowledge which that expert claims to possess.”⁵³

⁴⁵ Ireland and Beaumont “Admitting Scientific Expert Evidence in the United Kingdom: Reliability challenges and the Need for Revised Criteria- proposing an Abridged *Daubert*” 2015 *Journal of Forensic Practice* 4.

⁴⁶ Meintjes-van der Walt “The Paradoxes and Dilemmas of Expert in the Criminal Justice Process” 2000 *Acta Criminologica* 58-63.

⁴⁷ Meintjes-van Der Walt “Science Friction: The Nature of Expert Evidence in General and Scientific Evidence in Particular” 2000 *South African Law Journal* 773.

⁴⁸ Dumani *Aspects of Expert Evidence in the Criminal Justice System* (Magister Legum Thesis Nelson Mandela Metropolitan University May 2005) 5.

⁴⁹ *Ibid.*

⁵⁰ See *Holtzauzen v Roodt* 1997 4 SA 766 (W); *S v Harris* 1965 2 SA 340 (A) 365 B-C and *S v September* 1996 1 SACR 325 (A).

⁵¹ The Law Commission “Expert Evidence in Criminal Proceedings in England and Wales” 2011 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/229043/0829.pdf (accessed 26-06-2016) 22.

⁵² *Schneider v AA* 2010 5 SA 203 (WCC). See *Mathembula v RAF* 2006 ZAGPHC 261 Meyer J said, expert witness “is not entitled to give hearsay evidence as to any fact but those facts which expert draws as a conclusion by reason of his or her expertise from other facts which have been admitted or established by admissible evidence.” See also *S v Gouws* 1967 4 SA527 (EC).

⁵³ *Schneider v AA* 2010 5 SA 203 (WCC).

1 2 3 The importance of reliable expert opinion evidence for judicial decision making

South African law stipulates that expert opinion evidence would be relevant and admissible if it can assist the fact finder in reaching a proper decision on matters that fall outside the court's experience. However, the fact that opinion evidence is relevant to a particular set of facts, does not mean it was derived from a reliable source or that the technique used to produce the results is reliable. Ireland and Beaumont contend that whenever expert opinion evidence is in question, more is required than just a simple determination of helpfulness.⁵⁴ There is a danger in accepting expert opinion evidence without testing or challenging its reliability and validity. Haber and Haber state that reliability "means that a method should produce the same results for the same experiment every time it is used both by many experts and by the same experts knowingly or unknowingly repeating the test."⁵⁵ Thus it is important that expert opinion evidence be reliable before it is accepted or admitted because unreliable expert opinion evidence may lead to miscarriages of justice and wrongful convictions.⁵⁶ This can be substantiated by the findings of Professor Saks and his colleague Jonathan Koehler when they reviewed wrongful convictions and other DNA exonerations. They discovered that 63 percent of the cases they scrutinized, involved forensic science testing errors and 27 percent involved false or misleading testimony by forensic experts.⁵⁷

When a miscarriage of justice occurs, it is not usually the result of just one mistake, but rather a combination of events and as there are several problems associated with expert opinion evidence,

⁵⁴ Ireland and Beaumont "Admitting Scientific Expert Evidence in the United Kingdom: Reliability challenges and the need for revised criteria- proposing an Abridged *Daubert*" 2015 *Journal of Forensic Practice* 6.

⁵⁵ Haber and Haber "Scientific Validation of Fingerprint Evidence under *Daubert*" 2008 *Law, Probability and Risk* 88.

⁵⁶ Roman *et al* "Post-Conviction DNA Testing and Wrongful Conviction" 2012 Justice Police Center <http://www.urban.org/sites/default/files/alfresco/publication-pdfs/412589-Post-Conviction-DNA-Testing-and-Wrongful-Conviction.PDF> (accessed 25-05-2016) 9. It is stated that faulty forensic science has contributed to convicting innocent people and will continue to do so if careful steps are not taken to ascertain the reliability of the methods, technique or sources of the evidence presentment in court. Also the lack of laboratory oversight and forensic standards leaves forensic science distrusted and vulnerable to manipulation.

⁵⁷ Saks and Koehler "The Coming Paradigm Shift in Forensic Identification Science" 2005 <http://ssrn.com/abstract=962968> (accessed 23-07-2016). Upon reviewing 86 DNA exoneration cases they noted that "Percentages exceed 100% because more than one factor was found in many cases. Moreover, of the 340 DNA and non-DNA exonerations that Professor Samuel Gross and his University of Michigan colleagues examined, 24 involved forensic scientists who committed perjury. Finally, in the first study to explore forensic science testimony by prosecution experts in the trials of innocence people, University of Virginia Law Professor Brandon Garrett and Innocence Project Co-Director Peter Neufeld found that in 139 trials where forensic evidence supported the exoneree's conviction, 61 percent involved improper testimony by the prosecution's forensic expert."

the solutions to the challenges must be multifaceted as well.⁵⁸ The responsibility to prevent wrongful convictions is not only the duty of the fact finders, but it falls on all participants in the criminal justice system. When collecting evidence at criminal scenes, the law enforcement agents should be meticulous in collecting and storing the evidence in a proper manner to avoid distortion of the evidence and prosecutors⁵⁹ should strive to call reliable expert witnesses. Thus Edmond said “Expert witnesses, when presenting the evidence, should present in a manner that would enable the fact finder fully to become aware of what the technique is all about in order for him/ her to reach a proper and fair decision.”⁶⁰

In the *Frye v United States*⁶¹ case it was stated that expert evidence would be admissible if it is generally accepted in the scientific community.⁶² By the general acceptance standard it was meant that the basis for the forensic expert’s opinion should be accepted by his or her peers in the discipline. The general acceptance requirement was later criticised in the *Daubert* case⁶³ because it did not provide a platform in which expert evidence could be tested for its reliability. In *Daubert*, Judge Blackmun stated that when assessing expert evidence, trial judges must not just establish whether a technique or theory is generally accepted, but also whether it could be tested or falsified; whether the error rate is known or not, and whether the technique or theory that produced the opinion is peer reviewed.⁶⁴

However, it appears as if in some jurisdictions courts are reluctant to apply the expert standard as stipulated in *Daubert* and this has been viewed by some proponents of the standard as the cause of wrongful convictions.⁶⁵ In this regard Cooley stated that “[m]any suggest that unreliable forensic

⁵⁸ Macfarlane “Wrongful Convictions: The Effect of Tunnel Vision and Predisposing Circumstances in Criminal Justice System” 2005 *Manitoba Law Journal* 5.

⁵⁹ *Ibid* 5-25, discussing factors that contribute to wrongful convictions.

⁶⁰ Edmond “Forensic Science Evidence and the Conditions for Rational Jury Evaluation” 2015 *Melbourne University Law Review* 95.

⁶¹ *Frye v United States* 1923 293F 1013.

⁶² Cole “Out of the *Daubert* and into the Fryeing Pan? Self-validation, Meta-Expertise and Admissibility of Latent Print Evidence in *Frye* Jurisdictions” 2008 *Minnesota Journal of Law, Science and Technology* 454. Cole wrote that “[e]ssentially, *Frye* seeks to replicate the ideal of peer review in which the consensus judgment of the scientific community should be considered the best, if not the ‘true’ answer to scientific and technical questions”.

⁶³ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S 579 1993.

⁶⁴ *Ibid* 597. See also Cooley and Oberfield “Increasing Forensic Evidence’s Reliability and Minimising Wrongful Convictions: Applying *Daubert* Isn’t the only Problem” 2007 *Tulsa Law Review* 288.

⁶⁵ Cole “Out of the *Daubert* and into the Fryeing Pan? Self-validation, Meta-Expertise and Admissibility of Latent Print Evidence in *Frye* Jurisdictions” 2008 *Minnesota Journal of Law, Science and Technology* 462-466. <http://www.fitzhunt.com/sites/default/files/news/Admissibility%20of%20Expert%20Testimony%20in%20State%20>

evidence undermined the criminal process and presumably played a role in several wrongful convictions because the judiciary has not applied *Daubert* to prevent prosecutorial reliance on unreliable or ‘junk’ forensic evidence in the courtroom”.⁶⁶

Moreover, unreliability of expert evidence may be caused by a lack of independence and impartiality between the forensic laboratory, law enforcement and the investigative function.⁶⁷ This may cause scientists to feel aligned with the police.⁶⁸ Especially in adversarial systems where the trial is turned into a competition between two parties, the expert witness may give evidence that further the case of the person he or she is representing. The very nature of the presented evidence or the manner in which the evidence is presented, may be so imprecise and speculative that whatever probative value it may have, is significantly outweighed by its prejudicial effect.⁶⁹ When presenting their opinions, experts can do so in a manner that validation and proficiency studies may not support.⁷⁰ Therefore, in the absence of formal evaluation, claims about error rates, accuracy and uncertainty are speculative and likely to be wrong and misleading.⁷¹ Furthermore, during trial, defence counsel may lack the tools to test the accuracy and the value of the evidence through effective cross-examination.⁷² The mere fact that the expert witness has testified that the evidence has been tested and is based on recorded data, may not mean that the expert evidence is reliable.

A significant proportion of expert opinion evidence might well be based on unreliable data. This is so because, with the exception of DNA evidence, no single forensic technique yet has the ability

Courts-Hunt.pdf (accessed 08/09/2016) 4. In this article Hunt gives statistical analysis of American states which are still applying *Frye*, those that adopted *Daubert* and those that use neither *Daubert* nor *Frye* standard. The statistics are as follows: 14 States are using the *Frye* test, 35 States have adopted the *Daubert* test and lastly that only 2 States are neither applying *Daubert* nor *Frye*. See also See Pearson “Article 2 State Courts- *Frye v Daubert*” 2015 <https://experts.ims-expertservices.com/expert-library/may-2015/article-2-state-courts-frye-vs-daubert/> (accessed 08-09-2016).

⁶⁶ Cooley and Oberfield “Increasing Forensic Evidence’s Reliability and Minimising Wrongful Convictions: Applying *Daubert* Isn’t the only Problem” 2007 *Tulsa Law Review* 287.

⁶⁷ Macfarlane “Convicting the Innocent: A Triple Failure of the Justice System” 2006 *Manitoba Law Journal* 440-441.

⁶⁸ *Ibid.*

⁶⁹ *Ibid.*

⁷⁰ Edmond “Expert Evidence in Reports and Courts” 2014 *Australian Journal of Forensic Sciences* 4.

⁷¹ Edmond “Forensic Science Evidence and the Conditions for Rational Jury Evaluation” 2015 *Melbourne University Law Review* 96.

⁷² Macfarlane “Convicting the Innocent: A Triple Failure of the Justice System” 2006 *Manitoba Law Journal* 470.

definitely to link an evidence sample to its source.⁷³ Fingerprint evidence is an example of this. Besides the fact that people have different friction ridges and the fact that they are permanent, there is no data to show that the examiner would be able reliably to see whether the prints are from the same source or not, or see when the prints were left on the surface.⁷⁴ Despite the knowledge of the challenges and issues against expert opinion evidence of fingerprints, the courts still accept the evidence. Thus, fingerprint expert opinion evidence can be argued to be enjoying acceptance in courts without the techniques or methodologies being tested, scrutinised or showing that the evidence was obtained from a reliable source. This is also supported by the findings made in the report compiled in 2009 by the National Research Council where the committee discovered that many forensic disciplines are typically not supported by scientific research.⁷⁵

In short, the technique on which the opinion is based, should be reliable and when presenting the evidence in court, the expert witness must adduce the evidence in a manner that the fact finders would be able to evaluate the technique that produced the evidence and give it weight and probative value. It should also be noted that the fact that an expert is independent and have expertise in a specific field, does not necessarily mean that the technique is valid and reliable. It is of paramount importance that before an opinion is afforded probative value, its reliability should be tested. This may prevent and reduce the conviction of innocent persons. Quite apart from the extreme injustice involved in wrongful convictions, the conviction of innocent people may also damage the confidence of the people in the justice system.

1 2 4 Specific issues pertaining to expert opinion evidence in general and fingerprint evidence in particular

In most cases fact finders face difficulties in ascertaining the reliability of expert opinion evidence and yet they are required to consider all admissible evidence.⁷⁶ For fact finders to be in a position to know that the expert opinion evidence is reliable, they should be placed in a position that enables

⁷³ Committee on Identifying the Needs of the Forensic Science Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (2009)1. See also Gabel "Realizing Reliability in Forensic Science from the Ground Up" 2014 *Journal of Criminal Law and Criminology* 287.

⁷⁴ Pagea *et al* "Uniqueness in the Forensic Identification Sciences: Fact or Fiction" 2011 *Forensic Science International* 12-18.

⁷⁵ *Ibid* 6.

⁷⁶ De Villiers "Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the last number of years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?" 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016) 21. He emphasizes that when considering admissibility of evidence reliability plays a crucial role.

them to understand and evaluate such evidence. Gary Edmond, in his article entitled “Forensic Science Evidence and the Conditions for Rational Jury Evaluation”⁷⁷, wrote that the most fundamental issue in any attempt to evaluate opinion evidence is to know whether the underlying technique or process used to produce the results actually works.⁷⁸ Edmond further argued that:

If the limitations, uncertainties and error rates associated with a technique are unknown and the results produced by the said technique are admitted, there is a possibility that the said evidence may be speculative, wrong and misleading.⁷⁹

All techniques and expert claims, can and should be subjected to validation of some kind.⁸⁰ This would help to test the reliability of the technique used by the expert witness in order to reach the conclusion on which the opinion is based.

In several jurisdictions other than South Africa, a lack of relevant information about expert opinion evidence, affect the admissibility of such evidence. Admissibility of expert opinion evidence is crucial and contemporary literature shows that it has become a controversial issue in many jurisdictions across the world, especially with regard to identification expert evidence.⁸¹ De Villiers states that in Anglo-American jurisdictions, admissibility, to a large extent, is a question of law.⁸² If the experts are not truthful in their testimony, the fact finders might well be misled and make wrong decisions which will have a disastrous impact on the justice system. Meintjes –van der Walt stated that “(t)his may be so because the same fact finder who is expected to assess the probative value and give weight to such evidence might not have knowledge with regard to the field.”⁸³ More so, Meintjes -van der Walt contends that “(t)here is an inherent contradiction in that

⁷⁷ Edmond “Forensic Science Evidence and the Conditions for Rational Jury Evaluation” 2015 *Melbourne University Law Review* 96.

⁷⁸ *Ibid* 83. Edmond stated, “Forensic expert evidence error rates standards and claims could be said to be declaratory and speculative. This is so because the expert witness when testifying in court usually testify that the error is zero, yet in actual fact errors do occur.” It should be noted as well that whenever humans are involved in any experiment or evaluation, errors could occur.

⁷⁹ *Ibid* 83-84.

⁸⁰ Validation studies tell us whether the technique actually works, how well and in what conditions.

⁸¹ Edmond *et al* “Admissibility Compared: The Reception of Incriminating Expert Opinion (i.e. forensic science) Evidence in Four Adversarial Jurisdictions” <http://www.law.du.edu/documents/criminal-law-review/issues/v03-1/Admissibility-Compared.pdf> (accessed on 24-04-2016).

⁸² De Villiers “Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the last number of years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?” 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016) 21.

⁸³ Meintjes-van Der Walt “Science Friction: The Nature of Expert Evidence in General and Scientific Evidence in Particular” 2000 *South African Law Journal* 771.

expert witnesses are required in matters that go beyond the ordinary understanding of lay people, yet it is expected of lay judges and jurors to adjudicate on this expert opinion evidence.”⁸⁴

In jury systems, like that of The United States of America, admissibility plays a major role and evidence can only be admitted if it is reliable enough to be put to the jury, whereas in South Africa, admissibility of evidence is based on the degree of relevance of that evidence. In terms of South African law, expert opinion evidence will be deemed admissible if it is relevant in the sense that the expert by reason of skill, is better qualified than the court to draw an inference from the particular set of facts.⁸⁵ The dilemma faced in South Africa, is that as a result of permissive and accommodating admissibility requirements, the court might not usually have any means by which it can verify the witness’ conclusions.⁸⁶ For instance, the court might not have knowledge that there are no objective standards that govern fingerprint evidence and that there is no independent testing for the validation of the evidence or rigorous proficiency testing of the expert.⁸⁷ The other problem of fingerprint evidence is that there could be contextual bias in that fingerprint examiners often present only two sets of images and suggestive information about the suspect.⁸⁸ Suggestive information means that the fingerprint examiner tends to suggest what the court should rely on when the identity of a suspect is at issue, for instance his background, religion etc.

In South Africa a numeric value admissibility standard is followed and 7 points of similarity suffice for the purpose of identification of the perpetrator.⁸⁹ If the fingerprint examiner provides the court

⁸⁴ *Ibid.* Meintjes –van der Walt elaborated that, “the defence attorneys to cross examine the expert witness may not be well equipped with the knowledge of the field of expertise of the witness and as result most of their questions are directed towards the witness and not to whether the opinion falls under the scientific field and whether it has been validated or tested for its reliability.” Moreover Meintjes- van Der Walt referred to Kenny who noted that expert evidence is not based on untutored sense of observation of an average man but on specialized training, experience out of common and or theoretical information of recondite kind.

⁸⁵ Zeffertt *et al* *The South African Law of Evidence* (2003) 290.

⁸⁶ *Ibid* 305.

⁸⁷ Cole “Out of the *Daubert* and into the Fryeing Pan? Self-validation, Meta-Expertise and Admissibility of Latent Print Evidence in *Frye* Jurisdictions” 2008 *Minnesota Journal of Law, Science and Technology* 487-489. It was stated that most of the process happen in the examiner’s mind and when testifying the examiner will be expressing his subjective thinking towards the results or observation. No necessary qualification is needed to render an individual fingerprint examiner and it is up to the court to allow an individual testify even if he does not have necessary qualifications. If an error occurs no one would know that there was an error, the dispute is resolved in the Laboratory and reported as inconclusive or an exclusion.

⁸⁸ Cole and Roberts “Certainty, Individualisation, and the Subjective Nature of Expert Fingerprint Evidence” 2012 *Criminal Law Review* 844.

⁸⁹ *S v Blom* 1992 1 SACR 649 (E). See also Verburg Attorneys “Seven-point Standard followed by South African Courts regarding Fingerprint Evidence” 2015 <http://verburg.co.za/seven-point-standard-followed-by-south-african-courts-regarding-fingerprint-evidence/> (accessed 27-06-2016).

with enough evidence that there are 7 points of resemblance between the known print of the alleged perpetrator and an unknown print, the evidence will be admitted. The questions as to whether the process to determine matches was reliable, or whether the field has been scientifically tested, or whether there are standards that guide the examiner in declaring a match or exclusion, are not asked. Even if the 7 points of resemblance suffice for fingerprint evidence to be admitted, in general there is no agreement as to how many points of resemblance suffice for reliability requirements, it depends on laboratories and from examiner to examiner.⁹⁰ This is another problem of fingerprint evidence, in that if examiners could not agree on the number of points of resemblance that are sufficient to declare a match, the court may be confused as to how many points of resemblance constitute a match.

There is a substantial amount of case law in which the South African courts accepted fingerprint evidence without testing its reliability or scrutinising the methods used for examination and comparison of the prints as long as there are 7 points of resemblance.⁹¹ This is so because the courts may still be relying mainly on the general acceptance of fingerprint evidence and the premise of uniqueness of the print.⁹² However, on the international terrain this assertion has been challenged.

1 3 THE RESEARCH PROBLEM ADDRESSED IN THIS STUDY

With the knowledge of all the issues raised against fingerprint evidence in the reports discussed in this dissertation, the main question to be addressed by this study is whether the use of fingerprints as a tool for identification, is a reliable source of evidence. Another pertinent question is whether South African judicial decision makers should re-examine the weight they put on fingerprint evidence.

⁹⁰ Cole and Roberts “Certainty, Individualisation, and the Subjective Nature of Expert Fingerprint Evidence” 2012 *Criminal Law Review* 853.

⁹¹ *Ngaye v S* (A567/10) 2010 ZAWCHC 341 (3 December 2010); *Makhubu v S* (A475/2011) 2012 ZAGPJHC 89 (10 May 2012) *Nduna v S* (076/2010) 2010 ZASCA 120; 2011 1 SACR 115 (SCA); 2011 2 All SA 177 (SCA) (30 September 2010) and *S v Legote* 2001 SACR 179 SCA 3. In these cases, fingerprint evidence was accepted because the fingerprint examiners had proved that there were 7 points of resemblance between the unknown print and the known print of accused persons. These cases are further explored as the research unfolds.

⁹² *Frye v United States* 1923 293F 1013. However if due weight has been given to other factors the result would have been more damning of fingerprinting evidence. See also Cole “Out of *Daubert* Fire and into *Frye*ing Pan? Self-validation, Meta-expertise and admissibility of Latent Print Evidence in *Frye* Jurisdictions” 2008 *Minnesota Journal of Law, Science and Technology* 472. It is argued that, “just because the skin is unique, it does not follow that an analytic process is sufficiently diagnostic to always identify the true source of an impression of that unique skin.”

1 4 THE AIMS AND OBJECTIVES OF THIS RESEARCH PROJECT

The prime objective of this research project is to study and analyse five international forensic reports in order to determine the issues highlighted in the reports with regard to the reliability of fingerprint evidence. It is the goal of this research to establish lessons that South African lawyers could learn when using fingerprint evidence. Furthermore, it is the goal of this research project to add to the research work that has been done with regard to fingerprint evidence in South Africa.

1 5 THE PURPOSE AND SIGNIFICANCE OF THIS RESEARCH PROJECT

Fingerprint evidence is used as a tool for identification during criminal investigations and therefore it can be said that fingerprint evidence could assist law enforcement agents in efforts to combat crime. Despite concerns raised against the reliability of fingerprint evidence, it would seem that judicial decision makers in South Africa are not always aware of these problems as they often appear to put significant weight on fingerprint evidence. This study endeavours to gain an insight into the problems that are associated with fingerprint evidence. It is the intention of this research project to examine judicial investigations in comparator jurisdictions regarding the reliability of fingerprint evidence and in turn to determine whether these insights could be of assistance to judicial decision makers in South Africa.

Furthermore, this research project intends to provide insights which might be of assistance, not only to legal practitioners, but also to policy makers and the judiciary regarding the problems associated with fingerprint evidence. In this dissertation the findings of the reports are scrutinised and recommendations are suggested.

1 6 RESEARCH QUESTIONS

The study addresses the following questions:

- Is the use of fingerprint evidence a reliable tool for identification in South African Courts?
- How can the knowledge of the issues raised in the five international reports assist South African lawyers when using fingerprint evidence as a tool for identification?

1 7 DELIMITATION

The study does not deal with the validity and reliability of the entire field of forensic evidence; but rather focuses exclusively on fingerprinting. In particular, it confines itself to the issues raised

against fingerprint evidence in five international forensic reports which were ground-breaking in nature. These reports give a panoramic insight into the contemporary problems associated with the use of fingerprint evidence. The considerations of the implications of the research contained in the reports, geographically restricts itself to South Africa. As there are restrictions limiting the length of a Master's thesis, the study is based on a limited number of cases that have made an impact on fingerprint evidence.

1 8 NEXUS STUDY

An online search revealed that to date there have been no published, peer-reviewed studies directly examining the extent to which fingerprints can be matched.⁹³ A search also revealed that no attempt has been made to interrogate the use of fingerprint evidence in South Africa in relation to international investigations regarding the scientific reliability of fingerprint evidence. A number of problems have been highlighted in the five international forensic reports that are discussed and critically examined in this dissertation. These reports have highlighted a number of issues that may affect the reliability of fingerprint evidence and provide recommendations and standards that can be followed by fingerprint experts in order to improve the reliability of fingerprint evidence.⁹⁴

1 9 LITERATURE REVIEW

Generally, fingerprint evidence has become a common phenomenon in criminal trials. The public's faith in fingerprint evidence has become an important part of the reality of the way in which the Anglo-American system works.⁹⁵ Fingerprinting had been accepted for more than 100 years without being tested or challenged, and its acceptance is based mainly on the examiner's testimony in court.⁹⁶ However, there has been an increase in challenges against fingerprint evidence in many jurisdictions with regard to both its validity and its reliability.⁹⁷

⁹³ Cole "Individualization is Dead, Long Live Individualization! Reforms of Reporting Practices for Fingerprint Analysis in the United States" 2014 *Law, Probability and Risk* 117-150. See also Mnookin "The Validity of latent fingerprint identification: A Confession of a Fingerprinting Moderate" 2008 *Law, Probability and Risk* 133.

⁹⁴ *Ibid.*

⁹⁵ Lord Thomas of Cwmgiedd (Lord Chief Justice of England and Wales) "Expert Evidence: The Future of Forensic Science in Criminal Trials"; The 2014 Criminal Bar Association Lecture (14 October 2014) 7.

⁹⁶ Cole "Out of the *Daubert* and into the *Frye* Pan? Self-validation, Meta-Expertise and Admissibility of Latent Print Evidence in *Frye* Jurisdictions" 2008 *Minnesota Journal of Law, Science and Technology* 487.

⁹⁷ Epstein "Fingerprints meet *Daubert*: The Myth of Fingerprint Science is Revealed" 2002 *Southern California Law Review* 606. It is written, that some of the leading voices in the forensic science community have begun to question the scientific foundation of the fingerprint field and suggest that latent fingerprint identifications may not be nearly as reliable as people have long assumed. De Villiers "Fingerprint Comparison Evidence has been under Sustained Attack

A very important question is how likely it is that two people could have 4 points of resemblance, or 5 points or 6 points or 7 points. Are the odds of partial prints from different people matching, one in 1000 or one in a million?⁹⁸ No examiner can at present honestly answer such questions.⁹⁹ The answers to the questions posed above are critical to the evaluating of the probative value of the match. A further important question is with regard to how often fingerprint examiners find a match when none exists?¹⁰⁰ How often do experts make errors in declaring that the 2 prints come from a common source; yet in actual fact these prints are not from the common source? At present no credible answers can be given to these questions. Hence Ralph Haber contends that there has been a century of precedence and not a century of data.¹⁰¹ Trina Arpin, states that despite a century of courtroom use of fingerprints, fingerprint examiners have scant hard proof of the method's precision. Prints could be unique but it has been argued that it does not necessarily prove accuracy and that errors could be made during investigation, examination and upon testifying by fingerprint examiners.¹⁰²

The reports which are scrutinised in this study include a report on a review of the FBI's handling of the Brandon Mayfield case (Mayfield Report);¹⁰³ the report compiled by the National Research Council (NAS Report) in 2009;¹⁰⁴ The Scottish Fingerprint Inquiry Report (SFI Report) in 2011,¹⁰⁵

in the United States of America for the last number of years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?" 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016). See also Koehler and Saks "Individualization Claims in Forensic: Still Unwarranted" 2010 *Brooklyn Law Review* 1187-1208. See also Cole "Individualization is Dead, Long Live Individualization! Reforms of Reporting Practices for Fingerprint Analysis in the United States" 2014 *Law, Probability and Risk* 117-150.

⁹⁸ Saks and Koehler "The Individualization Fallacy in Forensic Science Evidence" 2008 *Vanderbilt Law Review* 199.

⁹⁹ Mnookin "Fingerprints: Not a Gold Standard" 2003 *Issues in Science and Technology* issues.org/20-1/mnookin/ (accessed 24-08-2016).

¹⁰⁰ For example, there are those people who have their fingerprints hard to match. Those people referred to as goats. Goats can be defined as people whose fingerprints are consistently matched below a given threshold.

¹⁰¹ Haber and Haber "Scientific Validation of Fingerprint Evidence under *Daubert*" 2006 *Law, Probability and Risk* 87.

¹⁰² Mnookin "Fingerprints: Not a Gold Standard" 2003 *Issues in Science and Technology* issues.org/20-1/mnookin/ (accessed 24-08-2016). As pointed out in the article the other problem associated with fingerprint is that fingerprint examiners lack objective standards for evaluating whether two prints match. There is simply no uniform approach to deciding what counts as a sufficient basis for making an identification. Some fingerprint examiners use a "point-counting" method that entails counting the number of similar ridge characteristics on the prints, but there is no fixed requirement about how many points of similarity are needed. Six points, nine, twelve? There is no agreement among fingerprint examiners as to how many points of resemblance suffice to declare a match."

¹⁰³ Office of the Inspector General, United States Department of Justice *A Review of the FBI's handling of the Brandon Mayfield case* (2006).

¹⁰⁴ Committee on Identifying the Needs of the Forensic Science Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (2009).

¹⁰⁵ Campbell *The Fingerprint Inquiry Report* (2011).

the National Institute of Science Technology Report (NIST Report) in 2012¹⁰⁶, and the Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods Report by President's Council of Advisors on Science and Technology (PCAST Report) in 2016.¹⁰⁷

The first report to be examined is the report compiled to review the FBI's handling of the Mayfield case.¹⁰⁸ In 2004, terrorists detonated bombs on a number of trains in Madrid, Spain. A large number of people were killed and more than two thousand injured. As a result, Mayfield was arrested as a material witness with respect to a federal grand jury's investigation into that bombing.¹⁰⁹ He was connected to the terrorist attack because it was alleged that his fingerprint had been found on a bag in Spain containing detonation devices similar to those used in the bombings. The government then announced that the Federal Bureau of Investigations (hereafter the FBI) had made an error in its identification of Mayfield's fingerprint. After the Mayfield case the FBI embarked on an investigation and the resulting report raised a number of disquieting issues.

The report mentioned above, stated that the culture at the laboratory was poorly suited to observe or recognise errors. For example, to challenge the superior's observation was an improbable response. If the results to be verified were found by an examiner with a higher rank than the rank of the examiner reviewing the results, he or she would not be expected to disagree with results obtained by the first examiner.¹¹⁰ In the Mayfield case the initial examiner was a highly esteemed supervisor with many years of experience and the second examiner could not disagree with his

¹⁰⁶Expert Working Group on Human Factors in Latent Print Analysis, *Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach* (2012).

¹⁰⁷ *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods Report* by President's Council of Advisors on Science and Technology (2016). <https://www.whitehouse.gov/blog/2016/09/20/pcast-releases-report-forensic-science-criminal-courts> (accessed 01-12-2016).

¹⁰⁸ Office of the Inspector General, United States Department of Justice *A Review of the FBI's handling of the Brandon Mayfield case* (2006).

¹⁰⁹ *Mayfield v US* No. 07-35805 D.C.NO. CV-04-01427-AA.

¹¹⁰ Mayfield Report 1.

findings. Moreover, the report pointed out that verification¹¹¹ of the print was not done blindly, and that there was confirmation bias by examiners.¹¹²

The next report to be analysed in this dissertation is the report compiled by the National Research Council in 2009 *Strengthening Forensic Science in the United States: A Path Forward*.¹¹³ This report highlighted many problems that are associated with various forensic science disciplines. In relation to fingerprint evidence it indicates that it is not only about proficiency testing and organisational culture, but also the lack of professional standards which make it difficult to decide with sufficient reliability that the finger that left the indentation at the crime scene, is the same as the finger that left an impression in the file of fingerprints.¹¹⁴

Furthermore, the report states that fingerprint evidence is not supported by scientific research and that it is not governed by objective standards.¹¹⁵ There was no research to show that the examiner had followed all the procedures.¹¹⁶ The report also states that it was unknown which standard the examiner used to declare a match, or what amounts to an exclusion.¹¹⁷ Usually it is the subjective decision of the examiner to choose which standard to follow in order to declare a match or an exclusion,¹¹⁸ yet the courts have to rely on what the examiner has to say and are required to decide on the probative value of the fingerprinting evidence even though the court might not have scientific knowledge and expertise with regard to fingerprinting. In summary, the NAS Report reveals that there are challenges with regard to the reliability of fingerprint evidence in general as well as with regard to the reliability of the ACE-V methodology which is preferred in the United States of America. The report also found that although fingerprint evidence had been used in courts for more than a century, there is inadequate proof to establish that fingerprint comparison is reliable or a reliable technique.

¹¹¹ Verification stage is like a transition phase of the two examiners' formal hypotheses into single unified hypothesis by way of concurrence.

¹¹² Mayfield Report 115. Confirmation bias is defined as the human tendency to see what one expects and desires to see when evaluating ambiguous evidence. Confirmation bias can be described as a situation whereby one examiner looks at what the initial examiner has concluded and thereby making his own conclusion.

¹¹³ Committee on Identifying the Needs of the Forensic Science Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (2009).

¹¹⁴ *Ibid* 141.

¹¹⁵ *Ibid* 139.

¹¹⁶ *Ibid* 142.

¹¹⁷ *Ibid* 139.

¹¹⁸ *Ibid*.

The third report examined in this thesis is the so-called Fingerprint Inquiry Report conducted in Scotland.¹¹⁹ In 2011, this report echoed the very same challenges against fingerprint evidence raised in the two reports discussed above. In this instance, Shirley Mckie¹²⁰ was connected to a murder case and fingerprints were the only evidence connecting McKie to the crime. The Fingerprint Inquiry¹²¹ was done so that Scotland could have an approach to identification, verification and the presentation of fingerprints that everyone could trust.¹²² The Inquiry looked at matters such as peer-review, the basis for finding a match between two fingerprints, the influence of the quality of materials examined on the reliability of finding matches and the certainty with which fingerprint matches can be stated.

The fourth report, analysed for the purposes of this research is the National Institute of Standards and Technology (NIST Report hereafter)¹²³ in 2012 which dealt with the human, organisational and environmental components that affect fingerprint evidence. It also addressed issues ranging from the acquisition of impressions of friction ridge skin; to courtroom testimony; from laboratory design and equipment to research into emerging methods for associating latent print exemplars.¹²⁴ It was conducted to assess the effects of human factors on fingerprint evidence and to establish recommendations to lessen the danger of error in identification. The NIST Report stated that human beings in all lines of work make mistakes and errors.¹²⁵ Therefore it states that if there is a procedure to be followed when doing fingerprint examination, individuals have to follow those procedures, since a mistake in one step may result in an error by the examiner.¹²⁶

The PCAST Report, the last report to be analysed in this dissertation, was compiled in 2016 after a request by President Obama to examine if there are procedures that could improve and strengthen the forensic-science disciplines and assure the validity of forensic evidence.¹²⁷ The objective of

¹¹⁹ Campbell *The Fingerprint Inquiry Report* (2011).

¹²⁰ *HM Advocate v Mckie* 1999 (unreported).

¹²¹ The Fingerprint Inquiry Submissions on behalf of Shirley Mckie, Iain Mckie and David Asbury 2009 www.shirley.com/documents/FINALREVISEDVERSION (accessed on 27-03-2016) 11, it was submitted that there seemed to have a belief by staff within SCRO that they were the best in the world and world class.

¹²² SFI Report 2.

¹²³ Expert Working Group on Human Factors in Latent Print Analysis, *Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach* (2012).

¹²⁴ *Ibid* 35.

¹²⁵ *Ibid* 21.

¹²⁶ *Ibid* 24.

¹²⁷ *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods Report* by President's Council of Advisors on Science and Technology (2016)

the report was to analyze feature comparison forensic methods used to associate the accused person with the crime scene and to close the gaps in these methods.¹²⁸ These methods include DNA, hair, latent fingerprints, firearms and spent ammunition, tool marks and bitemarks, shoeprints and tire tracks, and handwriting.¹²⁹ The PCAST Report found that there is a need for clear and precise scientific standards for the validity and reliability of forensic methods and there is a need to evaluate specific forensic methods to determine whether they have been scientifically established to be valid and reliable.¹³⁰

The report gave a thorough assessment of previous studies relating to forensic practice and Federal actions which were in progress at the time to strengthen forensic science; discussed the role and importance of scientific validity within the legal system; delineated the criteria by which the scientific validity of forensic feature-comparison methods can be decided on; applied the indicated criteria to six such methods in detail and scrutinized an evaluation by others of a seventh method; and provided recommendations on steps the Federal judges could take to reinforce forensic science and further its more careful use in the courtroom.¹³¹ The PCAST Report discovered that expert witnesses often overstated the probative value of their evidence, even to the extent of justifying what relevant science could not support.¹³²

With regard to latent fingerprints, the report elucidates that latent fingerprint analysis is a foundationally valid subjective methodology.¹³³ The fingerprint analysts in the USA follow the ACE-V methodology and this method requires them to make a series of subjective assessments to select particular regions of a latent print for analysis.¹³⁴ To add to that, the report stipulated that the verification stage, that is the last step of the ACE-V, is problematic because it is not done blindly. Often the second examiner knows the first examiner's conclusion which creates the potential for confirmation bias.¹³⁵ In summary, the report echoed the same sentiments expressed in the above mentioned reports with regard to fingerprint evidence and emphasised that caution

<https://www.whitehouse.gov/blog/2016/09/20/pcast-releases-report-forensic-science-criminal-courts> (accessed 01-12-2016).

¹²⁸ *Ibid* 1.

¹²⁹ *Ibid* 3.

¹³⁰ *Ibid* 2.

¹³¹ *Ibid* 3.

¹³² *Ibid*.

¹³³ *Ibid* 9.

¹³⁴ *Ibid* 90.

¹³⁵ *Ibid* 91.

and scrutiny should be exercised because its heavy reliance on human judgment means it is susceptible or prone to human error, inconsistency across examiners, and cognitive bias.¹³⁶

In short, the reports mentioned above echo the same sentiments with regard to the challenges that are associated with the use and acceptance of forensic evidence in general and specifically fingerprint evidence, without scrutiny of the evidence by the courts. These problems include the lack of clear rules on how much relevant weight to give to the various print characteristics, and the fact that there is no threshold regarding the number of points that must be matched¹³⁷, and no agreed standards of what constitutes a match and the fact that no peer reviewed scientific studies have been done to prove the basic assumption that every person's fingerprint is unique.¹³⁸ The issues emerging from these reports are crucial in that they brought an insight regarding the problems associated with fingerprint evidence and the need for the courts to be more cautious when admitting such evidence. As a result of these challenges raised in these reports, jurisdictions in the United States of America, England and Wales and Scotland have embarked on a journey to reform the rules for admissibility of expert evidence so as to minimize wrongful convictions and miscarriages of justice. The reports are from jurisdictions that generally are regarded as leading forensic science proponents. These Anglo-American jurisdictions also share the adversarial system used in South Africa.

1 10 THE RESEARCH METHODOLOGY

This is a desktop-based evaluative study. Primary and secondary sources are used. Primary sources include international instruments, national legislations and selected international and national case law that deal with fingerprint evidence and that are relevant in reviewing the five reports. Secondary sources that are employed by this research project include textbooks, journal articles, reports, newspaper articles, critical reviews and internet sources pertinent to the subject of fingerprinting.

¹³⁶ *Ibid* 6.

¹³⁷ NIST Report 24.

¹³⁸ Jones "Forensic Tools" <http://www.pbs.org/wgbh/frontline/article/forensic-tools-whats-reliable-and-whats-not-so-scientific/> (accessed on 04-05-2016).

1 11 ETHICAL IMPLICATIONS OF THIS STUDY

This research does not involve any moral, social and behavioural implications as questionnaires or interviews are not used in this study.

1 12 CHAPTER OUTLINE

This study is divided into five Chapters.

Chapter one provides a succinct overview of the nature of expert forensic science evidence in general and fingerprint evidence in particular. The recent debates surrounding the reliability of fingerprint evidence are highlighted and in the light of this the importance of this research is justified. The introductory chapter explains how this project sets out to investigate five recent international reports in the field of forensic science, in order to gain insights and solutions that may assist the South African legal system to confront the problems faced in the field of fingerprinting. The chapter outlines the research problem, objectives, delimitation and methodology of the research project and provides a succinct literature review of the reports interrogated in this dissertation.

Chapter two provides a history of fingerprint evidence and indicates how fingerprints became well known as a powerful tool for identification by investigators and lawyers. First the chapter explores the history of fingerprint identification techniques and evidence. Secondly, the examination of fingerprints as tools used for identification as well as the ways in which they are collected from crime scenes, are interrogated. The third part of this chapter explains the classification of fingerprints and graphics are used to demonstrate the categories of friction ridges. The last part of the chapter deals with the evaluation and comparison of fingerprints, including the method that is used by fingerprint examiners to compare and evaluate fingerprints.

Chapter three reviews five international forensic reports and interrogates problems emphasized there. This Chapter confines itself to problems highlighted in the reports and the recommendations contained in these reports. Chapter three concludes by highlighting the similarities in the issues raised in these reports and the extent to which these problems have been addressed in practice.

Chapter four explores the emerging solutions to issues raised by the five reports and highlights how knowledge of these issues can specifically assist South African courts to resolve problems surrounding fingerprint evidence in South African case law. The last part of the chapter presents

possible cross-examination questions the defence could use to test the reliability of fingerprint evidence.

The concluding chapter, Chapter five, sums up important issues and findings of the study in connection with the goals of the research.

1 13 REFERENCING STYLE

The referencing style utilized is that of *Speculum Juris*, an accredited law journal published by the Nelson R. Mandela School of Law, University of Fort Hare. The research does not have any intellectual property implications in terms of copyright law as all texts utilized are referenced.

CHAPTER TWO

THE HISTORY AND UNDERLYING PRINCIPLES OF FINGERPRINT EVIDENCE

2 1 INTRODUCTION

In primitive times perpetrators were identified by sight.¹³⁹ In time the world's population began to increase, people became more anonymous, societies became mobile and communities became more suspicious of unknown persons crossing their borders.¹⁴⁰ As the world population increased, commission of crime increased proportionally and it became a huge challenge for law enforcement agents to identify perpetrators of these crimes by sight only, hence techniques to determine the identity of criminals became a leading concern.¹⁴¹ The need to identify perpetrators highlights the important duty that forensic science has in identifying the perpetrators of crimes. Fingerprints, along with forensic dental and DNA analysis, are vital in the identification of unknown individuals, unknown deceased individuals and human remains.¹⁴² While the identification of perpetrators of

¹³⁹ Cothron "Fingerprint evidence Part 1: Tracing Friction Ridges through History" <http://ssrn.com/abstract=2130808>. (accessed 27-08-2016) 1. Also see Kaushal "Fingerprints: Historical Background and Future Trends" 2009 *The Internet Journal of Forensic Science* 1-5.

¹⁴⁰ Cole "Fingerprint Identification and the Criminal Justice System: Historical Lessons for the DNA Debate" 2004 *Department of Criminology, Law and Society* 63-89.

¹⁴¹ Cothron "Fingerprint Evidence Part 1: Tracing Friction Ridges through History" <http://ssrn.com/abstract=2130808> (accessed 27-08-2016) 1.

¹⁴² Cole "More than Zero: Accounting for Error in Latent Finger Print Identification" 2005 *Journal of Criminal Law & Criminology* 993-998.

crime has been a continuous challenge for all forensic disciplines, fingerprint analysis has been the core of forensic identification efforts for decades and it is the oldest known discipline of identification in forensics.¹⁴³ Barnes asserts “(t)he long story of that inescapable mark of identity has been told and retold for many years and in many ways.”¹⁴⁴

This chapter provides a history of fingerprint evidence and indicates how fingerprints became well known as a powerful tool for identification by investigators and lawyers. Firstly, the chapter explores the history of fingerprint identification techniques and evidence. Secondly, the examination of fingerprints as tools used for identification as well as the ways in which they are collected from crime scenes are interrogated. The third part of this chapter explains the classification of fingerprints and graphics are used to demonstrate the categories of friction ridges. The last part of the chapter deals with the evaluation and comparison of fingerprints, including the method that is used to compare and evaluate fingerprints to declare a match by the fingerprint examiners

2 2 THE HISTORICAL EVOLUTION OF FINGERPRINT EVIDENCE

Prior to the utilization of fingerprints to identify suspects or offenders, numerous less successful identification systems were used.¹⁴⁵ Studies that involved individualization identification procedures gained momentum as a result of the work of Alphonse Bertillon.¹⁴⁶ The Bertillonage system was based on measurements obtained or extracted from specific parts of the human body,

¹⁴³ Cothron “Fingerprint evidence Part 1: Tracing Friction Ridges through History” <http://ssrn.com/abstract=2130808>. (accessed 27-08-2016) 1.

¹⁴⁴ Barnes “History” in Holder *et al The Fingerprint Sourcebook* (2011) 1.

¹⁴⁵ Cole *Suspect Identities: A History of Fingerprinting and Criminal Identification* (2001) 15-23. It is stated that authorities sought to identify the criminal persons who could visually pass as upstanding citizens, not persons who usually appeared suspicious. The human body and head as a mechanism to both identify possible criminals to determine personality traits that may lead a person to commit a crime. For example, Cesare Lombroso the founder of the Italian School of Positivist Criminology, established the new the new science of criminal anthropology. Lombroso’s 1876 *Criminal Man* became a leading text of his new discipline, the theory stressed that each criminal act could be linked to a biological or social cause, as a result it led to people theorizing that the body of the criminal could be used to differentiate criminals from normal, law-abiding citizens. Carl Gustav Carus attempted to use skull size to identify criminals, this was also supported by Hubert Lauvergne when he asserted that criminals indeed could be identified by abnormalities of the skull. See also Saks, “Merlin and Solomon: Lessons from the Law’s Formative Encounters with Forensic Identification Science” 1998, wherein he quotes what Adolph Quetelet said, “a 19th century sociologist and statistician, hypothesized that nature never creates biological duplicates.”

¹⁴⁶ Saks and Koehler “The Individualization Fallacy in Forensic Science Evidence” 2008 *Vanderbilt Law Review* 207. Using Quetelet’s hypothesis that nature does not replicate, Bertillon established the first widely used system of identification, known as Bertillonage or anthropometry.

for example the length of several bones.¹⁴⁷ The premises of the Bertillonage system was the belief that people are different and that a person with adequate knowledge who measured with sufficient precision could read the measurement differences.¹⁴⁸ However, as more law enforcement agents began to use the Bertillonage system, a number of problems began to emerge in that different officers were taking measurements which were not exact and the record keeping necessary for the system was so exasperating that officers found themselves looking into an unwieldy number of cards.¹⁴⁹ Gradually fingerprints replaced the Bertillonage system as the preferred method to identify individuals.¹⁵⁰ The history of fingerprints as a method to identify people can be traced back to China in the 300s BC, in particular the Chinese records from the Qin, Han and T'ang Dynasties where thumb prints were used on clay seals.¹⁵¹

In China thumb prints were used on clay seals to prevent fraud and forgery.¹⁵² During this era it was both the name of the author and the fingerprint that gave the document originality.¹⁵³ The fingerprints were used to give authenticity to documents after the invention of paper. In the 1400s in Persia, papers from the government had signatures of fingerprints and consequently one doctor established that no two fingerprints look alike.¹⁵⁴ In the 1600s Marcello Malpighi included friction

¹⁴⁷ Mnookin "Fingerprinting Evidence in an Age of DNA Profiling" 2001 *Brooklyn Law Review* 29. It has been stated that anthropometry established the commencement of forensic individualization techniques and criminal identification bureaus around the world began to use Bertillonage. See also Saks and Koehler "The Individualization Fallacy in Forensic Science Evidence" 2008 *Vanderbilt Law Review* 207.

¹⁴⁸ Cothron "Fingerprint Evidence Part 1: Tracing Friction Ridges through History" <http://ssrn.com/abstract=2130808> (accessed 27-08-2016) 5.

¹⁴⁹ Hutchins "Systems of Friction Ridge Classification" in Holder *et al The Fingerprint Sourcebook* (2011) <http://www.nij.gov/pubs-sum/225320.htm> (accessed on 23-08-2016). It is written that "the Bertillonage system lacked permanency as people grow old and the measurements would change".

¹⁵⁰ Cothron "Fingerprint Evidence Part 1: Tracing Friction Ridges through History" <http://ssrn.com/abstract=2130808> (accessed 27-08-2016) 7. See also Giglio "The History and Evolution of Fingerprint Identification" 2013 <https://pvteyes.com/history-evolution-fingerprint-identification/> (accessed 27-08-2016).

¹⁵¹ Fingerprint America "History of Fingerprints" 2012 <http://www.fingerprintamerica.com/fingerprinthisory.asp> (Accessed 20-08-2016).

¹⁵² The Forensic Outreach Team "From Egypt to Babylon and beyond: uncovering Ancient Fingerprints" <http://forensicoutreach.com/library/from-egypt-to-babylon-and-beyond-uncovering-ancient-fingerprints/> (Accessed 20-08-2016). It is written that, "the Chinese term chin yin, literally means 'finger seal', appropriately named for the common practice of contractors signing legal documentations with the press of their fingertip. In China it became a practice that when sealing products one side would have the name of the author and the other side would have the fingerprint of the author." This was done to do away with manipulation of document before it reaches its final destination.

¹⁵³ Barnes "History" in Holder *et al The Fingerprint Sourcebook* (2011) 8.

¹⁵⁴ Fascinating Ancient History of Fingerprints 2016 <http://www.messagetoeagle.com/fascinating-ancient-history-of-fingerprints> (accessed 20-08-2016).

ridges,¹⁵⁵ spirals and loops in his treatise; however there was no indication of the uniqueness or permanence of fingerprints.¹⁵⁶ In the 17th century scientists started to show their considerations and understanding of human skin.¹⁵⁷ Even though, many scientists did their observations, they failed to address the aspect of individualization and permanence of friction ridges.¹⁵⁸ Sir William Herschel was the first person to employ fingerprints practically for identification purposes, when he required people to put their fingerprints and handprints as a signature on domestic contracts to preclude and reduce fraud and forgery.¹⁵⁹ Barnes states that “Herschel’s belief that fingerprints were unique to an individual and that they do not change for the entire life of an individual, influenced his work to develop the application of fingerprints”.¹⁶⁰

Henry Faulds acknowledged the vital role fingerprints play in the identification of individuals and he formulated a model to classify fingerprints.¹⁶¹ In the journal *Nature*, in 1880, he published an analysis of his observations on the identification prospects by fingerprints.¹⁶² The leading study done by Faulds forecasted the forensic application of fingerprints to apprehend criminals and gave a modern procedure of compiling fingerprints while applying black printer’s ink.¹⁶³ His premise concerning the evidentiary value of fingerprints, was established when he puzzled out a minor crime that dealt with the pilfering of purified alcohol from his hospital laboratory.¹⁶⁴ Faulds, in this case, differentiated greasy fingerprints lifted from a piece of glassware and compared them with inked impressions he had gathered from his staff, and he identified one of his medical students

¹⁵⁵ The Malpighi Layer was named after Marcello, and it is about 18mm thick. The Malpighian layer of the skin in the American Heritage Dictionary is defined as both the stratum basale and stratum spinosum as a unit in general, but it is occasionally defined as the stratum basale specifically. See American Heritage Dictionary of the English Language, 5ed (2011).

¹⁵⁶ Marcello noted the difference in individuals’ fingerprints and he started to create classification systems to describe different types of fingerprints.

¹⁵⁷ Friction ridge skin was first explained in detail by Dr Nehemiah Grew.

¹⁵⁸ Barnes “History” in Holder *et al The Fingerprint Sourcebook* (2011) 12.

¹⁵⁹ U.S. Marshals Service for Students “What Type of Fingerprints Do You Have? Fingerprint History” https://www.usmarshals.gov/usmsforkids/fingerprint_history.htm (accessed 20-08-2016).

¹⁶⁰ Barnes “The History of Fingerprints Chapter from The Source Book” 2014 <http://onin.com/fp/fphistory.html> (accessed 20-08-2016).

¹⁶¹ Barnes “History” in Holder *et al The Fingerprint Sourcebook* (2011) 11.

¹⁶² U.S. Marshals Service for Students “What type of fingerprints do you have? Fingerprint history” https://www.usmarshals.gov/usmsforkids/fingerprint_history.htm (accessed 20-08-2016) explains the works of Faulds. Faulds is regarded as true inventor of the friction ridges even though Galton and Herschel are credited for pioneering fingerprints. This is so because Galton and Herschel carried out the research of friction ridges to greater heights by showing that the friction ridges are unique and that they do not change with time.”

¹⁶³ Crime Scene Forensics LLC “History of Fingerprints” 2015 http://www.crimesceneforensics.com/History_of_Fingerprints.html (accessed 20-08-2016).

¹⁶⁴ Fingerprint America “History of Fingerprints” 2012 <http://www.fingerprintamerica.com/fingerprinthistory.asp> (Accessed 20-08-2016).

as the perpetrator. This marked the first fingerprint identification in history.¹⁶⁵ Sir Francis Galton developed the works of Herschel and Faulds when he published the book *Fingerprints*, in 1892.¹⁶⁶

The research conducted by Galton gave a thorough analysis of the individuality and permanence of friction ridge skin, giving actual or verifiable support to the fundamental scientific propositions of fingerprints.¹⁶⁷ Galton divided the fingerprint patterns into three categories namely arches, loops, and whorls and this premised the basis of applying fingerprint patterns to guide the compiling of criminal records in a way related to Bertillon's system founded on measurements.¹⁶⁸ This resulted in the extensive method of classification accepted and mostly used.¹⁶⁹ Edward Richard Henry¹⁷⁰ highlighted the shortcomings of Galton's categories of classification and decided that there must be an easier and more efficient method to give law enforcement agents the ability

¹⁶⁵ U.S. Marshals Service for Students "What type of fingerprints do you have? Fingerprint history" https://www.usmarshals.gov/usmsforkids/fingerprint_history.htm (accessed 20-08-2016).

¹⁶⁶ *Ibid.*

¹⁶⁷ Barnes "The History of Fingerprints Chapter from The Source Book" 2014 <http://onin.com/fp/fphistory.html> (accessed 20-08-2016).

¹⁶⁸ Cole "Fingerprint Identification and the Criminal Justice System: Historical Lessons for the DNA Debate" 2004 *Department of Criminology, Law and Society* 63-89. Cole elaborates that, "Galton's primary interest in fingerprints was as an aid in determining heredity and racial background. However, he discovered that fingerprints offered no firm clues to an individual's intelligence or genetic history, he was able to prove what Herschel and Faulds already observed, that fingerprints are permanent for an individual's entire lifetime, and that fingerprints are unique".

¹⁶⁹ Fingerprint America "History of Fingerprints" 2012 <http://www.fingerprintamerica.com/fingerprinthistory.asp> (accessed 20-08-2016). It states that, "the earliest fingerprint classification systems were developed almost simultaneously during the mid-1890s by Juan Vucetich, a police official in La Plata, Argentina, and Edward Henry, Azizul Haque, and Chandra Bose of the British colonial police in the Bengal province of India. The resourceful steps consisted of extending Galton's multilateral classification system by subdividing loops by means of ridge counting, measuring the number of intervening ridges between the delta, the point at which the transverse ridges separated to flow around the central pattern and the center of the print and whorls by means of ridge tracing, following a ridge from the delta and determining whether it passed inside or outside the center of the print. In this way, loops and whorls could be assigned to subcategories. By classifying each individual according to the pattern types and subtypes on all ten fingers, just like Bertillon operators, fingerprint classifiers could, reduce even very large collections of identification cards into relatively small groups. The closest parallel was probably one of the earliest forensic fingerprint cases, the Rojas case in Argentina in 1892. The initial suspect in the murder of two young children in the village of Necochea was the mother's suitor, one Velasquez. Standard tactics, including torture and forcing Velasquez to sleep with the corpses, failed to elicit a confession. Only then, did detectives, familiar with Vucetich's work with fingerprints, examine a bloody fingerprint found at the crime scene. This print matched, not Velasquez, but the victims' mother Francesca Rojas. Confronted with this evidence, Rojas confessed to the crime. While Velasquez had not yet been convicted when the fingerprint evidence was discovered, one might reasonably infer that, as the prime suspect in the grisly murder of two young children, he would have been. At the same time, the bloody fingerprint does not definitively prove the Rojas committed the crime since she may have touched the corpse's post-mortem". See also Griesel "Fingerprint Analysis in Forensic Investigations: An Interesting History" 2014 <http://www.csinvestigate.co.za/fingerprint-analysis-in-forensic-investigation-an-interesting-history/> (accessed 23-08-2016).

¹⁷⁰ Sir Edward Richard Henry was an Inspector General of Police in Bengal, India. He developed the classification system of fingerprints and was initially adopted in England and later on spread worldwide.

to file and recover various data of fingerprints.¹⁷¹ As a result Henry's classification system was embraced by the Indian government, recognizing fingerprints as the formal tool of criminal identification in India.

In South Africa fingerprints began to be used in 1900 when a fingerprinting office was established in Pietermaritzburg, with Britain's Scotland Yard following suit in 1901 and by 1925 several offices had mushroomed, necessitating the creation of the South African Criminal Bureau.¹⁷² The successful use of fingerprinting in India prompted England and Wales to implement fingerprints as a means of criminal identification and to establish a Fingerprint Bureau at New Scotland Yard.¹⁷³ The first English trial in which fingerprint evidence was used, was held in 1902. Fingerprint evidence was used by Scotland Yard in a burglary case and Inspector Charles Stockley Collins testified to the individualization of the fingerprint.¹⁷⁴ Henry Jackson pleaded not guilty to a charge of burglary and stealing. Jackson's thumbprint was compared with a thumbprint discovered in dirt on a newly painted windowsill. In this case photographic enlargements were used to explain fingerprint classification, and Jackson was found guilty and served seven years in jail. The defence attorney in Jackson's case contested the permanence of fingerprints, but did not contest the controversial uniqueness of fingerprints.¹⁷⁵

The first official utilization of fingerprints in the United States was when the New York Civil Service Commission in 1902 and the New York State Penitentiary System in 1903 embraced the application of fingerprints as a mechanism for civil and criminal identification respectively.¹⁷⁶ In 1910 the case of *People v Jennings*¹⁷⁷ became a watershed legal case as it was the first American

¹⁷¹ Barnes "History" in Holder *et al* *The Fingerprint Sourcebook* (2011) 13.

¹⁷² South African History Online: Towards the People's History 2011 <http://www.sahistory.org.za/organisations/south-african-police-sap> (accessed 24-08-2016).

¹⁷³ Fingerprint America "History of Fingerprints" 2012 <http://www.fingerprintamerica.com/fingerprinthishistory.asp> (accessed 20-08-2016). See Cothron "Fingerprint Evidence Part 1: Tracing Friction Ridges through History" <http://ssrn.com/abstract=2130808> (accessed 27-08-2016) 30. 1902 was the first full year of fingerprint identification being used by Scotland Yard. That year 1,722 identifications were made and in the following year fingerprint identifications doubled, and by 1904, Scotland Yard was processing approximately 350 fingerprint cards.

¹⁷⁴ Cole *Suspect Identities: A History of Fingerprinting and Criminal Identification* (2001) 90.

¹⁷⁵ *Ibid*. It can be argued that since its initial use, fingerprints were controversial, however it was not taken seriously and as a result lack of disproof by the defence was used as an indication to prove that fingerprints are infallible.

¹⁷⁶ Fingerprint America "History of Fingerprints" 2012 <http://www.fingerprintamerica.com/fingerprinthishistory.asp> (accessed 20-08-2016).

¹⁷⁷ *People v Jennings* 252 Ill.534,96 N.E 1077 1911. See also Acree "People v Jennings: A significant case in American Fingerprint History" 1998 1 <http://www.scafo.org/library/140401.html> (accessed 27-08-2016). In this article the author gives detailed facts of the case and its importance to the history of fingerprints in America.

appellate case that dealt with the admissibility of fingerprint expert testimony. In this case it was highlighted that identification by fingerprints constituted a science and that expert testimony was important to help or assist the court officials in the comprehension and interpretation of fingerprint evidence.¹⁷⁸ In 1918 Edmond Locard observed that “if 12 points were the same between two fingerprints, it would suffice as a positive identification.”¹⁷⁹ Subsequently the 12 points of similarity to declare a match was accepted. Despite the acceptance of the 12 points of similarity to declare a match, it is crucial for fingerprint examiners and the presiding officers to be aware that there is no specific or standardized number of points that are imperative to declare a match; it varies from country to country or from examiner to examiner.¹⁸⁰

The premises of permanence and uniqueness of friction ridges have made them powerful tools to identify perpetrators or offenders individually.¹⁸¹ Even though the friction ridge skin is durable, it is subject to injury and ageing, which may lead to the change of the impression of the same person taken many years ago.¹⁸² In recent years, the use of fingerprints to identify offenders has been found to be controversial by academic researchers, more particularly its accuracy, reliability and admissibility.¹⁸³

2 3 THE FORMATION, NATURE, TYPES AND METHODS OF COLLECTION OF FINGERPRINTS

2 3 1 Formation and nature of fingerprints

An ordinary person (in this sense someone who does not have knowledge of fingerprints and their nature) could be wondering when exactly are these friction ridges formed; could it be before birth

¹⁷⁸ Mnookin “Fingerprints: Not a Good Standard” 2003 *Issues in Science and Technology* issues.org/20-1/mnookin/ (accessed 24-08-2016). Professor Mnookin argues that “neither the court in *Jennings* nor subsequent judges ever required that fingerprint identification be placed on a secure statistical foundation.”

¹⁷⁹ Chisum and Turvey “Evidence Dynamics: Locard’s Exchange Principle & Crime” 2000 *Journal of Behavioral Profiling* http://www.profiling.org/journal/vol1_no1/jbp_ed_january2000_1-1.html (accessed 27-08-2016).

¹⁸⁰ Mnookin “Fingerprints: Not a Good Standard” 2003 *Issues in Science and Technology* issues.org/20-1/mnookin/ (accessed 24-08-2016).

¹⁸¹ Cherry *et al* “Another ‘View’ of Fingerprint Evidence” 2011 *Judicature* 306. Also see generally Zabell “Fingerprint Evidence” 2005 *Journal of Law and Policy* 143-179.

¹⁸² Saks and Koehler “The Coming Paradigm Shift in Forensic Identification Science” 2005 <http://www.sakkyndig.com/psykologi/artikler/ForensicShift.pdf> (accessed 23-08-2016).

¹⁸³ See Cole “Out of the *Daubert* Fire and into the *Fryeing* Pan? Self-validation, Meta-Expertise and the Admissibility of Latent print evidence in *Frye* Jurisdictions” 2008 *Minnesota Journal of Law Science and Technology* 459. See also Cooper “Challenges to Fingerprints Identification Evidence: Why the Courts need a New Approach to Finality” 2016 *Mitchell Hamline Law Review* 757.

and if so is it at the early stages of the pregnancy or at a later stage? The other questions would be what, why and how fingerprints are unique and permanent? It is important for fingerprint examiners to have a background knowledge of when, how and where friction ridges are formed, and what happens when fingerprints come into contact with a surface. People touch things every day and by doing that they transfer their fingerprints to objects, for instance upon touching coffee cups, water glasses, car doors, computer keypads, tables and even chairs.¹⁸⁴ Hence the comprehension on how the friction ridge skin behaves when it gets in touch with a surface, gives incalculable assistance when examining the friction ridge impressions.

The anatomy and physiology of the friction ridge skin establish the premise for various important components that are fundamental to the examination process;¹⁸⁵ and it explains how the attributes of the friction ridge skin endure and how the skin reacts to injury and age.¹⁸⁶ Friction ridges are found on the skin on the underside of the fingers, palms of hands and soles of feet and this allows humans to hold on to a surface firmly and each time this happens, there is transfer of the natural oils and perspiration present between friction ridges.¹⁸⁷ Friction ridges are formed during fetal development in the uterus through an unsystematic biological procedure.¹⁸⁸

The formation of primary friction ridges in fingerprints, commences during the ninth or tenth week of fetal development.¹⁸⁹ Moreover, around the seventeenth week of fetal evolution, the primary ridges cease to grow rapidly and the formation of the secondary friction ridges commences and they will mature over twenty-four weeks.¹⁹⁰ Genetics, chemicals, diseases, environmental factors

¹⁸⁴ Simplified Guide to Fingerprint Analysis <http://www.forensicsciencesimplified.org/prints/Fingerprints.pdf> (accessed 27-03-2016). See also Jain *et al* "Fingerprint Matching" 2010. In this article it is contended that, "the skin on our palms and soles exhibits a flow-like pattern of ridges and valleys. These papillary ridges on the finger, called friction ridges, help the hand to grasp objects by increasing friction and improving the tactile sensing of surface textures. The 'Friction Ridge Patterns' sidebar describes the nature and origin of these characteristics."

¹⁸⁵ Maceo "Anatomy and Physiology of Adult Friction Ridge Skin" 2002 <http://www.nij.gov/pubs-sum/225320.htm> (accessed 28-08-2016).

¹⁸⁶ *Ibid.*

¹⁸⁷ Jones "Friction Ridges Make a Lasting Impression" 2006 <http://www.forensicmag.com/article/2006/10/friction-ridges-make-lasting-impression> (accessed 28-08-2016).

¹⁸⁸ Cothron "Fingerprint Evidence Part 1: Tracing Friction Ridges through History" <http://ssrn.com/abstract=2130808> (accessed 27-08-2016) 39.

¹⁸⁹ *United States v Mitchell* 2004 365 F.3d 215 (3d Cir). In this case Dr Babler gave an explanation on the formation of friction ridges. Dr Babler stated that the friction ridges grow deep to the surface of the skin and that the development persists until roughly fifteen to seventeen weeks of fetal formation.

¹⁹⁰ Cothron "Fingerprint Evidence Part 1: Tracing Friction Ridges through History" <http://ssrn.com/abstract=2130808> (accessed 27-08-2016) 39.

and the shape of the finger, amid other factors in the uterus, affect the specific form of the ridges.¹⁹¹ The unsystematic procedure in which the formation of fingerprints takes place, caused scholars to have the belief that every fingerprint is unique, even from finger to finger on the same individual and even fingerprints of identical twins.¹⁹² Thus, the assumption that no two fingerprints are alike, is what scholars refer to as uniqueness. Wertheim and Maceo contend that:

The individuality of friction ridge skin, or all skin for that matter, falls under the larger umbrella of biological uniqueness. No two organisms are exactly alike. The intrinsic and extrinsic factors affecting the development of any individual are impossible to duplicate.¹⁹³

More so, the proposition that fingerprints are permanent, is based on the premise that fingerprints are durable in the absence of a dramatic injury to the finger(s). This proposition is derived from the fact that fingerprints are generated and imprinted in the dermis, the thick tissue underlying the epidermis, on which fingerprints are visible.¹⁹⁴ Maceo, in *The Fingerprint Sourcebook*, asserts that:

The ridges that are visible on the palm of the hands are firmly rooted in the dermis by primary ridges or undersurface ridges and the secondary ridges. The primary and secondary ridges are interlocked with the dermis to provide support and strength to the friction ridges.¹⁹⁵

The sweat glands and pores of the skin make fingerprints transferrable to certain surfaces; sweat is transmitted along the ridges, and because of sweat and some oils the friction ridges are transferred to the surface.¹⁹⁶ Therefore, it is the oil or fluid transfer that leaves impressions that

¹⁹¹ Ashbaugh "Ridgeology: Modern Evaluative Friction Ridge Identification" 1999 <http://onin.com/fp/ridgeology.pdf> (accessed 30-08-2016).

¹⁹² Coppock *An Investigator's basic Reference guide to Fingerprint Identification Techniques* (2001) 21. See also Peterson *et al* "Latent prints: A Perspective on the State of Science" 2009 *Forensic Science Community* <https://archives.fbi.gov/archives/about-us/lab/forensic-science-communications/fsc/oct2009/review> (accessed on 28-08-2016) This paper alludes to the proposition of the lasting or non-stop and individuality of friction ridge skin are well supported by a belief on the development of the friction ridge skin during fetal growth. It further states that the observations of the research that has been conducted shows that arrangements of friction ridge skin commence and eventually develop through a process of distinctive growth at the integration of the epidermal and dermal layers of the skin, thereby justify their limitless individuality

¹⁹³ Wertheim and Maceo "The Critical Stage of Friction Ridge and Pattern Formation" 2002 *Journal of Forensic Identification* 44.

¹⁹⁴ Maceo "Anatomy and Physiology of Adult Friction Ridge Skin" in Holder *et al The Fingerprint Sourcebook* (2011) 16.

¹⁹⁵ *Ibid.*

¹⁹⁶ Cothron "Fingerprint Evidence Part 1: Tracing Friction Ridges through History" <http://ssrn.com/abstract=2130808> (accessed 27-08-2016) 41.

law enforcement agents, when investigating crime scenes, lift, using various forensic science techniques.

2 3 2 Types of fingerprints and their methods of collection

The first thing that law enforcement agents need to do before comparing an unknown print to a known print, is to locate the print left by the suspect at the crime scene. Observing or finding fingerprints left on a surface, demands an acuity and determined exploration or hunting. If a print can be found by the naked eye observation, the process is relatively simple. However, the more tangled or difficult searches occur when the print cannot be found by mere optical observation. Therefore, the type of fingerprint left behind on the surface, generally determines the time and effort investigators will have to devote to finding the print. The type and nature of the surface where fingerprints have to be searched for, determine what technique the law enforcement agents would use. In forensic science there are three types of fingerprints that are used by law enforcement agents to establish the offender of a crime, namely patent, latent and impression prints.¹⁹⁷ Patent fingerprints are those prints that can be seen with the naked eye and are normally made because the individuals have had their fingers in some sort of liquid or powder for example blood, ink, or oil and generally a photograph will suffice in recording them.¹⁹⁸ Patent prints can be found on smooth, rough or porous surfaces, for instance paper, cloth or wood or on nonporous surfaces such as metal, glass or plastic.¹⁹⁹

Latent fingerprints are prints that are not visible to the naked eye but which are visible under certain conditions.²⁰⁰ Latent prints differ in their quality and in the number of friction ridges that can be lifted by investigators. Latent prints can also be described as those prints left unintentionally

¹⁹⁷ Lyle *Forensic Science* (2012) 255.

¹⁹⁸ Ulery *et al* "Accuracy and Reliability of Forensic Latent Fingerprint Decisions" 2011 www.pnas.org/cgi/doi/10.1073/pnas.1018707108 (accessed 02-09-2016) 1. Patent prints are also referred to as exemplars and are defined as prints that are collected under controlled conditions from a known subject using ink on paper or digitally with a live scan device. Usually they are of higher quality.

¹⁹⁹ Simplified Guide to Fingerprint Analysis <http://www.forensicsciencesimplified.org/prints/Fingerprints.pdf> (accessed 27-03-2016).

²⁰⁰ See The U.S. Department of Justice, FBI "The Science of Fingerprints: Classification and Uses" 1984 <http://www.gutenberg.org/files/19022/19022-h/19022-h.htm> (accessed On 23/05/2016) 170; wherein a brief description on how latent prints are formed is given:

"The ridges of the fingers and palms are in intermittent contact with other parts of the body, such as the hair and face, and with various objects, which may leave a film of grease or moisture on the ridges. In touching an object, the film of moisture and/or grease may be transferred to the object, thus leaving an outline of the ridges of the fingers or palm thereon. This print is called a latent impression, the word 'latent' meaning hidden, that is, the print many times is not readily visible."

at the crime scenes²⁰¹ and some latent print examiners look for additional identifying features beyond the basic ridge characteristics when comparing fingerprints, such as sweat pores and small edges on ridges.²⁰² A powder technique is usually utilised to identify latent prints on nonporous surfaces such as glass, marble, metal, plastic, and finished wood.²⁰³ Dr Lennard contended that the nature of latent fingerprints make them the most problematic as they are largely invisible, and require some form of physical or chemical treatment to differentiate them from the substrate material.²⁰⁴ Latent prints can be made visible or certainly more identifiable by introducing them to a powder or chemical agent. One of the most common methods for discovering and collecting latent fingerprints is by dusting a smooth surface with fingerprint powder.²⁰⁵ This, however, may contaminate the evidence and ruin the opportunity to perform other techniques that could uncover a hidden print or additional information. Moreover, if the surface is porous, such as fabric, unfinished wood, and paper, the powder technique is not effective, and in that case chemical methods to locate the print such as iodine fuming, silver nitrate, or ninhydrin are rather used.²⁰⁶ When one of these chemicals gets into contact with the chemicals present in the fingerprint residue, namely natural oils or fats, the print becomes visual.

The third kind of fingerprint, namely impressed fingerprints, are prints that have been made on the human body, or in soft material or tissue such as clay, wax or paint by pressing down with the finger or hand.²⁰⁷ Observing and identifying fingerprints left on human skin, is very challenging. According to Giannelli *et al*, the first major difficulty is finding the print since the oily residue left by fingers that form the fingerprint itself, is usually present on human skin, which in turn makes it

²⁰¹ Ulery *et al* "Accuracy and Reliability of Forensic Latent Fingerprint Decisions" 2011 www.pnas.org/cgi/doi/10.1073/pnas.1018707108 (accessed 02-09-2016) 1.

²⁰² *Ibid*.

²⁰³ Lyle *Forensic Science* (2012) 256. It is submitted, "[t]hat when the powder is spread on the surface, it heeds to the residue transferred from the finger's touch, allowing investigators to find the print. Most of the times, to avoid smudging the print, a magnetic powder technique is used in which the powder is poured on the surface and then spread evenly over the surface using a magnetic force instead of spreading the powder with a brush". Also the color of the powder should contrast that of the surface on which the print is to be located, for instance if the surface is black white or grey powder suffice. This allows better visibility and easy for the law enforcement agents to locate the prints.

²⁰⁴ Lennard "The Detection and Enhancement of Latent Fingerprints" 2001 <http://latent-prints.com/images/specialpresentation.pdf> (accessed 27-07-2016) 4.

²⁰⁵ Faigman *et al Modern Scientific Evidence: The Law and Science of Expert Testimony* (2012-2013) 413. Also an alternate light source can be used to examine any likely surfaces for example doors, windows, railings etc. For instance investigators may use a blue light with an orange filter to find latent prints on desks, chairs, computer equipment or other objects at the scene of a break in.

²⁰⁶ *Ibid*.

²⁰⁷ *Ibid* 414.

difficult to find the difference between the surface skin and the print. After a print is left on human skin, the oily residue often disperses and is absorbed into the skin, blurring the print. Two hours is the maximum amount of time that a print on skin may be reliable.²⁰⁸ It is important that the print be photographed before it is lifted.²⁰⁹ The photograph will assist in showing where the print was located in comparison to other objects and will capture the orientation of the print.²¹⁰ In addition, photographing a print before it is lifted can be a paramount piece of identification of a patent print and can be used to compare and possibly match the print to its source.²¹¹ Photographing the print's location at the crime scene, may also serve as a tool to avoid accusations of tampering with evidence by investigators. After photographing the print, the investigators lift the print from the surface. This means that a permanent impression of the fingerprint is made.²¹² When lifting a print, a rubber tape with a sticky surface is applied to the fingerprint, and this leaves an imprint on the tape.²¹³ Identification information and a description of the location of the print should be written on the back of the tape or card.

2 3 3 Classification of Fingerprints

Classification of fingerprints is done to make the process of identification easy and effective. The fingerprint classification is traceable to Sir Francis Galton, who divided fingerprints into three main categories of patterns that are used in most classification systems. These include the arch, the whorl and the loop.²¹⁴ To add to the work of Galton, Edward Richard Henry created a system

²⁰⁸ Giannelli *et al Scientific Evidence* 5ed (2012) 964.

²⁰⁹ *Ibid.*

²¹⁰ *Ibid.*

²¹¹ *Ibid* 965.

²¹² *Ibid* 967. Gianelli highlights that “most of the times, a flat object, for example a ruler, is slowly swiped across the top of the tape to ensure that there are no bubbles or ripples in the tape that will affect the imprint, and the tape is carefully peeled off the surface and a plastic cover is placed on the sticky side of the tape to prevent disruption or distortion of the print”.

²¹³ *Ibid* 968.

²¹⁴ Cole *Suspect Identities: A History of Fingerprinting and Criminal Identification* (2001) 77-79. Cole states that Galton may have categorized fingerprints into as many as sixty separate categories before coming to the conclusion that all prints have an arch, whorl or loop. See also Hutchins “Systems of Friction Ridge Classification” in Holder *et al: The Fingerprint Sourcebook* (2011) 6, it is stated that “Sir Galton realized that for fingerprints to become a reliable method of personal individualization, a systematic, understandable, and applicable system of fingerprint classification had to be developed. In his book, Galton formulated a classification system that was based on the alphabetical enumerations of the three fingerprint patterns: L for a loop, W for a whorl, and A for an arch. Thus, to categorize a set of fingerprints, the pattern for each finger was labeled with one of these three letters”.

of fingerprint classification based upon the presence or absence of whorls.²¹⁵ In *The Fingerprint Sourcebook*, Hutchins explains how Sir Henry created his classification model.²¹⁶

Henry's classification was successful and it continued to be used and is taught to American forensic science students to this day.²¹⁷ Before Henry's classification of fingerprints, Veutech also developed a system for classifying fingerprints.²¹⁸ Henry's classification system was, however, modified in order for it to cater for larger populations by the creation of extensions.²¹⁹ In short, all the classification systems were as a result of the expansion of Galton's established three patterns.²²⁰ Thus, before the birth of computerization, the examiners used the classification systems based on ridge formation. However, the manual search of the known prints, as the agencies were receiving and storing more and more prints, became time- consuming and laborious. Consequently, the need for an efficient method for known print identification became essential. The invention of computers was the solution to this problem and now fingerprints could be stored and be retained in a computer and it makes the search easy and the whole process of identifying the offender becomes quicker and more efficient.²²¹ As highlighted by Hutchins in *The Fingerprint Sourcebook*, another disadvantage of a manual search of known prints, is that the legal arrest of the offender could be delayed as the law enforcement agencies would be waiting for the identification division.²²²

Fingerprints, as pointed out above, can be classified into three different groups based on the pattern of the ridges: that is the loop, the whorl and arches. Loops refer to those ridges that start on one side and rise towards the centre and return back to the side they started from (**see illustration Figure 1.1 and Figure 1.2**).²²³ Arches may be described as those ridges that slope upwards and

²¹⁵ Hutchins "Systems of Friction Ridge Classification" in Holder *et al The Fingerprint Sourcebook* (2011) 8.

²¹⁶ *Ibid*.

²¹⁷ *Ibid* 9.

²¹⁸ *Ibid* 6-8.

²¹⁹ Dass "Classification of Fingerprints" Department of Statistics and Probability https://www.cse.msu.edu/~cse802/Papers/802_FPCClassification.pdf (accessed 28-08-2016).

²²⁰ Hutchins "Systems of Friction Ridge Classification" in Holder *et al The Fingerprint Sourcebook* (2011) 8.

²²¹ See "The History of Fingerprints" <http://www.onin.com/fp/fphistory.html> (accessed 12-08-2016) where the Automated Fingerprint Identification Systems (hereafter AFIS) is explained in detail.

²²² Moses "Automated Fingerprint Identification System (AFIS)" in Holder *et al The Fingerprint Sourcebook* (2011) 1-8.

²²³ Jackson and Jackson *Forensic Science* 3ed (2011) 110. 60% of all fingerprint patterns have loops. Loops can be radial or ulnar. Radial loops slope towards the thumb and ulnar slope towards the small finger. Also, every loop have a core, single delta, a minimum of one recurving ridge that flows between the delta and core and minimum ridge count of one.

then downwards, like narrow mountains and they are divided into two distinct groups (see **example Figure 2.1 and Figure 2.2**).²²⁴ Whorls refer to those ridges that form a circular or spiral pattern and they are divided into four distinct groups (see **Figure 3**).²²⁵



(Figure 1.1 Left Loop)

Reprinted from Crime Scene Investigator Network “The Science of Fingerprints: Classification and Uses”²²⁶



(Figure 1.2 Right Loop)

Reprinted from Crime Scene Investigator Network “The Science of Fingerprints: Classification and Uses”²²⁷

²²⁴ *Ibid.* 5% of all fingerprint patterns have arches. Usually a plain arch is regarded as the simplest fingerprint pattern while tended are considered as intermediate between arch and a loop.

²²⁵ *Ibid.* 35% of all the fingerprint patterns have whorls.

²²⁶ Crime Scene Investigator Network “The Science of Fingerprints: Classification and Uses” <http://www.crime-scene-investigator.net/fbiscienceoffingerprints.html> 2016 (accessed 27-03-16).

²²⁷ *Ibid.*



(Figure 2.1. Plain Arch) Reprinted from Crime Scene Investigator Network “The Science of Fingerprints: Classification and Uses”²²⁸



(Figure 2.2 Tented Arch)

Reprinted from Crime Scene Investigator Network “The Science of Fingerprints: Classification and Uses”²²⁹

²²⁸ *Ibid.*

²²⁹ *Ibid.*



(Figure 3. Whorl) Reprinted from Crime Scene Investigator Network “The Science of Fingerprints: Classification and Uses”²³⁰

Fingerprint examiners evaluate the arrangement, size, shape and number of lines in these fingerprint patterns to differentiate one from another.²³¹ The friction ridges do not run evenly and unbroken across a person’s fingers. Rather, they show a number of characteristics known as *minutiae*.²³² The categories of *minutiae* include ridge ending, bifurcation, dot, short ridge, and island. Fingerprint examiners look at the *minutiae*, which are invisible to the naked eye, in order to establish particular points on a perpetrator’s fingerprint with the same details as those in a known print (see **Figure 4.1- Figure 4.3**).²³³

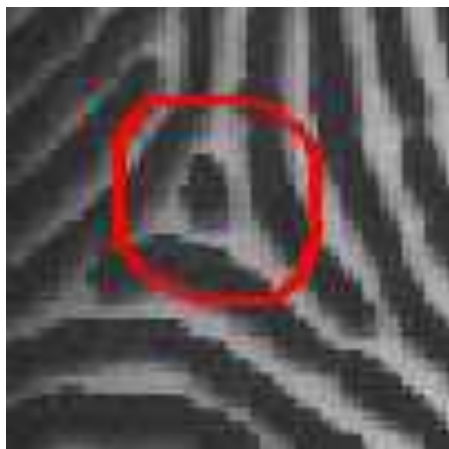
(Figure 4.1- Figure 4.3. Provide an illustration of the minutiae that the fingerprint examiner look for when comparing unknown print to a known print).

²³⁰ *Ibid.*

²³¹ Galton points consist of the points in a fingerprint where ridges terminate or bifurcate.

²³² Simplified Guide to Fingerprint Analysis <http://www.forensicsciencesimplified.org/prints/Fingerprints.pdf> (accessed 27-03-2016).

²³³ Margaret Rouse “*Minutiae*” <http://searchsecurity.techtarget.com/definition/minutiae> (accessed on 26-06-2016).



(Figure 4.1. The dot, may be defined as the ridge unit that is as long as it is wide).

Reprinted from “Fingerprint Identification”²³⁴



(Figure 4.2. A bifurcation; may be described as the ridge that follows a distinct part and divide into two ridges). Reprinted from “Fingerprint Identification”²³⁵

²³⁴ Fingerprint Identification 2008 http://www.realtimenorthamerica.com/download/Fingerprint_Identification.pdf (accessed 27-03-2016) 2.

²³⁵ *Ibid.*



Figure 4.3. Showing an Ending Ridge; an ending ridge is that ridge that follows a distinct path and ends abruptly) Reprinted from “Fingerprint Identification”²³⁶

As highlighted in *The Fingerprint Guide*, fingerprints comparison analysis can be done through examining the minutiae to establish whether the same details can be found in the unknown print, for instance a bifurcation, dot, end ridges etc and comparing whether the minutiae flow in the same direction, for example the bifurcation is a ridge running horizontally and the two divided ridges are to the right of the bifurcation; and the minutiae occupy the same relative positions to each other for example the bifurcation is separated from an enclosure below it by six intervening ridges.²³⁷

Where *minutiae* of two different fingerprint impressions meet these criteria, they are declared points of similarity. However, where *minutiae* do not meet these criteria, they are referred to as points of dissimilarity.²³⁸ When sufficient *minutiae* are located in the same true reasonable sequence or series or unit relationship, identification is presumed, and the points of similarity are referred to as points of identification.²³⁹ The presence of a particular type of ridge defines the class of a fingerprint and if the ridge type can be accurately determined, then the fingerprint can be correctly classified. One of the challenges that exists in the forensic discipline of fingerprint

²³⁶ Fingerprint Identification 2008 http://www.realtimenorthamerica.com/download/Fingerprint_Identification.pdf (accessed 27-03-2016) 2.

²³⁷ Fingerprint Guide <http://flash.lakeheadu.ca/~lubiote/Fingerprints%20Comparison%20Guide.pdf> (Accessed 26-09-2016).

²³⁸ Triplett and Cooney “Etiology of the ACE-V and its Proper Use: An Exploration of the Relationship between ACE-V and the Scientific Method of Hypothesis Testing” 2006 *Journal of Forensic Identification* 345-346.

²³⁹ Haber and Haber “Scientific Validation of Fingerprint Evidence under *Daubert*” 2008 *Law, Probability and Risk* 96.

identification, is that there is no standard number of points needed to declare a match. It varies from examiner to examiner, laboratory to laboratory, country to country and city to city.²⁴⁰

2.4 FINGERPRINT COMPARISON METHODOLOGY

In every scientific experiment to be carried out, there is a methodology to be followed by the person performing the experiment in order to reach a conclusion or to obtain results.²⁴¹ If an analyst carrying out a scientific experiment or laboratory examination, fails to follow a scientific method he or she may reach an incorrect observation.²⁴² In the forensic discipline of fingerprint evidence, fingerprint examiners follow the analysis, comparison, evaluation and verification (hereafter ACE-V) methodology, and it has become the most prevalent method for fingerprint examination in the USA.²⁴³ The ACE-V method, is one depiction of a method of examining details, creating a presupposition about the source, experimenting to determine whether there is an agreement or disagreement and consequently analyzing the sufficiency thereof; as well as rendering an evaluation and retesting to determine whether the conclusion can be repeated.²⁴⁴ If, for instance, fingerprint examiners do not follow the methodology step by step, errors are inevitable and this would have long lasting repercussions in the forensic science area.²⁴⁵ The fingerprint comparison methodology is followed in order to reach an independent decision. ACE-V is a favored method of examination by law enforcement agents as a way to change forensic identification into a more objective process, and as a way to improve the number of genuine identifications.²⁴⁶ Below, the fingerprint comparison methodology is discussed stage by stage.

²⁴⁰ Champod and Chamberlain “Fingerprints” in *Handbook of Forensic Science* (2009) 72; “Minutiae frequency varies greatly as a function of their type and their position. Hence any system suggesting a fixed addition of points cannot be supported from a statistical perspective.”

²⁴¹ Buthorn and Reitnauer “ACE-V: A Latent Print Examiner’s Scientific Method” 2014 https://az-forensics.com/docs/pdfs/ACE-V_for_Latent_Print_Examiners.pdf (accessed 28-08-2016).

²⁴² *Ibid.*

²⁴³ Mnookin “The Courts, the NAS and The Future of Forensic Science” 2010 *Brooklyn Law Review* 1217-1218. See also Fingerprint Guide <http://flash.lakeheadu.ca/~lubiotech/Fingerprints%20Comparison%20Guide.pdf> (Accessed 26-09-2016).

²⁴⁴ Vanderkolk “Examination Process” in Holder *et al The Fingerprint Sourcebook* (2011) 13.

²⁴⁵ A Review of the FBI’s handling of the Brandon Mayfield Case <http://www.justice.gov/oig/special/s0601/exec.pdf> (accessed 15-09-2016). If an error of identification occurs; it may result in wrongful convictions. Wrongful convictions occur when an innocent person is prosecuted, convicted and sentenced for an offence he or she did not commit.

²⁴⁶ Vanderkolk “Examination Process” in Holder *et al The Fingerprint Sourcebook* (2011) 1.

2 4 1 Analysis

Analysis is the first step of the fingerprint comparison process. At this stage the fingerprint examiner analyses the latent impressions so as to establish if there are sufficient details in the latent impression.²⁴⁷ At this initial step of the examination process of the known and unknown print, the fingerprint examiner gathers information in order to decide if the unknown print is useful for comparison.²⁴⁸ This is achieved by scrutinizing the three levels of detail present within the impression.²⁴⁹ At level one detail, it is the existence of comprehensive ridge flow or pattern type of impression that a fingerprint examiner analyses.²⁵⁰ The attributes of level one of detail may be found by the appearance of a loop, whorl or arch pattern in fingers.²⁵¹ The second level of detail includes individual features, or *minutiae*, of ridge formation, for instance bifurcations, dots etc. that are used as points of comparison by the fingerprint examiner. The third level of detail used at the analysis stage include the pores and edges.²⁵²

In short it can be said that the analysis stage is when the examiner brings about, available components to be used in comparison; the relevance of the information regarding a print as well as the quantitative and qualitative components thereof. During the analysis stage fingerprint examiners make use of worksheets, diagrams and digital annotation so as to document the whole process. As there are no objective protocols that guide fingerprint examiners in arriving at the conclusion of sufficient identification, inconclusive identification and exclusion depend on laboratory policy and could vary from examiner to examiner.²⁵³

²⁴⁷ Epstein “Fingerprints meet *Daubert*: The Myth of Fingerprint ‘Science’ is Revealed” 2002 *California Law Review* 629-630.

²⁴⁸ Moenssens “Fingerprint Identification: A Valid, Reliable ‘Forensic Science’?” 2003 *Criminal Justice* 30-33.

²⁴⁹ Ashbough “Ridgeology: Modern Evaluative of Friction Ridge identification” Forensic Identification Support Unit 1999 <http://onin.com/fp/ridgeology.pdf> (Accessed 30-08-2016).

²⁵⁰ *Ibid.*

²⁵¹ Vanderkolk “Examination Process” in Holder et al *The Fingerprint Sourcebook* (2011) 4.

²⁵² Ashbough “Ridgeology: Modern Evaluative of Friction Ridge identification” 1999 <http://onin.com/fp/ridgeology.pdf> (accessed 30-08-2016), the author in this article describes level three of detail as the poroscopy and edgeoscopy. He further asserted that the poroscopy and edgeoscopy may be found or not found in a latent fingerprint. See also Richmond “Do Fingerprint Ridges and Characteristics within Ridges Change with Pressure?” 2004 <http://www.latent-prints.com/images/changes%20with%20pressure.pdf> (accessed 27-08-2016) 9.

²⁵³ De Villiers “Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the Last Number of Years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?” 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016).

2 4 2 Comparison

After the analysis stage, the fingerprint examiner proceeds to compare the unknown print to the known print.²⁵⁴ Comparison is the second step of the fingerprint comparison methodology and it involves the side by side comparison of friction ridge details to determine whether the details in the two prints are in agreement based on likeness, chronological order and structural relationship.²⁵⁵ The examiner reaches a subjective, relative estimation of all the types of information in the prints and their arrangement and order.²⁵⁶ During the comparison stage the examiner compares the features that were identified during the analysis stage to determine whether the mark and print are topographically consistent. This phase entails subjective judgment because the same feature may produce quite different appearances in different impressions.²⁵⁷ Different features may also produce similar appearances. Thus, when faced with differences in appearance, the examiner has to decide whether those differences are as a result of different sources of the mark and print, or whether they represent the “tolerable” difference in appearance that a given feature may be capable of producing.²⁵⁸ As the Scottish Fingerprint Inquiry Report notes “there is no objective standard by which to determine the appropriate limit of “tolerance.”²⁵⁹

2 4 3 Evaluation

After comparing the prints, the examiner proceeds to evaluate the prints. If the examiner finds all features consistent, the examiner, during this third stage then evaluates whether the amount of consistency is “sufficient” to warrant the conclusion that the source of the print is the only possible source of the mark.²⁶⁰ Historically, sufficiency was defined as a numerical standard as it still is in South Africa. In South Africa 7 points of correspondence is required for identification.²⁶¹ For

²⁵⁴ Vanderkolk “Examination Process” in Holder *et al The Fingerprint Sourcebook* (2011) 5.

²⁵⁵ Ashbaugh “Ridgeology: Modern Evaluative of Friction Ridge identification” Forensic Identification Support Unit 1999 <http://onin.com/fp/ridgeology.pdf> (accessed 30-08-2016). See also Scientific Working Group Friction Ridge Analysis Science and Technology “Fingerprint Examination Methodology for Latent Fingerprint Examination” 2002 www.swgfast.org (accessed 23-08-2016) 3.

²⁵⁶ Vanderkolk “Examination Process” in Holder *et al The Fingerprint Sourcebook* (2011) 12.

²⁵⁷ Cole and Roberts “Certainty, Individualisation and the Subjective Nature of Expert Fingerprint Evidence” 2012 *Criminal Law Review* 834.

²⁵⁸ *Ibid.*

²⁵⁹ SFI Report 517.

²⁶⁰ Cole and Roberts “Certainty, Individualisation and the Subjective Nature of Expert Fingerprint Evidence” 2012 *Criminal Law Review* 835.

²⁶¹ *S v Blom* 1992 1 SACR 649 (E). See also Verburg Attorneys “Seven-point Standard followed by South African Courts regarding Fingerprint evidence” 2015 <http://verburg.co.za/seven-point-standard-followed-by-south-african-courts-regarding-fingerprint-evidence/> (accessed 27-06-2016). *Ngaye v S* (A567/10) 2010 ZAWCHC 341 (3 December 2010); *Makhubu v S* (A475/2011) 2012 ZAGPJHC 89 (10 May 2012); *Nduna v S* (076/2010) 2010 ZASCA

example, the numerical standard in the United Kingdom at the time of the *McKie* case was 16 points. The examiner upon evaluating the prints, would then make a final deduction whether there is identification or individualization, exclusion or whether it is inconclusive.²⁶² For there to be an identification or individualization, it means that the unknown print matches the known print positively. This is described by McMurtrie:²⁶³

The second premise of fingerprint identifications is one of ‘individualization’. When fingerprint examiners conclude that there is a ‘match’ between the latent print and the suspect’s print, it is expressed in absolute terms as an ‘individualization,’ meaning that [t]he determination that corresponding areas of friction ridge impressions originated from the same source to the exclusion of all others (identification).²⁶⁴

A decision of exclusion can be reached if the first, second and third levels of details are in disagreement and this results in a negative identification.²⁶⁵ However, if the examiner excludes a finger as having made the unknown print, it does not necessarily mean that he/she is excluding a person as having made the unknown print.²⁶⁶ For instance, a latent print is excluded if it is of poor quality and the quality factor has a bearing on the ability of the examiner reliably to evaluate the latent and known print. The poorer the quality, the lesser the chances of producing reliable and valid results. Furthermore, the source being excluded must be indicated and the reason for exclusion must be given.²⁶⁷ If the examiner failed to pinpoint the actual disagreements between the prints, the observation would be inconclusive; that is, the level of details may seem to be agreeing or disagreeing, but there is uncertainty.²⁶⁸ The indecision could be caused by the inadequacy of the unknown print and known print, or a combination of both.²⁶⁹

After the examiner has completed the analysis, comparison and evaluation of the unknown print, compared to the known print and concluded that there is a match, the results are then sent to an

120; 2011 1 SACR 115 (SCA); 2011 2 All SA 177 (SCA) (30 September 2010) and *S v Legote* 2001 SACR 179 SCA 3.

²⁶² Vanderkolk “Examination Process” in Holder *et al The Fingerprint Sourcebook* (2011) 12.

²⁶³ Mcmurtrie “Swirls and Whorls: Litigating Post-Conviction Claims of Fingerprint Misidentification after the NAS Report” 2010 *Utah Law Review* 267-297.

²⁶⁴ *Ibid* 273.

²⁶⁵ Vanderkolk “Examination Process” in Holder *et al The Fingerprint Sourcebook* (2011) 14.

²⁶⁶ *Ibid*.

²⁶⁷ Scientific Working Group Friction Ridge Analysis Science and Technology “Standards for conclusion: quality assurance guidelines for latent print examiners” 2006 5 www.swgfast.org (accessed 23-08-2016).

²⁶⁸ Vanderkolk “Examination Process” in Holder *et al The Fingerprint Sourcebook* (2011) 14.

²⁶⁹ *Ibid*. it was elaborated that the inadequacy could be as a result of poor quality sample, lack of comparable features or insufficient number of corresponding or dissimilar features to be certain.

independent examiner to verify the results. It can be argued that the analysis stage, comparison stage, and evaluation stage comprise much more than simply taking into consideration the points of similarity in a crime scene mark, checking the inked print, and counting until a threshold number is reached. Hence it is imperative for an examiner applying ACE-V methodology to make decisions throughout the process. Vanderkolk states:

The examiner must ask and correctly answer all relevant questions to reach a proper conclusion, in the examination process. There is more to prints comparison than counting to a predetermined threshold of a limited number of generically labeled parts within the wonderfully unique tapestries of skin and prints.²⁷⁰

2 4 4 Verification

The verification stage is said to be an independent examination by another qualified examiner resulting in the same conclusion as the one done by the initial examiner²⁷¹ and is likened to peer review of the initial examiner's conclusions or observations. Verification can be done by way of applying the analysis, comparison and evaluation processes (ACE) between known and unknown print by another examiner without knowing prior conclusions.²⁷² However, the second examiner may redo or rework the case knowing the results of the original examiner. In short, the verification stage may be referred to as a step that does not form part of the identification process. Preferably the verification process should be done blindly and without bias; hence the method of verification selected must have the ability not improperly to influence the verifier by the initial examiner's findings and observations.²⁷³

2 5 CONCLUSION

The people who initiated the use of fingerprints aimed to give authority to the authenticity of documents and did not think that it could be used as a tool to identify perpetrators of offences. Fingerprint evidence has been used and accepted as tools of identification because it has been contended by fingerprints proponents that friction ridges are unique and permanent and that they can be transferred to a surface. Moreover, it has been argued that the uniqueness of fingerprints, is caused by the random process in which the friction ridges are formed in the womb. The ACE-V

²⁷⁰ Vanderkolk "Examination Process" in Holder *et al The Fingerprint Sourcebook* (2011) 21.

²⁷¹ Scientific Working Group Friction Ridge Analysis Science and Technology "Fingerprint Examination Methodology for Latent Fingerprint Examination" 2002 www.swgfast.org (accessed 23-08-2016) 4.

²⁷² Vanderkolk "Examination Process" in Holder *et al The Fingerprint Sourcebook* (2011) 17.

²⁷³ Mayfield Report 115.

methodology is the most preferred method employed to compare the unknown print and the known print. The purpose of this method is to individualize or exclude prints.²⁷⁴ The fingerprint comparison methodology relies on the discovery of relevant and distinct information that can be used in the comparison and prediction of aspects regarding a particular set of facts.

It is crucial that the examiner must, before embarking on the examination process and reach a conclusion, establish the fundamental attributes of the source or skin.²⁷⁵ The underlying principles of fingerprints are uniqueness and persistency which have been dealt with above. Moreover, the examiner must have an understanding of variations in appearances that can be found in prints before the examination process can commence.²⁷⁶ This is so because prints of the same source could be recorded at two different times, namely before and after trauma to the friction ridges skin.²⁷⁷ For example, scars could be present on the unknown print and not on the known print that was recorded from the same source. In addition, the variations maybe caused by the way in which the skin touches the surface,²⁷⁸ the nature of the surface,²⁷⁹ residues or matrices,²⁸⁰ temperature, humidity or weather before, during and after the skin came into contact with the surface, powders and chemicals to lift the unknown print, handling, packaging, storage of the unknown print²⁸¹ and the techniques used to view or enlarge prints could have an influence on the difference in appearance of the prints.²⁸² Therefore it is important for the examiner to have knowledge of the plethora of events that occurred before the prints could be made available for examination as these events could be the reason for the variations in appearances of the prints.

²⁷⁴ *Ibid.*

²⁷⁵ Vanderkolk "Examination Process" in Holder *et al The Fingerprint Sourcebook* (2011) 7. See also Scientific Working Group Friction Ridge Analysis Science and Technology "Fingerprint Examination Methodology for latent fingerprint examination" 2002 www.swgfast.org (accessed 23-08-2016) 1.

²⁷⁶ *Ibid.*

²⁷⁷ *Ibid.*

²⁷⁸ When unknown prints are left on the surface; they are left unintentionally hence some would be flat, slitting or rolling.

²⁷⁹ The surface that the skin comes into contact has an impact on the appearance of prints, for instance porous or non-porous surfaces, whether the surface was clean or not, whether it is textured or not etc.

²⁸⁰ For instance, sweat, blood, oil may be the reason for the different appearances in prints.

²⁸¹ For example, the packaging can get scratched and this may distort some of the information on the prints. Also, if the print is improperly packaged it may cause the print to evaporate and as a result it would be transferred to the package.

²⁸² Vanderkolk "Examination Process" in Holder *et al The Fingerprint Sourcebook* (2011) 7.

CHAPTER 3

ANALYSIS OF THE FIVE INTERNATIONAL REPORTS

3 1 INTRODUCTION

The discipline of fingerprints was the first forensic discipline that caught the public's imagination and it also provided a valuable tool for police and criminal investigators.²⁸³ It has been of great assistance in shaping a large number of criminal cases worldwide and for more than 100 years, the matching of fingerprints collected from the crime scene and the known print of the suspect has been used in the identification of perpetrators.²⁸⁴ The forensic discipline of identification plays a pivotal role in solving many crimes that would have gone unsolved.²⁸⁵ The basis for the acceptance of fingerprints evidence as a tool of identification of a perpetrator is that every individual is presumed to have unique prints, which are permanent and which can be transferred to any surface.²⁸⁶ It is undeniable that fingerprints, if used properly and if the methodology of examination and evaluation is followed correctly, can play an important part in courts for securing convictions and exonerating innocent people. Hence, it would be irrational and disastrous totally to abandon the use of fingerprints as evidence to identify suspects because of the limitations associated with the technique.

Nevertheless, courts should not turn a blind eye to the intrinsic shortcomings of the nature of fingerprints (uniqueness and permanence), methods of collection,²⁸⁷ analysis, and interpretation of the evidence as these factors have a strong impact on the weight to be given to the evidence. Although fingerprint exponents argue that fingerprints are unique, this does not necessarily prove the accuracy of fingerprint identification.²⁸⁸ There have been no published, peer-reviewed studies

²⁸³ Gabel "Realizing Reliability in Forensic Science from the Ground Up" 2014 *Journal of Criminal Law & Criminology* 287. See also Lytle "Return of Repressed: Coping with Post Conviction Innocence Claims in Wyoming" 2014 *Wyoming Law Review* 569.

²⁸⁴ Cooper "Challenges to Fingerprint Identification Evidence: Why Courts need a New Approach to Finality" 2016 *Mitchell Hamline Law Review* 756.

²⁸⁵ NAS Report 4.

²⁸⁶ McMurtrie "Swirls and Whorls: Litigating Post-Conviction Claims of Fingerprint Misidentification after the NAS Report" 2010 *Utah Law Review* 267-273. See also Benedict "Fingerprints and the *Daubert* Standard for Admission of Scientific Evidence: Why Fingerprints Fail and a Proposed Remedy" 2004 *Arizona Law Review* 527-528. See also Peterson *et al* "The Role and Impact of Forensic Evidence in the Criminal Justice Process" 2010 <https://www.ncjrs.gov/pdffiles1/nij/grants/231977.pdf> (accessed 23-03-2017).

²⁸⁷ Methods of collection of different types of fingerprints have been dealt with in chapter two of this thesis.

²⁸⁸ Mnookin "Fingerprints: Not a Good Standard" *Issues in Science and Technology* 2003 issues.org/20-1/mnookin/ (accessed 24-08-2016). See also Koehler and Saks "Individualization Claims in Forensic: Still Unwarranted" 2010

directly examining the extent to which people can correctly match fingerprints to one another; the error rate of the method is unknown and furthermore there are no objective standards for a match.²⁸⁹ There is also no universally agreed upon threshold for the number of points needed to declare a match.²⁹⁰

These problems have been critically discussed and evaluated in the five seminal international forensic reports that are examined and interrogated by this research. The reports which are scrutinised in this thesis include a report on a review of the FBI's handling of the Brandon Mayfield case ("Mayfield Report");²⁹¹ the report compiled by the National Research Council (NAS Report) in 2009;²⁹² The Scottish Fingerprint Inquiry Report (SFI Report) in 2011;²⁹³ the National Institute

Brooklyn Law Review 1187-1208. See also Cole "Individualization is Dead, Long Live Individualization! Reforms of Reporting Practices for Fingerprint Analysis in the United States" 2014 *Law, Probability and Risk* 117-150.

²⁸⁹ De Villiers "Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the Last Number of Years: Is the Critique with regard to Reliability Sufficiently Penetrating to Warrant the Exclusion of this Valuable Evidence?" 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016). See also Cole "Comment on Scientific Validation of Fingerprint Evidence under *Daubert*" 2008 *Law, Probability and Risk* 119-126; Cole "More than Zero: Accounting for Error in Latent Fingerprint Identification" 2005 *Journal of Criminal Law & Criminology* 985; O'Brien and Black "Science in the Court: Pitfalls, Challenges and Solutions" 2015 *Philosophical Transactions of the Royal Society B: Biological Sciences* 1-10; Pardo "Theory and NAS Report on Forensic Science" 2010 *Utah Law Review* 367-383; Cherry and Imwinklerried "How We Can Improve the Reliability of Fingerprint Identification" 2006 *Judicature* 1-5 also available at (www.ajs.org); Mnookin "Fingerprint in an Age of DNA Profiling" 2001 *Brooklyn Law Review* 13-71; Cole "Is Fingerprint Identification Valid? Rhetorics of Reliability in Fingerprint Proponents' Discourse" 2006 *Law and Policy* 109-135; Cole "Individualization is Dead, Long Live Individualization! Reforms of Reporting Practices for Fingerprint Analysis in the United States" 2014 *Law, Probability and Risk* 117-150; Cooper "Challenges to Fingerprint Identification Evidence: Why the Courts Need a New Approach to Finality" 2016 *Mitchell Hamline Law Review* 756-789; Thompson, Tangen and McCarthy "Expertise in Fingerprint Identification" 2012 *Journal of Forensic Science* 1-5; Cooper "The Collision of Law and Science: American Court Responses to Developments in Forensic Science" 2013 *Pace Law Review* 234-30; Kaye "Probability, Individualization, and Uniqueness in Forensic Science Evidence" 2013 *Brooklyn Law Review* 1163-1185; Kaye "Beyond Uniqueness: The Birthday Paradox, Source Attribution and Individualization in Forensic Science Testimony" 2010 *Law, Probability and Risk* 3-11; Koehler and Saks "Individualization Claims in Forensic Science: Still Unwarranted" 2010 *Brooklyn Law Review* 1187-1208; Swofford "Individualization using Friction Ridge Skin Impressions: Scientific Reliable, Legally Valid" 2012 *Journal of Forensic Identification* 62-79; Haber and Haber "Error Rates for Human Fingerprint Examiners" in Rath *et al Automatic Fingerprint Recognition Systems* (2004) 339-360; Gertner "National Academy of Sciences Report: A Challenge to the Courts" 2012 *Criminal Justice* 8-11; Neumann "Fingerprints at the Crime Scene: Statistically Certain, or Probable?" 2012 *Significance* 21-25; Giannelli "Scientific Evidence in Criminal prosecutions-A Retrospective" 2010 *Brooklyn Law Review* 1137-1152; Edmond "What Lawyers should know about Forensic Sciences" 2015 *Adelaide Law Review* 33-100. This list, however, does not exhaust all articles, journals and reports that indeed raises challenges against fingerprint evidence.

²⁹⁰ In South Africa seven points of similarity is the required minimum.

²⁹¹ Office of the Inspector General, United States Department of Justice: *A Review of the FBI's handling of the Brandon Mayfield case* 2006 (Mayfield Report).

²⁹² Committee on Identifying the Needs of the Forensic Science Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (National Academic Press, 2009) ("NAS Report").

²⁹³ Campbell *The Fingerprint Inquiry Report* 2011 (SFI Report).

of Science and Technology Report (NIST Report) in 2012²⁹⁴ and the Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods Report by President's Council of Advisors on Science and Technology (PCAST Report) in 2016.²⁹⁵ This chapter interrogates the challenges that have been raised against fingerprints evidence in these reports and the concluding section of the chapter highlights the similarities in the reports.

3 2 OFFICE OF THE INSPECTOR GENERAL, UNITED STATES DEPARTMENT OF JUSTICE: A REVIEW OF THE FBI'S HANDLING OF THE BRANDON MAYFIELD CASE REPORT (THE MAYFIELD REPORT)

3 2 1 The factual background of the Brandon Mayfield case

The first report to be examined by this study is the report of the Federal Bureau of Investigations' (hereafter the FBI) handling of the Mayfield case.²⁹⁶ In 2004 terrorists detonated bombs on a number of trains in Madrid, Spain.²⁹⁷ One hundred and ninety two people lost their lives and two thousand were injured. Fingerprints on a bag containing the detonating devices were found by the Spanish authorities. The Spanish National Police (SNP) shared the fingerprints with the FBI through Interpol. Twenty possible matches for one of the fingerprints were found in the FBI database and one of the possible matches was Brandon Mayfield, a Portland attorney.²⁹⁸ His prints were in the FBI database as they were taken as part of standard procedure when he joined the military.²⁹⁹ He became the prime suspect because of his conversion to Islam and because he had represented one of the Portland Seven.³⁰⁰ As a result, Mayfield was arrested as a material witness

²⁹⁴ Expert Working Group on Human Factors in Latent Print Analysis, *Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach* (US Department of Commerce, National Institute of Standards and Technology, 2012) ("NIST Report").

²⁹⁵ *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods* Report by President's Council of Advisors on Science and Technology 2016 (PCAST Report). <https://www.whitehouse.gov/blog/2016/09/20/pcast-releases-report-forensic-science-criminal-courts> (accessed 01-12-2016).

²⁹⁶ Office of the Inspector General, United States Department of Justice: *A Review of the FBI's handling of the Brandon Mayfield case* 2006 (Mayfield Report).

²⁹⁷ *Mayfield v US* No. 07-35805 D.C.NO. CV-04-01427-AA.

²⁹⁸ Mayfield Report 1.

²⁹⁹ *Ibid* 11.

³⁰⁰ *Ibid* 11, 36 and 37. The Portland seven is a matter, "that involved the federal prosecution in Oregon of seven individuals. Of the seven individuals six had allegedly plotted to travel to Afghanistan to participate in combat against the United States armed forces on behalf of Taliban and Al Qaeda. The six of the seven were charged, pled guilty to various charges which include conspiracy to levy war against United States and money laundering, consequently the six have been sentenced. However, the seventh individual charged in the case was killed in Pakistan. These individuals of the Portland seven were Muslims. The SNP believed that the Madrid bombings have been done by radical Muslims

with respect to a federal grand jury's investigation into that bombing.³⁰¹ He was connected to the terrorist attack because it was alleged that his fingerprints had been found on a bag in Spain containing detonation devices similar to those used in the bombings.³⁰² After its evaluation of the fingerprints, the SNP informed the FBI that they had made a mistake in identifying Brandon Mayfield as a material witness. Consequently, the FBI withdrew its identification of Mayfield and he was released.³⁰³

The government then announced that the FBI had made an error in its identification of Mayfield's fingerprint. The problem regarding the FBI's investigation is that it failed to give any relevant information which linked Mayfield to the Madrid train attacks.³⁰⁴ The FBI gave various explanations of the misidentification. These were (1) the poor quality of the digital image of Latent Fingerprint 17 (hereafter the LFP17), (2) the lack of access to the original fingerprint on the bag of detonators and (3) the similarity of LFP17 to Mayfield's fingerprint.³⁰⁵ The question arises as to how it could be possible that 3 different experienced fingerprints examiners at the FBI laboratory made an error and that as a result thereof an innocent man was incarcerated for more than two weeks. Even though the FBI blamed the quality of the fingerprint image, it admitted that the points of similarities between the LFP 17 and the known print of Mayfield were remarkable. It can, therefore, be deducted that the poor quality image of LFP 17 was not the entire cause of the misidentification. A further question which arises is what could have caused the erroneous identification? The answers are provided in the findings of the report by the Office of the Inspector General.

3 2 2 The purpose of the report

The main purpose of the report was to establish the root cause of the misidentification and to assess the FBI's laboratory reaction to the error. The report also sought to establish whether Mayfield

and they had hope that when the suspects are identified they would be Muslims. Thus, Mayfield's connection with these seven individuals raised a lot of suspicions. Moreover, Mayfield and the seven individuals were attending at the same Mosque and he also legally presented one of the seven individuals in a child custody dispute matter."

³⁰¹ Mayfield Report 1.

³⁰² *Ibid.*

³⁰³ *Ibid.*

³⁰⁴ *Ibid* 2.

³⁰⁵ *Ibid* 3.

was earmarked because of his religion.³⁰⁶ The report also interrogated whether the FBI's submissions to the USA District Court reinforcing the request for a material witness warrant and search warrants, were correct and reliable.³⁰⁷ In particular the report sought to determine how the examination of the LFP 17 failed and finally the report made recommendations for changes to FBI fingerprint processes.³⁰⁸

3 2 3 The causes of the misidentification as explored in the report

The report stated that the main cause of the misidentification was the unusual similarity between the fingerprints found on the bag of detonators in Madrid and that of Mayfield.³⁰⁹ This unusual similarity confused three experienced FBI examiners.³¹⁰ The 10 points in the LFP 17 that were used to identify Mayfield, were also used by different FBI examiners to identify David Daoud as a source of the fingerprint on the bag of detonators.³¹¹ Therefore the 10 points in the LFP 17 formed a constellation of points that were generally consistent with the constellation of points in the known fingerprints of Mayfield and Daoud.³¹² As highlighted in the report, “the unusual similarity was reflected in the relative location of the points, the orientation of the ridges coming into the points and the number of intervening ridges between the points”.³¹³ Despite the rarity of the similarity between the aforementioned prints, the Office of the Inspector General (hereafter the OIG) did not find methodical research of the causes of such rarity, but narrative informal reports suggested that the condition is an extremely unusual circumstance.³¹⁴ In short, the rare similarity between the LFP 17 and Mayfield's prints, misled the examiners and contributed to and played a role in overlooking other important differences between the LFP 17 and Mayfield's fingerprint.

Moreover, in the Mayfield case the examiner who commenced the evaluation of the LFP 17, failed to conduct a complete analysis before conducting an Integrated Automated Fingerprint

³⁰⁶ The Office of the Inspector General observed that upon investigation by FBI, it was discovered that Mayfield was an attorney in Portland, a Muslim, married to an Egyptian immigrant, represented a convicted terrorist in a child custody dispute in Portland and had contacts with suspected terrorists.

³⁰⁷ Mayfield Report 1.

³⁰⁸ *Ibid* 3.

³⁰⁹ *Ibid* 6.

³¹⁰ *Ibid* 6. During examination of fingerprints the examiners depend on the relationship of minutiae or points within prints. These points may be described as places where individual ridges in the fingerprints end or split, for example bifurcations, dots, end ridges.

³¹¹ *Ibid* 6.

³¹² *Ibid* 7.

³¹³ *Ibid*.

³¹⁴ *Ibid*.

Identification System (hereafter the IAFIS) search and consequently disregarded critical differences in appearance between the LFP 17 and that of the Mayfield known print.³¹⁵ The IAFIS is designed to select candidates whose known prints most closely resemble the unknown print and it is used not only to find the source of the print, but also the closest possible non-matches.³¹⁶ The IAFIS system was found not to be ideal when searching prints in which points have been encoded in two or more clusters separated by a gap.³¹⁷ Thus if the ridge count between two clusters of points in the latent print is unclear, the system is most likely to fail to find the correct origin of the print.³¹⁸ IAFIS is distinguished from ACE-V in that to encode a print for IAFIS, the examiner makes use of only part of the data that is gathered during the analysis phase, specifically the location and orientation of the chosen minutiae.³¹⁹ Another shortcoming of the IAFIS is that many searches do not result in identification because the known print of the suspect may not be in any of the databases.³²⁰ Thus with IAFIS, even if a person is not a suspect but has similar prints to the latent print found on the crime scene, he or she is at risk of being arrested.

The report highlights that it was not only the unusual similarity that caused the error in identification, but circular reasoning³²¹ in respect of some features in the LFP 17.³²² For instance in the Mayfield's case, in spite of the fact that the examiners found as many as 10 points of similarity, they began to recognise additional features in the LFP17 that were not in existence but rather were indicated to FBI examiners by attributes in the Mayfield prints.³²³ Therefore, the

³¹⁵ *Ibid* 3. Further on page 118 of the report, IAFIS was defined as a system for conducting computerized searches of the FBI database containing the known fingerprint of over 40 million individuals. IAFIS is usually utilized to identify latent fingerprint in cases where subjects are unknown. In addition, it contains the criminal master file encompassing known prints taken from local, state, federal arrestees; the civil file which includes known prints taken in a non-criminal context for instance for military services or government employment; a special file containing the known fingerprints of terrorism suspects and victims and the unsolved latent file containing unidentified latent fingerprint from unsolved crimes.

³¹⁶ *Ibid* 137.

³¹⁷ *Ibid* 119.

³¹⁸ *Ibid*.

³¹⁹ *Ibid*. The encoding procedure precludes information of level three details and complete ridge paths between the points.

³²⁰ *Ibid* 120.

³²¹ *Ibid* 138, circular reasoning is described as a "premature assumption of donorship that leads to transportation of data from the original into latent print".

³²² *Ibid* 7.

³²³ *Ibid*.

debatable and indefinite details in the LFP 17 were inaccurately identified as points which were the same as that of Mayfield's prints.³²⁴

In addition, the OIG recognised that the FBI examiners gave significant weight to the apparent agreement between the extremely tiny details in the LFP 17 and Mayfield's fingerprint.³²⁵ In the Mayfield case, examiners were not muddled by the rarity of similarity in level 3 details of Mayfield's fingerprints and that of Daoud because the alleged level 3 attributes in the LFP 17 used to identify Mayfield, matched the attributes in the known prints of the true donor (Daoud).³²⁶ The OIG discovered that the fingerprint examiners in the Mayfield case, chose to depend on certain details in level 3, such as pores, ridge, edge shapes and a small gap between ridge details in the LFP17, that were not in agreement with the known fingerprint of Mayfield. This is the danger that underlies the process of fingerprints identification, as the examiner chooses what to analyse, compare and examine in as far as latent prints are concerned:

There were several other differences between LFP 17 and Mayfield's known fingerprints. Although the explanations that the examiners gave for each difference were individually plausible, they cumulatively required too many rationalizations to support identification with requisite certainty.³²⁷

The report further stated that the culture at the laboratory was poorly suited to detect mistakes. For example, the culture to disagree was not an expected response. If the results to be verified were found by the examiner with a higher rank than the rank of the examiner reviewing the results, he or she would not be expected to disagree with the results of the first examiner.³²⁸ Once the first examiner made the error, the follow-up examinations were also tainted because he had knowledge of the previous examiner's conclusions (especially since the initial examiner was a highly respected supervisor with many years of experience). Once the individualization had been made by the examiner, it became increasingly difficult for others in the agency to disagree.³²⁹

³²⁴ *Ibid.*

³²⁵ Ashbaugh "Ridgeology: Modern Evaluative of Friction Ridge Identification" Forensic Identification Support Unit 1999 <http://onin.com/fp/ridgeology.pdf> (accessed 30-08-2016).

³²⁶ *Ibid* 8. Level 3 details include individual pores, incipient dots between ridges and ridge edges. Level 3 details are so small that, the appearance of such details is highly variable, even between different fingerprints made by the same finger. Consequently, depending on level 3 details is controversial within the latent fingerprint community.

³²⁷ Office of the Inspector General "A Review of FBI's Handling of the Bandon Mayfield Case 2006: Unclassified Executive Summary" <https://oig.justice.gov/special/s0601/exec.pdf> (accessed 25-06-2017) 9.

³²⁸ Mayfield Report 1.

³²⁹ *Ibid* 13.

Moreover, the report pointed out that the verification³³⁰ of the print was not done blindly, and that there was confirmation bias by examiners.³³¹ Confirmation bias was not only highlighted in the Mayfield report to be a challenge for fingerprint evidence examiners, but has been pointed out by other critiques of fingerprint evidence which include jurists, academic writers, analysts and lawyers that it is dangerous to the outcome of the evaluation process by examiners.³³²

The failure adequately and properly to follow the ACE-V³³³ methodology by the initial examiner in the Mayfield case, contributed to the erroneous identification. The other factor that contributed to erroneous identification was the failure of the FBI to examine and acknowledge the variation in distance between the LFP 17 and Mayfield's known print.³³⁴ For instance, the FBI recognized that the whole upper left portion of the LFP 17 did not correspond with Mayfield's fingerprint. However, the examiners gave an explanation that the difference was as a result of a separate touch, possibly by a different finger or a different person.³³⁵ The FBI examiners did not apply the "discrepancy rule" with sufficient stringency to substantiate the level of certainty needed for a decision of identification.³³⁶ The OIG found the explanation given by the examiners to be unsatisfactory because the distance between the prints was inconsistent. In addition, error in identification of Mayfield as a material witness was also as a result of the failure of the FBI to re-examine the LFP 17 after the negative report on April 13. The report was an indication to the FBI

³³⁰ Verification stage is like a transition phase of the two examiners' formal hypotheses into single unified hypothesis by way of concurrence.

³³¹ Mayfield Report 115. Confirmation bias can be defined as the human tendency to see what one expects and desires to see when evaluating ambiguous evidence. Also, confirmation bias can be described as a situation whereby one examiner looks at what the initial examiner has concluded and thereby making his own conclusion. Confirmation bias is as a result of contextual information available to the fingerprint examiners. See Osborne and Zajac "An Imperfect Match? Crime-Related Context Influences Fingerprint Decisions" 2015 *Applied Cognitive Psychology* 126-134, in this article the writers argued that fingerprint interpretation is vulnerable to contextual influence, in particular the more the contextual information available the more the emotional intensity, and as a result fingerprint examiners increase the rate at which they declare a match. Contextual information includes any other relevant information connecting the suspect to the crime scene or the decision of match by the initial examiner.

³³² Dror *et al* "Contextual Information Renders Experts Vulnerable to Making Erroneous Identifications" 2006 *Forensic Science International* 74-78. Stacey "Report on the Erroneous Fingerprint Individualization in the Madrid train bombing case" 2005 *Forensic Science Communications* 1-20.

³³³ Triplett and Cooney "Etiology of the ACE-V and its proper use: An exploration of the relationship between ACE-V and the Scientific Method of Hypothesis Testing" 2006 *Journal of forensic Identification* 345-346. See also Burthorn and Reitnauer "ACE-V: Latent Print Examiners Scientific Method" 2014 https://az-forensics.com/docs/pdfs/ACE-V_for_Latent_Print_Examiners.pdf (accessed 28-08-2016). The steps of ACE-V are described fully in Chapter Two.

³³⁴ Mayfield Report 168.

³³⁵ *Ibid*.

³³⁶ *Ibid* 172. Discrepancy rule clearly states that identifications are subject to 100% certainty, and the presence of a single difference in appearance is supposed to preclude identification.

to re-examine anew the identification. Nevertheless, the FBI failed to take any steps to consider the disagreements from other laboratories.³³⁷ Mayfield's religion played a role in the erroneous identification in that after acquiring knowledge that Mayfield was a Muslim and that he once represented Muslim terrorists, the examiners said that "if the person identified had been someone without these characteristics, the laboratory might have revisited the identification with more skepticism and caught the error."³³⁸ This shows that, to some extent, Mayfield's religion played a role in his identification.

3 2 4 A summary of the recommendations

After the investigation the OIG provided various recommendations to the FBI to correct the problems associated with identification by fingerprints in order to help to prevent future errors.³³⁹ Even though the OIG highlighted the causes of the misidentification of Mayfield, it stated that erroneous identification was not intentional. The Mayfield report raised issues that are of concern to the fingerprint community. The report concurred with the fingerprint critiques that challenged the basis of the evidence.

The OIG recommended that there must be a reinforcement of the basis for the use of Level 3 details to underpin identification conclusions.³⁴⁰ In the light of the above, the OIG emphasized that there must be a concrete background against which the clarity of the fingerprint is adequate to support the use of level 3 details to support an identification.³⁴¹ It was also highlighted that the FBI Laboratory must consider moving away from giving more attention to research of level 3 detail as the issue of permanence, but rather as the issue of reproducibility and give definite circumstances under which level 3 must be used.³⁴² It is also the suggestion of the OIG that there

³³⁷ *Ibid.*

³³⁸ *Ibid* 11.

³³⁹ *Ibid* 195, most of the recommendations given by the OIG were given by seven independent Latent Review Teams that gathered and it comprised of Forensic experts from distinct units of the FBI laboratory and from external organizations. The teams dealt with different issues with the intention to respond to the International Panel's reports and the FBI Laboratory re-examination of practices in the LPU. The issues include (a) policies for examining and reporting cases with less than original evidence, (b) documentation and case notes, (c) technical and administrative review, (d) management and organizational culture, (e) training, (f) standard operating procedures review and (g) science of latent fingerprint identification. The recommendations given by the teams were found to be important and to be of great assistance in minimizing errors when using fingerprints to identify suspects. Thus, Melisa Smrz, the section Chief of the LPU agreed that all the recommendations shall be implemented by the LPU.

³⁴⁰ Mayfield Report 199.

³⁴¹ *Ibid.*

³⁴² *Ibid.*

must be illumination of the “one discrepancy rule” and assurance that it is employed in a manner consistent with the level of certainty affirmed for latent fingerprint identifications.³⁴³

Moreover, there must be extensive documentation of features discovered in the latent fingerprint before the comparison phase to assist in averting circular reasoning, as well as records of all different stages of the ACE-V methodology other than the statement of findings or results.³⁴⁴ Documentation of what transpired during the stages of fingerprint comparison methodology, is important in that it will give a clear explanation as to what informed the decision of inclusion or exclusion during the comparison process and or discrepancies/ dissimilarities observed.³⁴⁵ The major problem associated with this method is that it takes place in the examiner’s mind and the mental processes and criteria employed in reaching the decision of a match are only partially reflected in the documentation and in other cases are not documented at all. For example, in the case of Mayfield there was no contemporaneous record that existed of the explanations accepted by the examiner for numerous dissimilarities in the prints.³⁴⁶ Thus, meticulous documentation of the stages of the fingerprint comparison methodology will assist to strengthen accuracy and avoid errors like the Mayfield misidentification.³⁴⁷ Moreover, it is suggested that fingerprint examiners should be obliged to produce and keep more meaningful and independent documentation of the causes of errors as part of the Laboratory’s corrective action procedures.³⁴⁸

3 3 THE NAS REPORT

The next report to be analysed is the report compiled by the National Research Council in 2009, “Strengthening Forensic Science in the United States: A Path Forward.”³⁴⁹ It is considered as a watershed report in that it scrutinized many problems that are associated with various forensic

³⁴³ *Ibid* 196.

³⁴⁴ *Ibid* 199.

³⁴⁵ *Ibid* 200. The OIG alluded that lack of documentation of the stages of the ACE-V is one of the disadvantages of SOPs. On page 202 the OIG elaborates further that “[w]e believe that there is a strong possibility that if the examiner and verifier had been required to document the analysis and comparison phases of their examinations, they might have noticed more dissimilarities and appreciated the cumulative impact of them before reaching their flawed conclusions.”

³⁴⁶ *Ibid* 202.

³⁴⁷ *Ibid* 203. However, rigorous documentation requirement means that there must be increase in manpower and reduction in case loads.

³⁴⁸ *Ibid* 202.

³⁴⁹ Committee on Identifying the Needs of the Forensic Science Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (National Academic Press, 2009) (NAS Report).

science disciplines.³⁵⁰ As forensic science evidence has a major impact on the outcome of both criminal and civil cases,³⁵¹ when the NAS Report was released, the world noticed it because of the seriousness of the limitations of forensic science evidence. The report thoroughly discusses the major weaknesses of fingerprint identification analysis and court testimony given by latent print examiners.³⁵² The report also dealt with the following issues inter alia: (1) the basis of the scientific method as applied to forensic practice, (2) the application of forensic evidence in criminal and civil litigation, (3) forensic science practices and assessment of forensic data, (4) accuracy and error rates of forensic analyses, (5) sources of potential bias and human error in interpretation by forensic experts and (6) proficiency testing of forensic experts.³⁵³

3 3 1 The purpose of the NAS Report

The aim of the report was to evaluate the present and future resource needs of the forensic science community, to suggest recommendations for maximizing the use of forensic technologies and techniques to solve crimes, investigate deaths, and protect the public; to identify potential scientific advances that may assist law enforcement in using forensic technologies and techniques to protect the public; to make recommendations for programs that will increase the number of qualified forensic scientists and medical examiners available to work in public crime laboratories; to disseminate best practices and guidelines concerning the collection and analysis of forensic evidence to help to ensure quality and consistency in the use of forensic technologies and techniques to solve crimes, investigate deaths, and protect the public; to examine the role of the forensic community in the homeland security mission; examine interoperability of AFIS; and to examine additional issues pertaining to forensic science as determined by the Committee.³⁵⁴

³⁵⁰ McMurtrie “Swirls and Whorls: Litigating Post-conviction claims of fingerprint misidentification after the NAS Report” 2010 *Utah Law Review* 267. In her introduction she stated emphatically that the NAS Report has heralded as a block bust that will entirely reform or modify the legal landscape so far as forensic science is concerned. See also Magruder “NAS Report to be Force of Change in Forensic field” *ASU News* 9 February 2009 <http://www.asunews> (accessed 24-11-2016).

³⁵¹ Plumtree “A Perspective on the Appropriate Weight to be given to the National Academy of Sciences’ Report on Forensics in Evidentiary Hearings: The Significance of Continued Court Acceptance of Fingerprint Evidence” 2013 *Southwestern Law Review* 608.

³⁵² *Ibid* 607.

³⁵³ NAS Report 3-4.

³⁵⁴ *Ibid* 1-2.

3 3 2 Challenges to the forensic science field in general according to the NAS Report

The Report noted that forensic science evidence plays a major role in both criminal and civil courts. The NRC Committee found the existing system of forensic sciences in the USA “fragmented” and “inconsistent”, and found the general absence of “meaningful” standards disturbing:

Often there are no standard protocols governing forensic practice in a given discipline. And, even when protocols are in place (e.g. SWG [Scientific Working Group] standards); they often are vague and not enforced in any meaningful way. In short, the quality of forensic practice in most disciplines varies greatly because of the absence of adequate training and continuing education, rigorous mandatory certification and accreditation programs, adherence to robust performance standards, and effective oversight. These shortcomings obviously pose a continuing and serious threat to the quality and credibility of forensic science practice.³⁵⁵

Other problems include the absence of standards and the lack of research to validate the techniques used. The reports states that;

Little rigorous systematic research has been done to validate the basic premises and techniques in a number of forensic science disciplines. The committee sees no evident reason why conducting such research is not feasible.³⁵⁶

The reliability of forensic science has been called into question in that it is not always based on scientific studies to determine its validity, that it lacks research to determine limits and measures of performance and that questions as to whether a particular forensic discipline is founded on a reliable scientific methodology that gives it capacity accurately to analyze evidence and report findings, are not asked. Nor are questions asked as to whether practitioners in a specific forensic science discipline depend on human interpretation that could be tainted by errors or bias.³⁵⁷

3 3 3 Criticisms against fingerprints evidence in particular

The NAS report deals with various types of forensic science evidence and with regard to identification forensic evidence the report states that:

No forensic method other than nuclear DNA analysis has been rigorously shown to have the capacity to consistently and with a high degree of certainty support conclusions about ‘individualization’ (more commonly known as ‘matching’ of an unknown item of evidence to a specific known source).³⁵⁸

The statement above by the Committee of the NAS report, shows that most of the forensic evidence employed by law enforcement agencies to identify perpetrators, have a limitation one way or the

³⁵⁵ *Ibid* 6.

³⁵⁶ *Ibid* 189.

³⁵⁷ *Ibid* 7-20.

³⁵⁸ *Ibid* 87.

other. Specifically, in relation to fingerprint evidence, it indicates that it is not only about proficiency tests³⁵⁹ and organisational culture, but also the lack of professional standards which make it difficult to determine with adequate reliability that the finger that left the impression at the crime scene, is the same as the finger that left an impression in the file of fingerprints.³⁶⁰ The report shows that fingerprint evidence is based on assumptions of uniqueness and permanence and states that:

Uniqueness and persistence are necessary conditions for friction ridge identification to be feasible, but those conditions do not imply that anyone can reliably discern whether or not two friction ridge impressions were made by the same person. Uniqueness does not guarantee that prints from two different people are always sufficiently different that they cannot be confused, or that two impressions made by the same finger will also be sufficiently similar to be discerned as coming from the same source.³⁶¹

The random process that occurs when the friction ridges are formed in the uterus, which the examiners say, is the cause of uniqueness of friction ridges, may raise more questions than answers.³⁶² For example, is the process randomly variable for eternity? Fingerprint examiners also do not provide the logical reasoning as to why the same result cannot be caused by a different process. In the light of this, literature reveals that no study or research has been performed to evaluate the effects of factors such as, for example, pressure, fluid dynamics, skin tension, temperature etc on fingerprints.³⁶³ One can also argue that the proposition of uniqueness is based on assumptions because the declaration relies on observations that have neither been listed nor assembled in a systematic manner.³⁶⁴

³⁵⁹ Cole “Is Fingerprint Identification Valid? Rhetorics of Reliability in Fingerprint Proponents’ Discourse” 2006 *Law and Policy* 117.

³⁶⁰ NAS Report 141. See also Cole “Forensic without Uniqueness, Conclusions without Individualization: The New Epistemology of Forensic Identification” 2009 *Law, Probability and Risk* 233-255.

³⁶¹ NAS Report 143-144.

³⁶² See Cole “Forensics without Uniqueness, Conclusions without Individualization: The New Epistemology of Forensic Identification” 2009 *Law, Probability and Risk* 240, wherein he refers to McLachlan’s article “No Two Sets the Same? Applying Philosophy to the Theory of Fingerprints” 1995 12-18. In his article, McLachlan elaborates that, “even if each finger arrives at its friction ridge pattern through a unique causal pathway, there is no logical basis to assume that two fingers cannot arrive at identical patterns through different causal pathways.”

³⁶³ NAS Report 144. The report also refers to an article by David H. Kaye “Questioning a Courtroom Proof of the Uniqueness of Fingerprints” 2003 *International Statistical Review* 524, in this article Kaye pointed out the design and analysis flaws related to the unpublished study in 1999 by the Lockheed-Martin Corporation, the “50K v 50K Fingerprint Comparison Test” that fingerprints proponents point as evidence of the scientific validity of fingerprint uniqueness. It is further states that “even if it were valid, the study provides only a highly optimistic estimate of the reliability of friction ridge analyses, biased toward highly favorable conditions.”

³⁶⁴ NAS Report 144. See also Cole “Forensics without Uniqueness, Conclusions without Individualization: the new Epistemology of Forensic Identification” 2009 *Law, Probability and Risk* 239. See also Haber and Haber *Challenges to Fingerprints* (2009) 20-22 where it is stated that fingerprint examiners hold on to the premise of uniqueness because there has never been a report or research to show that different people have the same friction ridges. This by itself

Another underlying principle for relying on fingerprints, namely that of permanence, has also been criticized in that friction ridges change with pressure; for example, when a person is getting old her or his skin becomes soft, this may cause the disappearance of some of the ridges. In short, fingerprints can be unique, but it does not prove the accuracy of the method used by an examiner to reach a conclusion. Therefore, assumptions of permanence and uniqueness can be considered as an excuse for a lack of research data regarding the true likelihood of any particular trait being considered a match.

The report highlights that the ACE-V methodology is not supported by peer reviewed published studies and that it lacks protocols to guide experts' subjective assessments of matching the characteristics.³⁶⁵ Literature indicates the fingerprint comparison methodology is tested through the adversarial process during each trial, but this does not make it a scientifically reliable method.³⁶⁶ In the case of adversarial proceedings, the ground truth is unknown,³⁶⁷ and therefore the outcome cannot be used to assess the validity of the method being used. Moreover, during cross-examination, the examiners may not be asked the question as to which method and standard they applied to reach that conclusion and whether the method has been scientifically tested and proven.³⁶⁸ In the USA it has been argued that the fact that examiners do not state whether the

does not validate the assumption of individuality. Subsequently the possibility of finding two prints with same friction ridges relies on the capacity and ability of a fingerprint examiner to remember every fingerprint they have ever seen - perfect memory is necessary in this aspect and memory research has shown that such demands are in actual fact impossible.

³⁶⁵ NAS Report 139.

³⁶⁶ Mnookin "The Validity of Latent Fingerprint Identification: Confession of Fingerprinting Moderate" 2008 *Law Probability and Risk* 133.

³⁶⁷ Ground truth refers to certain knowledge that the latent print and exemplar fingerprint came from the same donor or from two different donors. It cannot be known in case work, and therefore, research using results from case work cannot be used to establish the validity of the method. See Haber and Haber "Scientific Validation of Fingerprint Evidence under *Daubert*" 2006 *Law, Probability and Risk* 91. Scientifically reliability of a method refers to the ability to produce same results in each instance with the test performed being consistent.

³⁶⁸ Haber and Haber "Scientific Validation of Fingerprint Evidence under *Daubert*" 2006 *Law, Probability and Risk* 101. See also *People v Jennings* 252 Ill. 534.96 N.E 1077 1911. In this case fingerprints were introduced in evidence in the 1910 trial of Thomas Jennings for the murder of Clarence Hiller. The defendant was linked to the crime by some suspicious circumstantial evidence, but there was nothing definitive against him. However, the Hiller family had just finished painting their house, and on the railing of their back porch, four fingers of a left hand had been imprinted in the still-wet paint. The prosecution wanted to introduce expert testimony concluding that these fingerprints belonged to none other than Thomas Jennings. Four witnesses from various bureaus of identification testified for the prosecution, and all concluded that the fingerprints on the rail were made by the defendant's hand. The judge allowed their testimony, and Jennings was convicted. What was striking in *Jennings*, as well as the cases that followed it, is that courts largely failed to ask any difficult questions of the new identification technique. Just how confident could fingerprint identification experts be that no two fingerprints were really alike? How often might examiners make mistakes? How reliable was their technique for determining whether two prints actually matched? How was forensic use of fingerprints different from police use? The judge did not analyze in detail either the technique or the experts'

method has been scientifically proven, contradicts the requirements that need to be met for expert evidence to be admissible as envisaged in the case of *Daubert*.³⁶⁹ In the *Daubert* case it was pointed out that the evidence should be supported by some form of appropriate validation.

Furthermore, there is no standard number of points that is required for a match, as each laboratory or examiner determines the number of points needed.³⁷⁰ In actual fact some jurisdictions apply the numeric value and other jurisdictions apply a nonnumeric standard. Internationally, there is no common approach regarding the criteria for fingerprint identification. The practice varies from countries applying a numerical standard where a definite number of minutiae in agreement is required, to countries that make use of a holistic approach that leaves the assessment of the latent print and known print to the examiner to make a decision relying on the overall available features.³⁷¹ This raises the question as to how many points suffice to constitute a match. As far as the aspect of sufficiency of the number of points is concerned, it differs across jurisdictions, examiners, and laboratories.³⁷²

The report states that the method lacks objective standards as it relies on the subjective standards of examiners.³⁷³ This is so because examiners make subjective assessments throughout the process and the examiner has to consider both the quantity and quality of comparable details.³⁷⁴ In *Maryland v Rose*³⁷⁵ it was held that the ACE-V methodology of latent fingerprint identification is a subjective untested, unverifiable identification procedure that purports to be infallible and as a result fingerprint evidence in this case was ruled inadmissible.³⁷⁶ The report³⁷⁷ refers to recent

claims to knowledge; instead, he believed that the new technique worked flawlessly based only on interested participants' say-so. The *Jennings* decision proved quite influential and binding to many jurisdictions whenever the fingerprint evidence is in question which has led to its admission without any substantial analysis at all, relying instead on *Jennings* and other cases as precedent. There after fingerprint evidence was internationally recognized and was believed to be a reliable source of human identification.

³⁶⁹ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993.

³⁷⁰ Haber and Haber "Scientific Validation of Fingerprint Evidence under *Daubert*" 2008 *Law, Probability and Risk* 87-109.

³⁷¹ *Ibid* 101. For example, Anglo-American countries are using the holistic approach.

³⁷² *Ibid* 101-102.

³⁷³ Subjectivity maybe described as when a person depends on personal knowledge, judgments and views concerning a particular subject or process.

³⁷⁴ NAS Report 139.

³⁷⁵ *Maryland v Rose* K06-0545 2007. See also NAS Report 139.

³⁷⁶ *Ibid*.

³⁷⁷ NAS Report 139.

research by Dror and Charlton³⁷⁸ that has found that experienced examiners do not necessarily agree with even their own past conclusions when the examination is presented in a different context some time later. Another study that provides some support for the basic proposition that expectancy-inducing information can bias the results of forensic science examinations, was done by Langenburg, Champod and Wertheim³⁷⁹

Haber and Haber in their article³⁸⁰ (quoted in the NAS report³⁸¹) contend that there is no official description of the ACE-V methodology and that the definition of ACE-V is based on what has been published in most literature.³⁸² This implies that there is no specific or agreed definition for the ACE-V methodology, as no professional body has approved any description of ACE-V methodology in the fingerprint profession. This means that examiners may be unclear with regard to the procedure to follow in ACE-V methodology. If they are unclear of the meaning and interpretation, they cannot be a hundred percent convinced and definite that they are using it correctly or applying it as a scientific method. Consequently, the validity of the ACE-V methodology cannot be tested.³⁸³

³⁷⁸ Dror and Charlton “Why Experts make Errors” 2006 *Journal of Forensic Identification* 600-616. In this study six experienced fingerprint examiners were given eight sets of two prints each by their supervisor. All of the print pairs given each examiner were from previous cases where that examiner had declared that there was a sufficient basis to declare a match (four each) or an exclusion (four each). In addition, each of these cases had been rated as to difficulty by the examiner when originally performing the comparison. In four of the test cases presented (two of previous —match [one hard, one easy] and two of previous —exclusion [one hard, one easy], no extraneous context information was provided, merely a request for comparison. In the other four cases (similarly distributed), not uncommon context information was given (—suspect has confessed, etc.). The test thus resulted in 48 decisions (6 examiners x 8 comparisons each). Of those 48 decisions, 6 were inconsistent with the previously rendered decision in the actual case (12.5%). Two of the six examiners gave results completely consistent with their previous decisions. The other four did not. Three of the four remaining examiners changed one decision each, and the other examiner changed three. Four of the changes were in tests where context information was supplied, and two were in cases where no context information was supplied. Five of the switches were in cases rated as difficult, but the one switch in an easy case (from match to exclusion) was in a case containing context information suggesting exclusion.

³⁷⁹ Langenburg *et al* “Testing for Potential Contextual Bias Effects during the Verification Stage of the ACE-V Methodology when Conducting Fingerprint Comparisons” 2009 *Journal of Forensic Science* 571.

³⁸⁰ Haber and Haber “Scientific Validation of Fingerprint Evidence under *Daubert*” 2008 *Law, Probability and Risk* 87-109.

³⁸¹ NAS Report 143.

³⁸² Haber and Haber “Scientific Validation of Fingerprint Evidence under *Daubert*” 2008 *Law, Probability and Risk* 89. Haber and Haber states that neither the International Association for Identification (IAI) as the professional organization of fingerprint examiners, the FBI, or any other fingerprint organization has given a specific description of the ACE-V methodology.

³⁸³ NAS Report 143.

The report further stipulates that, following the stages of ACE-V does not imply that one is proceeding in a scientific manner or that reliable results are produced.³⁸⁴ This is so because there has been no substantial research or empirical data given to prove the authenticity and accuracy of the whole or complete fingerprints, let alone latent or partial prints.³⁸⁵ The NAS Report found that the ACE-V methodology does not guard against bias³⁸⁶, is too broad to ensure repeatability and transparency and does not guarantee that two analysts following the same steps of the methodology arrive at the same conclusion.³⁸⁷ Recommendation 5 reflects the NAS report's response to the threat of bias:

The National Institute of Forensic Science (NIFS) should encourage research programs on human observer bias and sources of human error in forensic examinations. Such programs might include studies to determine the effects of contextual bias in forensic practice (e.g. studies to determine whether and to what extent the results of forensic analyses are influenced by knowledge regarding the background of the suspect and the investigator's theory of the case). In addition, research on sources of human error should be closely linked with research conducted to quantify and characterize the amount of error. Based on the results of these studies, and in consultation with its advisory board, NIFS should develop standard operating procedures (that will lay the foundation for model protocols) to minimize, to the greatest extent reasonably possible, potential bias and sources of human error in forensic practice. These standard operating procedures should apply to all forensic analyses that may be used in litigation.³⁸⁸

Moreover the fingerprint comparison methodology does not have objective standards or guiding protocol, to govern the way in which the fingerprint examiners should follow stage by stage.³⁸⁹ The actual examination takes place in the examiner's mind; there is no research to show that the examiner has followed all the procedures.³⁹⁰ This is so because fingerprint examiners usually give

³⁸⁴ *Ibid* 142.

³⁸⁵ Mnookin "Fingerprints: Not a Good Standard" *Issues in Science and Technology* 2003 issues.org/20-1/mnookin/ (accessed 24-08-2016).

³⁸⁶ NAS Report 142. It must be noted that bias may not be deliberate and maybe caused by certain factors as stated in the article by Saks *et al* "Context effects in Forensic Science: a Review and Application of the Science to crime laboratory practice in the United States" 2003 *Science and Justice* 77-90. Bias may cause a high number of erroneous results. However, it may not be deliberate. It also cannot be denied that environmental factors, assumptions and other mental inputs may influence analysis, conclusions and outcomes. The causes of bias include having knowledge of a particular crime, that is other relevant and reliable evidence connecting the suspect to the crime scene, police officers work hand in hand by fingerprint examiners, many of the fingerprint examiners were once employed in the same department but now they have a different job under the very same department, prior exposure to exemplar print before analysis of the characteristics and features in latent print. See Jones "The ACE-V Methodology-Reliable or Accurate" 2014 http://auburnhillscriminallawyer.com/wp-content/uploads/2014/05/Fingerprints.Forensic.Paper_.pdf (accessed 23-06-2016) 11. Jones states that the bias may not be deliberate but the common desire to please others and the pursuit to avoid conflicts may impair one's judgment. See also Cole "Is Fingerprint Identification Valid? Rhetorics of Reliability in Fingerprint Proponents' Discourse" 2006 *Law and Policy* 109-111.

³⁸⁷ NAS Report 142.

³⁸⁸ *Ibid* 24.

³⁸⁹ Cole "Out of the *Daubert* Fire and into the Fryeing Pan? Self-Validation, Meta-Expertise and the Admissibility of Latent Print Evidence in *Frye* Jurisdictions" 2008 *Minnesota Journal of Law, Science and Technology* 487-491.

³⁹⁰ NAS Report 141.

a description on how he or she compared two prints, but may not necessarily give details of his work in the instant case.³⁹¹ Fingerprint examiners generally do not take notes when following the stages of the fingerprint comparison methodology and there is subsequently no way the court can be able to assess the steps or procedures taken by the examiner.³⁹²

The report also notes that the error rate³⁹³ when following the ACE-V methodology is unknown. This is so because fingerprint examiners testify that if the fingerprint comparison methodology is followed by a well-trained practitioner, one will not reach an erroneous decision, the methodology error rate is zero.³⁹⁴ The claim that ACE-V methodology has a zero error rate is, according to the report, “unrealistic”³⁹⁵ as “the method, and the performance of those who use it, are inextricably linked, and both involve multiple sources of error (e.g., errors in executing the process steps, as well as errors in human judgment).”³⁹⁶ Cole states that indicating and maintaining that there is zero error rate when ACE-V is followed, is completely incorrect and misleading because there have been documented misattributions dating back to 1920.³⁹⁷

The report approvingly quotes Jennifer Mnookin in respect of fingerprint examiners typically testifying in the language of absolute certainty:

Both the conceptual foundations and the professional norms of latent fingerprinting prohibit experts from testifying to identification unless they believe themselves certain that they have made a correct match. Experts therefore make only what they term ‘positive’ or ‘absolute’ identifications—essentially making the claim that they have matched the latent print to the one and only person in the entire world whose fingertip could have produced it . . . Given the general lack of validity testing for fingerprinting; the relative dearth of difficult proficiency tests; the lack of a statistically valid model of fingerprinting; and the lack of validated standards for declaring a match, such claims of absolute, certain confidence in identification are unjustified . . . Therefore, in order to pass scrutiny under *Daubert*, fingerprint identification experts should exhibit a

³⁹¹ *Ibid* 140.

³⁹² *Ibid*.

³⁹³ See Haber and Haber “Scientific Validation of Fingerprint Evidence under *Daubert*” 2008 *Law, Probability and Risk* 92. Disclosing the error rate of a method is very crucial as it is proof or an indication that an expert employed a scientifically validated method. In other words, the method has been shown to produce conclusions that agree with ground truth, or it is intended to assure the court of the accuracy of that method used in the instant case. Likewise, the published error rate information informs the court of the amount of confidence that can be placed on a conclusion based on the method used to reach that conclusion.

³⁹⁴ NAS Report 143. See Cole “More than Zero: Accounting for Error in Latent Fingerprint Identification” 2005 *Journal of Criminal Law & Criminology* 988. In this article Cole stated that error rate has been alluded as one of the very crucial criteria for admissible scientific evidence under the United States Supreme Court’s decision in *Daubert v. Merrell Dow Pharmaceuticals*.

³⁹⁵ NAS Report 143.

³⁹⁶ *Ibid*.

³⁹⁷ Cole “Is Fingerprint Identification Valid? Rhetorics of Reliability in Fingerprints Proponents’ Disclosure” 2006 *Law and Policy* 116.

greater degree of epistemological humility. Claims of ‘absolute’ and ‘positive’ identification should be replaced by more modest claims about the meaning and fingerprinting; the relative dearth of difficult proficiency tests; the lack of a statistically valid model of fingerprinting; and the lack of validated standards for declaring a match, such claims of absolute, certain confidence in identification are unjustified . . . Therefore, in order to pass scrutiny under *Daubert*, fingerprint identification experts should exhibit a greater degree of epistemological humility. Claims of ‘absolute’ and ‘positive’ identification should be replaced by more modest claims about the meaning and significance of a ‘match’.³⁹⁸

The NAS Report found that although fingerprint evidence has been used in courts for more than a century, there is insufficient evidence to conclude that fingerprint comparison is reliable. The reason for this is that “(m)any of these difficulties with forensic science may stem from the historical reality that many methods were devised as rough heuristics to aid criminal investigations and were not grounded in the validation practices of scientific research.”³⁹⁹

3 3 4 A summary of the recommendations

The NAS report made 13 recommendations of which the first 10 are applicable to fingerprint evidence. It was recommended that⁴⁰⁰:

1. A National Institute of Forensic Sciences (NIFS) should be created;
2. terminology and reporting practices should be standardized;
3. research on the accuracy, reliability, and validity of the forensic sciences should be expanded;
4. forensic science services should be removed from the administrative control of law enforcement agencies and prosecutors’ offices;
5. forensic science research on human observer bias and sources of error should be undertaken;
6. tools for advancing measurement, validation, reliability, information sharing, and proficiency testing and to establish protocols for examinations, methods, and practices, should be developed;
7. the mandatory accreditation of all forensic laboratories and certification for all forensic science practitioners should be required;
8. laboratories should establish routine quality assurance procedures;
9. a national code of ethics with a mechanism for enforcement should be created;

³⁹⁸ NAS Report 142.

³⁹⁹ *Ibid* 128.

⁴⁰⁰ *Ibid* 14-28.

10. higher education in the form of forensic science graduate programs, including scholarships and fellowships, should be supported.

The creation of a stand-alone ‘National Institute of Forensic Science’ as recommended by the NAS, however, has not been done. The decision was made to, ‘capitalize on existing expertise and structures, rather than calling for the creation of a costly new agency.’⁴⁰¹

3 3 5 The effect of the NAS Report on case law

The NAS Report provides an insight with regard to the issues related to the use of fingerprints in courts without testing the validity of the techniques and the reliability of the premises relied upon by fingerprints experts. It does not only highlight the problems; it also provides recommendations that, if applied, could reduce erroneous identification when fingerprints are used. After the report had been published, some members of the forensic science community, academic writers and courts acknowledged it, while others disagree with the findings of the report.⁴⁰² As a result, there has been some developments in the manner in which fingerprints evidence is handled both inside and outside courts in some jurisdictions.⁴⁰³ Moreover, the report has been used as a tool for defence⁴⁰⁴ and to some extent the courts acknowledge the issues raised in the reports, but it seems that most are reluctant to rule fingerprint evidence unreliable. This is evident in the subsequent cases after the report.

In *United States v. Rose*⁴⁰⁵ the Court held that the NAS report identified a need for additional research but did not conclude that fingerprint evidence was unreliable such as to render it

⁴⁰¹ See http://www.leahy.senate.gov/press/press_releases/release/?id=6ae7da4b-ec1f-465e-b521-d763ecdc853f (accessed 25-06-2017).

⁴⁰² Giannelli “The 2009 NAS Forensic Science Report: A Literature Review” 2012 *Criminal Law Bulletin* 383.

⁴⁰³ Cooper “Challenges to Fingerprints Identification: Why the Courts Need a New Approach to Finality” 2016 *Mitchell Hamline Law Review* 756-790 (discussing the developments that took place from 2009 to 2014). See also The American Association for the Advancement of Science “Forensic Science Assessments: A Quality and Gap Analysis- Latent Fingerprint Examination” September 2017. Available at DOI: 10.1126/srhl.aag2874. See also Champod “Fingerprint identification: Advances since the 2009 National Research Council Report” 2015 *Philosophical Transactions of the Royal Society B: Biological Sciences* 1-10. In this article the author discusses the developments that have been made since 2009 to 2015.

⁴⁰⁴ Cothron “Using the National Academy of Science Report ‘Strengthening Forensic Science in the United States: A Path Forward as a Criminal Defense Tool in Florida’ <http://ssrn.com/abstract=1906715> (accessed on 25-08-2017) 1-36. See also Plumtree “A Perspective on the Appropriate Weight to Be Given to the National Academy of Sciences’ Report on Forensics in Evidentiary Hearings: The Significance of Continued Court Acceptance of Fingerprint Evidence” 2013 *Southwestern Law Review* 605, 608–609 (stating that “the defence bar nationwide utilized the report as a foundation for motions to exclude fingerprint evidence or to severely restrict expert testimony”).

⁴⁰⁵ *United States v. Brian Keith Rose*, 672 F. Supp. 2d 723, 725 (D. Md. 2009).

inadmissible. Judge Edwards (Chairman of the committee who prepared the NAS report) reacted strongly against that view and suggested quite the contrary that judges should account for the NAS report in their decision-making regarding admissibility.⁴⁰⁶ Judge Edwards made extensive reference to the order by Judge Gertner in *United States v Oliveira*⁴⁰⁷ where she indicated that although the admissibility of this kind of evidence was effectively presumed, largely because of its pedigree—the fact that it had been admitted for decades—admissibility ought not to be presumed but carefully examined in each case in light of the NAS concerns.⁴⁰⁸

In *Commonwealth v Gambora*⁴⁰⁹, Gambora was convicted of murder and other offences. He used the NAS Report to challenge the fingerprint evidence. He argued that his fingerprint did not match the latent print lifted from the door. The court conceded that the NAS report stated that “[u]niqueness and persistence are necessary conditions for friction ridge identification [i.e., fingerprint identification] to be feasible, but those conditions do not . . . guarantee that prints from two different people are always sufficiently different that they cannot be confused, or that two impressions made by the same finger will also be sufficiently similar to be discerned as coming from the same source.”⁴¹⁰ The court indeed appreciated the criticisms levelled against fingerprints, including the subjective nature of the ACE-V methodology, unknown error rate and the need for extensive research to establish and ground the discipline. Judge Spina took a strong stance on the claim of certainty: “Claims of absolute certainty are particularly irresponsible by a science based in large part on human judgment.”⁴¹¹ Nevertheless, the court held that the NAS Report does not conclude that fingerprint evidence is so unreliable that courts should no longer admit it.

In *United States v Aman*⁴¹², Mr Aman challenged fingerprint evidence which allegedly connected him to the crime of arson. Just like in the case of *Gambora*, the court acknowledged the concerns raised against fingerprint evidence. Nevertheless, the court held that Mr Aman’s challenge was

⁴⁰⁶ Edwards “The National Academy of Sciences Report on Forensic Sciences: What it means for the Bench and Bar. In Conference on the Role of the Court in an Age of Developing Science and Technology, Washington DC, 6 May 2010 Superior Court of the District of Columbia

⁴⁰⁷ Procedural Order: Trace Evidence, *United States v. Oliveira*, No. 1:08-cr-10104-NG (D. Mass. Mar. 8, 2010).

⁴⁰⁸ *Ibid.*

⁴⁰⁹ *Commonwealth v Gambora* 933 N.E.2d50 2010.

⁴¹⁰ *Ibid* 725.

⁴¹¹ *Ibid* 58-59.

⁴¹² *United States v Aman* 748 F.Supp.2d E.D.Va.2010.

appropriate for cross examination but not for grounds of exclusion.⁴¹³ In *United States v McCluskey*⁴¹⁴, the court held “that the fingerprint identification testimony, while perhaps not ‘scientific’, is sufficiently reliable to be admitted into evidence at trial, but the expert will not be permitted to testify that any individual is the source of a particular print ‘to the exclusion of all others,’ or that she is ‘100% certain’ about an identification, or any variant thereof.”⁴¹⁵

In *United States v Herrera*⁴¹⁶ the court suggested that fingerprint expert opinion regarding sources is akin to an art expert or similar to eyewitness testimony. The court stated that:

Matching evidence of the kinds that we’ve just described, including fingerprint evidence, is less rigorous than the kind of scientific matching involved in DNA evidence.⁴¹⁷

The court recognized that “evidence doesn’t have to be infallible to be probative”⁴¹⁸ and consequently, the court declared fingerprint evidence to be admissible evidence.

In *United States v Strayhorn*⁴¹⁹ the court held that:

Viewing these cases holistically, they reveal that in challenges to convictions involving fingerprints on movable objects, in the absence of evidence regarding when the fingerprints were made, the government must marshal sufficient additional incriminating evidence so as to allow a rational juror to find guilt beyond a reasonable doubt. Although the government may meet this burden with circumstantial evidence, that evidence must be sufficiently incriminating to support the conviction.⁴²⁰

In all the cases referred to above, the courts admitted that there are challenges associated with identification by fingerprints but did not exclude the evidence. It must be noted that the selected cases referred to above, do not provide a complete picture of the reluctance of US courts to exclude fingerprint evidence.⁴²¹

3 4 THE SCOTTISH FINGERPRINT INQUIRY REPORT

The third report that is examined below, is the so-called Fingerprint Inquiry report conducted in Scotland (hereafter SFI Report).⁴²² In 2011, this report, compiled by Judge Campbell, after Shirley

⁴¹³ *Ibid* 534.

⁴¹⁴ *United States v McCluskey* United States District Court, Tenth Circuit, Case 1:10CR02734-JCH 2013.

⁴¹⁵ *Ibid*.

⁴¹⁶ *United States v Herrera* No. 13-1527 10th Cir. 2015.

⁴¹⁷ *Ibid*.

⁴¹⁸ *Ibid*.

⁴¹⁹ *United States v Strayhorn* 743 F.3d 917 923 4th 2014.

⁴²⁰ *Ibid*.

⁴²¹ See also *State v Sheehan* 273 P.3d 417 430 Utah Ct. App. 2012 and *United States v Cerna* No. CR 08-0730 WHA12; 2010 U.S. Dist. LEXIS 144424 23 N.D. Cal. Sept. 1, 2010.

⁴²² Campbell *The Fingerprint Inquiry Report* (APS Group Scotland, 2011) SFI Report.

Mckie, was connected to a murder case by one fingerprint only, echoed the challenges against fingerprint evidence raised in the Mayfield Report and the NAS Report.

3 4 1 The factual background of *HM Advocate v Mckie* (1999)

In 1997, Miss Marion Margaret Campbell Ross was murdered and found dead in her house in Kilmarnock, Scotland. The murder investigation took place, examinations of the crime scene were conducted and 428 fingerprints were found and were sent to the Fingerprint Bureau of the Scottish Criminal Record Office (hereafter the SCRO).⁴²³ After the examination of the fingerprints, the SCRO identified a latent print marked Y7 as Ms Mckie's fingerprint.⁴²⁴ Ms Mckie was part of the investigating team of the death of Ms Ross. Another fingerprint lifted from a gift tag in the house marked XF was identified as Mr David Asbury's. The trial proceeded and Mr Asbury was convicted of the murder of Miss Ross. During the trial, issues arose against the provenance of some fingerprints and suggestions of planting were made. However, no issue arose with any of the identifications made by SCRO.⁴²⁵ Ms McKie was one of the witnesses and she gave evidence about her involvement in the murder investigation. In her evidence she denied that the fingerprint attributed to her was hers, she denied being in the house of the deceased beyond the porch.⁴²⁶ Subsequently Shirley McKie was charged with perjury and the grounds that justified the conviction were that she had testified falsely under oath.⁴²⁷

In 1999 American fingerprint experts, Mr Pat Wertheim and Mr David Grieve, questioned the identification of Y7 and as result the jury unanimously acquitted Ms McKie.⁴²⁸ After acquittal her father, Mr Iain McKie, raised a number of issues concerning the prosecution of his daughter and the expertise and conduct of those on whose fingerprint evidence the prosecution relied.⁴²⁹ In the years that followed he conducted a campaign through the media, members of Parliament and others to address what he saw as failings in the justice system that were not being addressed and the case featured globally on the internet.⁴³⁰ In early 2000, the case was given added publicity in two

⁴²³ SFI Report 31.

⁴²⁴ *Ibid.*

⁴²⁵ *Ibid.*

⁴²⁶ *Ibid.*

⁴²⁷ *Ibid.*

⁴²⁸ *Ibid.*

⁴²⁹ *Ibid.*

⁴³⁰ *Ibid.*

television programs.⁴³¹ In these, doubt was cast, not only on the identification of Y7 as having been made by Ms McKie, but also on the identification of Q12 found on a tin box found in Mr Asbury's house as having been made in part by Miss Ross.⁴³² Ms McKie sued the state and the state accepted to pay Ms McKie but did not explicitly accept liability.⁴³³

3 4 2 The purpose of the report

The Fingerprint Inquiry was done so that Scotland could have an approach to the identification, verification and presentation of fingerprints that everyone could trust.⁴³⁴ The report inquired into the procedure followed to verify fingerprints connecting McKie to the murder case.⁴³⁵ Also it was the aim of the report to establish the effects of the steps taken and or not taken.⁴³⁶ As a result the report came up with recommendations and measures that could reduce the dangers associated with using fingerprints evidence.⁴³⁷ The Inquiry looked at matters such as peer-review, the basis for finding a match between two fingerprints, the influence of the quality of materials examined on the reliability of finding matches, and the certainty with which fingerprint matches can be stated.

3 4 3 Causes of the misidentification of latent fingerprints Y7 and Q12

The report highlighted a number of factors that contributed to the erroneous identification of Y7 and Q12. These included poor police investigation, failure to secure and control the locus, failure to investigate properly allegations regarding Gary Gray, the SCRO relationship with the police and the culture and lack of procedures within the SCRO.⁴³⁸ With regard to poor police investigation, the report stated that after the identification of Asbury as a potential suspect, it was apparent that the police wanted to secure a conviction.⁴³⁹

In as much as the police wanted to secure a conviction, the only evidence connecting Asbury to the scene was fingerprint evidence. The police regarded the fingerprint evidence against Asbury as strong evidence. The police should have seen the deficiency or that the evidence against the suspect, if challenged successfully, would not hold water and that the case of the police would be

⁴³¹ *Ibid.*

⁴³² *Ibid* 132.

⁴³³ *Ibid* 133.

⁴³⁴ *Ibid* 2.

⁴³⁵ *Ibid* 25. See also http://www.wow.com/wiki/Fingerprint_Inquiry (accessed on 27-06-2017).

⁴³⁶ *Ibid.*

⁴³⁷ *Ibid.*

⁴³⁸ SFI Report 370-371.

⁴³⁹ *Ibid* 96.

damaged.⁴⁴⁰ There was also no reliable evidence as to who had been in the house and when.⁴⁴¹ The report highlights that it is not only challenging to prove, without doubt Shirley McKie's movements, but also other possible donors of Y7 could not be explicitly established.⁴⁴² Therefore, it could be argued that the investigations were improperly handled at the initial stage. In connection with the failure to secure and control the locus, the report states that there was a lack of consistency as to whether it was suicide or murder and this on its own raises questions and a number of concerns.⁴⁴³ Further, the SCRO failed to investigate properly the allegations that Gary Gray, during investigations, was wearing a damaged glove and that he was seen leaning on the bathroom doorframe.⁴⁴⁴

This is so because when the SCRO became aware of the information by Mr Moffat, instead of investigating about the information, the SCRO confronted, Mr Moffat with aggression and perceived the threats to indicate that he should stay quiet.⁴⁴⁵ From the previous statement one would ask why the SCRO was reluctant to investigate the allegations. Could it be because the SCRO was careless to discover the truth? Could it perhaps be the fear of the truth being uncovered that indeed the fingerprint belonged to Gary Gray? This portrayed an attitude that is unbecoming of police officials dealing with serious crimes. The SCRO had a relationship with the police. However the SCRO denied having a close relationship with the police and the influence thereof. Yet in actual fact the SCRO and the police knew each other.⁴⁴⁶ The culture and lack of procedures within the SCRO had an impact on the conclusion of the identification of Y7 and Q12. There was poor management morale and the procedures followed could have contributed to the erroneous identification.⁴⁴⁷

⁴⁴⁰ *Ibid* 124.

⁴⁴¹ *Ibid* 280 and 296.

⁴⁴² *Ibid*.

⁴⁴³ *Ibid* 295. The report elaborated that the evidence of Ms Scott did not in any way support the proposition that Ms McKie was within the house. Further Mr McAllister had no evidence that Ms McKie was in the locus. Mr McAllister's information that Ms McKie was inside the house was based upon the suggestion that her fingerprint was found in the house. He agreed that apart from the fingerprint he had been unable to find any evidence from anyone who saw her in the house.

⁴⁴⁴ SFI Report 69.

⁴⁴⁵ *Ibid*.

⁴⁴⁶ *Ibid* 370. The Inquiry committee found that there were calls that were made to the police officials and even visits to police station or the Bureau.

⁴⁴⁷ *Ibid* 364-370.

In addition, just as in the Mayfield case, junior examiners were not expected to make findings that were against the senior examiners' findings. In this case the report alludes to the fact that the junior experts were pressurized to sign the identifications of a 16 point standard even after the blind test was done.⁴⁴⁸ After the blind verification test, some examiners could not find 16 points but an identification of Y7 was made. However, there was the suggestion that no examiner had a different opinion or findings and that all examiners were satisfied with the identification of Y7.⁴⁴⁹ Hence the inquiry felt that the procedure itself was completely irregular and inappropriate because some examiners felt pressurized.⁴⁵⁰

3 4 5 Limitations of fingerprint evidence in general

The report echoes the sentiments expressed in the NAS Report and in the Mayfield report as well as the views of some other academic writers on the problems with fingerprint evidence. The Inquiry found that fingerprint examiners must not give evidence in court with 100% certainty. This is premised on the fact that fingerprint examiners are taught that once they have reached a conclusion, they can be 100% certain in their own mind that the identification is correct and that they expect any other examiner of similar training and experience to reach the same decision.⁴⁵¹ Expressing identification with 100% certainty, may undermine the intention of the verification step as the verifying examiner might just be confirming the view of the first examiner.⁴⁵²

If the examiner gives his or her opinion on fingerprint evidence with 100% certainty, it may not give the fact finder a fair presentation of the evidence. This includes the strengths and weaknesses of the evidence, so that the fact finder may determine the weight of such fingerprint evidence in any particular case.⁴⁵³ The Inquiry states that fingerprint examiners deal with impressions that are distorted and they are expected to make assumptions in order to compensate for the incomplete

⁴⁴⁸ *Ibid* 383-384, 513-514.

⁴⁴⁹ *Ibid* 386.

⁴⁵⁰ *Ibid* 385. Even if the junior examiners would raise complaints they would not be taken seriously and this shows the arrogant attitude within the SCRO environment.

⁴⁵¹ *Ibid* 513.

⁴⁵² *Ibid*. The Inquiry discovered that some SCRO examiners personally re-examined the marks (Y7 and Q12) on several occasions by reference to the variety of source materials but because each had already reached a conclusion with 100% certainty it is no surprise that each individual's re-examination led to the confirmation of initial conclusion. See also Mnookin "Fingerprints: Not a Good Standard" *Issues in Science and Technology* 2003 issues.org/20-1/mnookin/ (accessed 24-08-2016). See also Cole "More than Zero: Accounting for Error in Latent Fingerprint Identification" 2005 *Journal of Criminal Law & Criminology* 985-1078.

⁴⁵³ SFI Report 630.

and distorted state of materials.⁴⁵⁴ There is a danger of circular reasoning when dealing with fingerprints examination. For instance, the Inquiry highlighted that when a 16 point standard was still applicable in Scotland, there was a belief that the existence of such a number of points in a sequence and agreement itself was sufficient to declare a match and prove beyond reasonable doubt the identity of the suspect.⁴⁵⁵ Circular reasoning is dangerous in that it results in discounting a genuine variation between prints.⁴⁵⁶ The report further mentioned that there is contextual bias and impropriety in the fingerprint environment or among examiners⁴⁵⁷ and that fingerprint evidence does not depend on statistical information (these issues were dealt with thoroughly in the above mentioned reports).⁴⁵⁸ Moreover the report also criticised the fingerprint comparison methodology in that it does not provide guidance to an examiner to decide whether certain features actually match or differ, that there is little precise content of each stage of the method and examiners are required to make subjective assessments throughout the stages of the ACE-V.⁴⁵⁹

To a large extent the report reiterated what the NAS Report states about validation studies. It stated that fingerprint examiners, when making conclusions, do not rely on validated statistics of the incidence of variation in friction ridge details in the population. Rather the examiner's opinion is derived from personal assessments founded on training and personal experience.⁴⁶⁰ The report, in short, criticised fingerprint evidence in the same manner in which it is criticised by the reports analysed above.

⁴⁵⁴ *Ibid* 516. The Inquiry gave an example of Y7 and Q12, that the detail reproduced lacked clarity, the examiner is expected to apply wider tolerances in the assumptions he makes. This has the danger of an adventitious match because the width of tolerances may in fact be in fact accommodating genuine points of difference.

⁴⁵⁵ *Ibid* 520.

⁴⁵⁶ Circular reasoning in fingerprint comparison may be described as the situation whereby the examiner is attempting to make an argument by beginning with an assumption that the conclusion of identification to be proved in a particular case is already true. For instance in this case of Shirley Mckie the report states that, "By assuming an explanation for differences from the mere fact that 16 points are believed to be in sequence and agreement, examiners deprived themselves of the opportunity properly to evaluate the tolerances being applied in deeming the 16 to be truly in agreement." See SFI Report 521.

⁴⁵⁷ *Ibid* 528.

⁴⁵⁸ *Ibid* 548.

⁴⁵⁹ SFI Report 633, 634, 652 and 653. The report also states that even where the protocols are in place subjectivity remains the core of the analysis. Also when examiners are making conclusion it is not as a result of single subjective judgment but a plethora of judgments each of which maybe a matter of personal opinion. Edwards "Solving the Problems that Plaque the Forensic Science Community: Keynote Address at Conference on Forensic Science for the 21st Century: the NAS Report and Beyond" 2009 *Arizona State University* 9. He stated that "my concern is that some forensic practitioners may not know what they do not know about the limits of their discipline, they have to be taught this so they can be circumspect in their testimony."

⁴⁶⁰ SFI Report 683.

3 4 6 A summary of the recommendations

The report, after a thorough investigation and evaluation of the dangers that are associated with fingerprints as a tool of identification, made recommendations in an attempt to improve the validity and reliability of fingerprint evidence. Of the 86 recommendations made in the SFI Report, the following were listed as the ten “key recommendations”:

1. fingerprint evidence should be recognised as opinion evidence, not fact, and those involved in the criminal justice system need to assess it as such on its merits;⁴⁶¹
2. examiners should discontinue reporting conclusions on identification or exclusion with a claim to 100% certainty or on any other basis suggesting that fingerprint evidence is infallible;⁴⁶²
3. examiners should receive training which emphasises that their findings are based on personal opinion; and that this opinion is influenced by the quality of the materials that are examined, their ability to observe detail in mark and print reliably, the subjective interpretation of observed characteristics, and the cogency of explanations for any differences and the subjective view of “sufficiency”;⁴⁶³
4. differences of opinion between examiners should not be referred to as “disputes”;⁴⁶⁴
5. the SPSA's Standard Operating Procedures should set out in detail the ACE-V process that is to be followed;⁴⁶⁵
6. features on which examiners rely on should be demonstrable to a lay person with normal eyesight as observable in the mark;⁴⁶⁶
7. explanations for any differences between a mark and a print, require being cogent if a finding of identification is to be made;⁴⁶⁷

⁴⁶¹ *Ibid*, Recommendation 1.

⁴⁶² *Ibid*, Recommendation 3.

⁴⁶³ SFI Report, Recommendation 2.

⁴⁶⁴ *Ibid*, Recommendation 4.

⁴⁶⁵ *Ibid*, Recommendation 20.

⁴⁶⁶ *Ibid*, Recommendation 9.

⁴⁶⁷ *Ibid*, Recommendation 11.

8. a finding of identification should not be made if there is an unexplained difference between a mark and a print;⁴⁶⁸

9. the Scottish Police Services Authority (SPSA) should develop a process to ensure that complex marks are treated differently. The examination should be undertaken by three suitably qualified examiners who reach their conclusions independently and make notes at each stage of their examination. The substantive basis for the examiners' conclusions should be reviewed. The reasons why they have reached their respective conclusions should be explored and recorded, even where they agree that identification can be made;⁴⁶⁹

10. an emphasis needs to be placed on the importance, not only of learning and practising the methodology of fingerprint work, but also of engaging with members of the academic community working in the field.

Like the NAS Report, the SFI Report documents inadequacies in the research base. Specific areas warranting attention include:

- (i) the frequency of particular characteristics or combinations of characteristics in fingerprints;
- (ii) the use of data as to the frequency of particular characteristics or combinations of characteristics as a means of assisting examiners in their work;
- (iii) the weight to be given to third level detail, and as to its reliability;
- (iv) distortion and the effect of movement;
- (v) which marks ought to be assessed as complex;
- (vi) the specific factors that may cause variations among examiners; and
- (vii) contextual bias.⁴⁷⁰

Recommendation 83 extends this to include “probabilistic analysis”.⁴⁷¹ As part of the need to develop the research base, there was a conspicuous need for fingerprint examiners to engage with

⁴⁶⁸ *Ibid*, Recommendation 12.

⁴⁶⁹ *Ibid*, Recommendation 42.

⁴⁷⁰ *Ibid* 752, Recommendation 82. See also SFI Report at 432, 702 and 734.

⁴⁷¹ *Ibid*.

mainstream research scientists and engagement with the academic community generally.⁴⁷² The SPSA, in conjunction with members of the academic community as appropriate, should design a practical system for examiners to assess and evaluate (a) tolerances and (b) any reverse reasoning.⁴⁷³ The Report also draws explicit attention to the serious threat posed by human factors, in the guise of contextual bias.⁴⁷⁴ The SPSA should review its procedures to reduce the risk of contextual bias.⁴⁷⁵ The SPSA should ensure that examiners are trained to be conscious of the risk of contextual bias.⁴⁷⁶ The SPSA should consider what limited information is required from the police or other sources for fingerprint examiners to carry out their work and only such information should be provided to examiners, and the information provided should be recorded.⁴⁷⁷

The SFI Report further makes a number of recommendations to improve practice, including the following:

The need to “set out in detail the ACE-V process to be followed”;⁴⁷⁸ documenting and attaching less weight to “characteristics first found at the comparison stage”;⁴⁷⁹ emphasising the need to focus on “tolerances, the quality of similarities, the nature of differences, any explanations for differences, the extent to which reverse reasoning may have been employed and the sufficiency of matching characteristics’ during ‘the evaluation stage’; and blinding reviewers to the reasoning during the verification stage.” Attention was also directed to improving the quality of images, particularly digital images and documenting changes to digital images (Recommendations 37-40).⁴⁸⁰ The Report placed conspicuous emphasis on the subjective (i.e. non-certain and interpretive) nature of fingerprint comparison (Recommendation 1).⁴⁸¹ In addition to the need for procedures to manage disagreement between examiners (Recommendations 34 and 36), it stressed the need for practitioners to; conduct their individual ACE comparisons conscious of the fact that they are working in a field where there is no certainty and where there is scope for differences of opinion. When it comes to verification, examiners should be encouraged to be open and to adopt

⁴⁷² SFI Report, Recommendation 16, Para 35.135.

⁴⁷³ *Ibid*, 742.

⁴⁷⁴ *Ibid*, Recommendation 6, Para 35.137.

⁴⁷⁵ *Ibid*, Recommendation 7, Para 35.138.

⁴⁷⁶ *Ibid*, Recommendation 8, Para 35.139.

⁴⁷⁷ *Ibid* 741. See also SFI Report at 743, Recommendation 24.

⁴⁷⁸ *Ibid* 743.

⁴⁷⁹ *Ibid*. That is, once they have had an opportunity to look at both prints side-by-side.

⁴⁸⁰ *Ibid* 745.

⁴⁸¹ *Ibid* 741.

a challenging attitude to the opinions of other examiners, irrespective of seniority. Standard Operating Procedures should emphasise that the fact that one examiner reaches the opposite conclusion from another, or entertains⁴⁸² any doubt, does not necessarily cast any aspersion on the competence of either examiner.⁴⁸³

The SFI Report placed emphasis on the need for improved “record-keeping and note-taking” (Recommendations 44-52).⁴⁸⁴ Recommendations 54-56 address the need to provide information to prosecutors, and Recommendations 60-63 address disclosure and the provision of access to the defence. Sensitive to the circumstances of its origin, the Report was concerned that those identified (and their legal representatives) should have access to all images of prints, not only those relied upon by the state's examiners. The SFI Report also insisted on the need for training, improved performance management (Recommendations 70-4) and the certification and authorisation of examiners (Recommendations 76-80).⁴⁸⁵ Notwithstanding the need for examiners to be authorised to prepare reports and testify, the Report was open to the possibility of allowing those who were not authorised under Scottish legislation to act as expert witnesses (under common law principles), so that the defence, in particular, might have access to potentially critical perspectives and insights. In terms of the provision of evidence, Recommendation 59 lists the factors that should be included in an examiner's report.⁴⁸⁶ Recommendations 64 and 65 insist on the need to “pay particular attention to ensuring that fingerprint evidence is presented to the court in such manner as to be

⁴⁸² *Ibid* 655 para 36.118, 744 Recommendation 33.

⁴⁸³ *Ibid* 746-747.

⁴⁸⁴ *Ibid* 747-749.

⁴⁸⁵ *Ibid* 750-751

⁴⁸⁶ *Ibid* 679-680, 748, Recommendation 59:

“Each examiner's separate opinion should cover: (i) the images of the mark and also the specific print used in the comparison; (ii) the examiner's opinion about the quality of the mark; (iii) if the examiner considers the mark to be complex; (iv) whether third level detail is relied upon and the fact that such detail still requires to be supported by further research that has been validated; (v) identifying any differences between mark and print; (vi) a summary of the reasons why any differences between mark and print have been discounted and whether the examiner relies on objective studies and evidence to account for such differences or on common sense and experience; (vii) the characteristics relied on in making the identification, the number of such characteristics, and the classification of such characteristics, (e.g. ridge ending, bifurcation); (viii) a marked up image of the mark and print with a legend specifying the type of the ridge detail (including any third level detail) relied upon and the associated ridge counts; (ix) the opinion of the examiner; (x) any consultation with another examiner during the ACE-V process, including any facilitated discussion or panel review; and (xi) the fact that any novel method such as probabilistic analysis has been used or relied on.”

readily understood by the judge and jury and ‘exploring’ the use of technology to assist with the presentation.”⁴⁸⁷

In addition, there is a perceived “need for both examiners and prosecutors to maintain ‘up-to-date knowledge’ of cases and developments in Anglophone jurisdictions, particularly where courts, inquiries or other investigating bodies have made significant criticism of existing fingerprint practice” (Recommendation 85).⁴⁸⁸

3 5 THE NIST REPORT

The fourth report to be analysed for the purposes of this dissertation is the National Institute of Standards and Technology Report (NIST Report hereafter) ⁴⁸⁹in 2012. This report, entitled “The Expert Working Group on Human Factors in Latent Print Analysis, Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach”, deals with the human, organisational and environmental factors that affect fingerprint evidence. It defines “human factors” as issues that “can arise in any experience- and judgment-based analytical process such as latent print examination.”⁴⁹⁰ It also addresses issues ranging from the acquisition of impressions of friction ridge skin to courtroom testimony; from laboratory design and equipment to research into emerging methods for associating latent print exemplars.⁴⁹¹

3 5 1 The purpose of the report

The NIST Report was conducted to assess and develop an understanding on the role of human factors in mistakes that can occur in the latent print analysis.⁴⁹² The Expert Working Group assessed the measures that could reduce the occurrence of errors in order of their efficiency.⁴⁹³ Another purpose of the report was to give guidance to fingerprint examiners or the fingerprint community at large on the applicable, scientific and policy decisions of their work through peer reviewed publications.⁴⁹⁴ The report gave direction and guidance to policy makers and government

⁴⁸⁷ *Ibid* 680, 749.

⁴⁸⁸ *Ibid* 734, 752.

⁴⁸⁹ Expert Working Group on Human Factors in Latent Print Analysis, *Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach* (US Department of Commerce, National Institute of Standards and Technology, 2012) (“NIST Report”).

⁴⁹⁰ *Ibid* vi.

⁴⁹¹ *Ibid* 35.

⁴⁹² NIST Report iv.

⁴⁹³ *Ibid*.

⁴⁹⁴ *Ibid*.

agencies so as to promote a national agenda to reduce or avoid the occurrence of erroneous identification.⁴⁹⁵ The report made a number of suggestions for future recommendations.⁴⁹⁶

3 5 2 Challenges against fingerprint evidence as explored in the report

The NIST Report echoes the same sentiments expressed in the above analyzed reports. With regard to fingerprint comparison methodology, the report argues that merely following the steps of the method carefully and completely, does not mean that the examiner is proceeding in a scientific manner or that the examiner will produce reliable and repeatable results.⁴⁹⁷ It states that there is no research that shows or that helps to establish accurately that the examiners were good or excellent while following the stages carried out, either in monitored conditions or case work.⁴⁹⁸ Although the ACE-V process is described as a scientific method, this label can or should not be attached to the process with respect to human factors.⁴⁹⁹ ACE-V is a systematic, skill-based, and widely used process to establish whether two impressions are from the same source.⁵⁰⁰ Fingerprint comparison methodology requires the fingerprint examiner to follow a sequence where he or she makes a judgment of the complicated process. However, the methodology does not give essential guidance regarding criteria to be followed or used within this sequence.⁵⁰¹ Thus two examiners may both advance correctly that they are using the ACE-V methodology, yet they may be using different cognitive processes and those differences create an opportunity for human factors to come into play.⁵⁰² The report further criticizes the fingerprint comparison methodology method in that it does not guard against bias and that where bias exists, mistakes are bound to occur.⁵⁰³ Similar to

⁴⁹⁵ *Ibid.*

⁴⁹⁶ *Ibid.*

⁴⁹⁷ NIST Report 9.

⁴⁹⁸ *Ibid.*

⁴⁹⁹ *Ibid* 124.

⁵⁰⁰ *Ibid.*

⁵⁰¹ *Ibid.*

⁵⁰² *Ibid.*

⁵⁰³ *Ibid* 10. Bias in the NIST Report is defined in both legal, psychological and statistics form. In the legal world bias may be defined as a state where a witness is partial towards one party or against other party as a result of financial, emotional or other interests and attitudes. In statistics bias means the extent to which an average statistic departs from the parameter, it is estimating or to the extent which measurements on individual units systematically diverting from true values. In psychology bias is coined as cognitive bias; cognitive bias is defined as the effect of many observers in the mind of a person, some which can result to perpetual distortion, inaccurate judgment or illogical interpretation. A form of cognitive bias that is confirmation bias is also described as the seeking or interpreting of evidence in a manner that is partial to the existing beliefs, expectations or a hypothesis in hand. For instance, contextual information produces confirmation bias. The report also mentions personal bias, racial bias, gender bias, cultural bias etc. See also Dror *et al* "Cognitive Issues in Fingerprint Analysis: Inter-and Intra-Expert Consistency and the Effect of a 'Target Comparison'" 2011 *Forensic Science International* 10-17. See also Langenburg *et al* "Testing for Potential Contextual

the other reports dealt with above, the report criticizes the uniqueness of friction ridges⁵⁰⁴, the way fingerprint examiners describe the error rate, interpreting fingerprint comparison and court room testimony.⁵⁰⁵

Fingerprint examiners argue that when the ACE-V methodology is followed properly, the error rate is zero. Nevertheless, this notion was criticized in this report. The report avers that forensic sciences should follow other scientific and medical practices which entail the identification, reduction and quantification of error.⁵⁰⁶ It states that:

A basic tenet of experimental science is that ‘errors and uncertainties exist that must be reduced by improved experimental techniques and repeated measurements, and those errors remaining must always be estimated to establish the validity of our results.’ What applies to physics and chemistry applies to all of forensic science: ‘A key task ... for the analyst applying a scientific method is to conduct a particular analysis to identify as many sources of error as possible, to control or eliminate as many as possible, and to estimate the magnitude of remaining errors so that the conclusions drawn from the study are valid.’ In other words, errors should, to the extent possible, be identified and quantified.⁵⁰⁷

The report further raises concerns regarding the manner in which fingerprint examiners report and testify their conclusions, in particular the identification of the assumed source to the exclusion of all others.⁵⁰⁸ The Working Group argues that “this claim is needlessly strong”:

a fingerprint identification was traditionally considered an ‘individualization,’ meaning that the latent print was considered identified to one finger of a specific individual as opposed to every other potential source in the universe. However, the recent attention focused on this issue reveals that this definition needlessly claims too much, is not adequately established by fundamental research, and is impossible to validate solely on the basis of experience. Nor does fingerprint evidence have objective standards or a well-validated statistical model that can provide an objective measure of the strength of the fingerprint evidence in a given instance. Therefore, examiners should not claim to be able to exclude every other finger in the world as a potential source. Rather, an identification decision suggests a substantial enough similarity that the examiner believes that the two impressions originated from a common source. But whether any other finger in the world might also be able to leave an impression with a comparable amount of similarity is not fully known, and the examiner’s testimony should not suggest otherwise. Regardless of the specific words used to describe identification, examiners should refrain from claiming that identification means that they have excluded all other individuals in the world.⁵⁰⁹

Bias Effects during Verification Stage of ACE-V Methodology when Conducting Fingerprint Comparisons” 2009 *Journal of Forensic Science* 571-582.

⁵⁰⁴ NIST Report 15-18.

⁵⁰⁵ *Ibid* 18-19.

⁵⁰⁶ *Ibid* 21.

⁵⁰⁷ *Ibid* 12, 21.

⁵⁰⁸ *Ibid* 72-73.

⁵⁰⁹ *Ibid* 197.

Thus, fingerprint examiners, when testifying, giving error rates or interpreting fingerprint comparison methodology, must employ or make use of probable terms as well as qualifying their conclusions.⁵¹⁰

3 5 3 A summary of the analysis of human factors and errors as given in the report

The NIST Report states that human beings in all lines of work make mistakes and errors.⁵¹¹ In order for fingerprints to be reliable evidence, certain executing procedures must be followed. The report highlights that the environment in which examiners work, encompasses physiological, cognitive, management, leadership, culture, communications and physical workspace factors.⁵¹² The report raises the issue of a lack of openness among examiners with regard to errors. Being open about errors, is not necessarily a path to punitive sanctions but rather a part of an effective system to detect deviations from desired practices and incorrect judgement in latent fingerprint comparison.⁵¹³ However, it should be noted that interactions can either reduce or increase the errors made by examiners. The report went on further to state that Agency policies that are not well defined, adversarial, conflicting, or supplanted by unofficial rules and values, may result in confusion, and can lead to poor quality.⁵¹⁴

Moreover unreachable upper management, deficiency in accountability for actions, insufficient explanation of organizational values, improper allocation of resources, and vague or conflicting assignments of responsibility, can lead to a negative organizational climate.⁵¹⁵ A negative organizational climate is disastrous to the results or conclusions the fingerprint examiner is likely to reach. Moreover, the examiner's mental state, physiological state, and physical or mental

⁵¹⁰ *Ibid* 18-19, 72, and 77. Probability therein is defined as a "number between zero and one, that is to say probability is zero means that a proposition is truly false and a probability of 1 infers that a proposition is definitely true." Therefore, in empirical sciences absolute certainty is impossible, which is the reason why if fingerprint examiners are saying matching of fingerprints is a science they must refrain from being 100% certainty.

⁵¹¹ *Ibid* 21.

⁵¹² *Ibid* 140, 147 and 149. The report shows that errors do occur as a consequence of the entire system, not as a result of an individual examiner. Hence a well-designed work environment can improve productivity, user satisfaction and reduce risk of errors. Environment, as explained in this report, influences working ability. For instance, fingerprint examination requires a lot of concentration. If the examiner is stressed or is disrupted or the work environment is unsafe, errors could occur as a result of these interferences. Hence it was pointed out that hazardous working environments could be disastrous for the results of fingerprint examination. For example, if the bag containing the latent print is cut by sharp objects, contamination and distortion of the results will occur. Sufficient space is needed for exemplars, latent print documentation sheets, magnifying glasses, pointers, writing instruments and desktop lighting. This is so because these items must be accessible without undue attention or effort.

⁵¹³ *Ibid* 23.

⁵¹⁴ *Ibid* 181.

⁵¹⁵ *Ibid*.

limitations may have an impact on the performance.⁵¹⁶ For example, the examiner may be stressed or going through personal challenges and at the same time he or she is expected to deal with large backlogs.⁵¹⁷

To sum up, the NIST Report extensively and thoroughly examines human factors that may cause errors. It also deals with practices or organisational culture in laboratories and their attitude to erroneous identification. The report does not only point out issues associated with human factors which might affect fingerprint evidence, but it provides solutions and recommendations that, if employed properly, may reduce the number of challenges against the evidence.

3 5 4 Recommendations provided for in the report

The recommendations and suggestions of the Working Group covers issues from the acquisition of impressions of friction ridge skin, to courtroom testimony, as well as aspects from laboratory design and equipment to research into emerging methods for associating latent prints with exemplars. Nevertheless, the issues raised in the report are not being addressed for the first time. The recommendations aid and build on the research that has already been done by many practitioners and academics of forensic science. The report provides more than 30 recommendations that fingerprint examiners, laboratories, and management thereof must implement in order to curb errors, biases, and conflicts that could occur. Moreover, the report does not only evaluate current practices and their contribution to errors, but also investigates how to reduce error and how to implement these solutions practically. Some critical recommendations echo the NAS Report. The recommendations are discussed below.

⁵¹⁶ *Ibid* 178.

⁵¹⁷ *Ibid*. It is not only about stress and exhaustion that affect mental state of an examiner but also, anger, apprehension about reaching conclusions, boredom and complacency, distraction, expectancy, fatigue, overconfidence, peer pressure, and personal problems. The report advises that both the examiner and the management must consider whether the examiner is fit for work under these circumstances. Accordingly, because the examiner is given unrealistic and unreasonable deadlines, his focus would be more inclined to the results thereof. In doing this the examiner may skip other necessary stages (analysis and documentation) in order to meet the deadline and as a result quality assurance is neglected. Examiner's physiological instability may affect the examination procedure and its outcome. For instance, if the examiner is to work in a laboratory where in most cases he has to bend over a desk or for a long period of time without rest, looking through a magnifier, and making numerous comparisons. This becomes a heavy burden on the neck (stiffness), back and eyes of the examiner. In addition, if the examiner does not get enough sleep and rest, may be ill and is on medications it may affect negatively the outcome of the evaluation procedure. In short, the report highlighted the human factors that affect the examination procedure as well as the outcome thereof and it suggests a number of recommendations which, if followed, could prevent some of the errors caused by individuals as a result of environmental or organisational factors.

The report, in the same way as the other reports mentioned above, highlights the need for documentation by fingerprint examiners when comparing latent prints to known prints. Recommendation 3.1 of the report states that the fingerprint report and contemporaneous supporting notes or materials should document the examination to make the interpretive process as transparent as possible.⁵¹⁸ It further suggests in Recommendation 3.2 that changes to the results of any step of the ACE-V, for instance changes in feature selection, utility assessment, and discrepancy interpretation, after seeing a known print, should be treated with caution. In particular the documents must show that the said changes took place after the comparison stage had begun.⁵¹⁹ After the examiner has completed the analysis process and documented what transpired at every stage, the Working Group suggests, that the report of the examination should ensure that the findings and their limitations are comprehensive and understandable to non-experts (Recommendation 5.1).⁵²⁰ To this effect the NIST Report additionally states in Recommendation 5.2 that the report should:⁵²¹

(a) Identify the latent print examiner(s); (b) Describe the items submitted to the examiner(s); (c) List the procedures used by the examiner to develop, visualize, or enhance the friction ridge impressions; (d) List all comparisons conducted; (e) State all conclusions with the method used to reach them; (f) Note any important limitations to the conclusions; (g) Indicate whether a verification was made and whether there was any conflict of opinion among examiners prior to the reported conclusions; (h) Note (or refer to external documentation of) any information about the case that the examiner(s) received; (i) Note the existence of additional documentation; and (j) Define important technical terms, either explicitly or by reference to an authoritative, readily available source.

Furthermore, given the dangers of cognitive bias, the report in Recommendation 3.3 advocates that measures should be taken to prevent examiners from including unnecessary and irrelevant information in their assessment.⁵²² Nevertheless, this is not to suggest that examiners be denied access to information that is reasonably relevant to the examiners' substantive analysis.⁵²³ Since, in the fingerprint community, there is no agreement as to how much detail suffices for a match, the report suggests that "each agency or forensic service provider should define 'suitable' or 'sufficient' in its standard operations procedures" (Recommendation 3.4).⁵²⁴ In doing so the

⁵¹⁸ *Ibid* 42.

⁵¹⁹ *Ibid* 43.

⁵²⁰ *Ibid* 94.

⁵²¹ *Ibid* 100.

⁵²² *Ibid* 44.

⁵²³ *Ibid*. This kind of information includes information about the type of surface from which a print was lifted, or the fact that the source print is the result of an AFIS search.

⁵²⁴ *Ibid* 54.

specification must be unambiguous in stipulating what is needed for sufficiency determinations at different steps of the fingerprint comparison methodology.⁵²⁵

Moreover the report emphasizes the importance of statistical information when deciding what weight to give to fingerprint evidence, and to this effect it suggests that when training fingerprint examiners, the best available empirical data should be made available and that examiners must be enlightened about the probabilistic reasoning in applying such information (Recommendation 3.5).⁵²⁶ The Working Group also highlights the possibilities and dangers of incidental similarity when evaluating prints produced through IAFIS searches. In this regard it recommends adjustments such as a higher decision threshold and stricter tolerances for differences in appearance (Recommendation 3.6). It is also recommended that there should be an improvement in quality assurance.⁵²⁷ Recommendation 3.8 clearly states that the fingerprint world and other experts must establish under what circumstances a qualified, rather than an absolute conclusion, is justified.⁵²⁸ The Working Group elaborates that “empirical evidence and statistical reasoning do not support a source attribution to the exclusion of all other individuals in the world.” It is therefore recommended that examiners must not testify, directly or by implication, to a source attribution to the exclusion of all others in the world (Recommendation 3.7).⁵²⁹

In most cases if not all, the presiding officers and defence lawyers, may not have an in-depth knowledge of how fingerprints work, and what examiners consider to determine a match or an exclusion. Thus, the report proposes that the trial arrangement procedures must address the presentation of technical information in non-expert terms to enable lay presiding officers and defence lawyers to understand the evidence (Recommendation 6.1).⁵³⁰ It also recommends that the fingerprint experts, when testifying, must avoid furthering the case of any party and must be able to answer questions fairly, precisely, fully and truthfully when asked by both prosecution and defence, as well as furnishing the court with significant, relevant and applicable scientific data

⁵²⁵ *Ibid.* See generally articles at <http://www.sciencedirect.com/science/article/pii/S0379073813000182> and <http://www.sciencedirect.com/science/article/pii/S0379073816301475>.

⁵²⁶ *Ibid* 62. In 2013 the Scientific Working Group on Friction Ridge Analysis, Study and Technology (SWGFAST) published “Standards for Examining Friction Ridge Impressions and Resulting Conclusions (Latent/Tenprint)” to develop a statistical measure of the uncertainty of the decisions made on the evidential value of fingerprint comparison.

⁵²⁷ NIST Report, Recommendation 3.6.

⁵²⁸ *Ibid* 74.

⁵²⁹ NIST Report 72.

⁵³⁰ *Ibid* 115.

before, during and after trial (Recommendation 6.2).⁵³¹ Fingerprint examiners usually testify that, when they follow the ACE-V methodology appropriately, there is a zero error rate, but this does not mean that errors do not occur. Hence the NIST Report put forward that, upon giving evidence, a fingerprint expert must be well conversed with the literature associated with error rates.⁵³² In addition to that, the expert must be ready to explain the measures taken when following the ACE-V methodology to minimize the danger of observational and judgmental error.⁵³³ Consequently the Working Group advises that examiners must not testify that the method has an essentially zero error rate and or that it is inherently impossible for errors to occur (Recommendation 6.3).⁵³⁴

The report also emphasized that fingerprint examiners must receive training to develop their abilities, educate them in the scientific method, inform them about the substantial scientific literature, educate them in communicating and how reasonably to advance decisions and explain their observations (Recommendation 8.1).⁵³⁵ It also pinpoints that the training must not only focus on the technicality of the fingerprints and the fingerprint comparison methodology, but should also include: (a) Documentation of work and case notes and written and oral communication; (b) Professional ethics; (c) Human factors issues such as fatigue, bias, cognitive influences, perceptual influences, and error; (d) Research methods; and (e) Legal aspects of expert testimony (Recommendation 8.5).⁵³⁶ In Recommendation 8.7 the report advocates for continuous participation in education and accreditation programs. This will enable the fingerprints to be up to date with evolving technology and modifications in the scientific world.⁵³⁷ Subsequently the Certifying Bodies must ensure that examiners, during training, are taught competency and the said bodies must analyze the effectiveness of the programs meant to train the examiners (Recommendation 8.8).⁵³⁸

⁵³¹ *Ibid* 117.

⁵³² *Ibid* 127.

⁵³³ *Ibid*.

⁵³⁴ *Ibid*.

⁵³⁵ *Ibid* 166-167.

⁵³⁶ *Ibid* 168.

⁵³⁷ *Ibid* 170.

⁵³⁸ *Ibid* 171.

The organizational climate,⁵³⁹ in this report is argued to have an impact on the examination process of fingerprints, in that sometimes examiners work in fear of retribution from management and co-workers; and as result they end up making mistakes and errors.⁵⁴⁰ The report advises that management must develop a culture in which it accommodates the fact that human errors do occur and that openness about such errors results in advancements in the practice (Recommendation 9.1).⁵⁴¹ In addition to that it is commendable for the management to use a system to recognize and track mistakes as well as the root cause of the errors (Recommendation 9.2).⁵⁴² In Recommendation 9.4 the report urges that management must initiate and put in place policies and procedures for case review and conflict resolution, corrective action, and preventive measures.⁵⁴³

3 6 THE PRESIDENT’S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY (PCAST) REPORT

The PCAST Report was compiled in 2016 at a request of President Obama to examine if there are procedures that could improve and strengthen the forensic science disciplines and ensure the validity of forensic evidence.⁵⁴⁴

3 6 1 The purpose of the report

The objective of the report was to analyze feature comparison forensic methods used to associate the accused person with the crime scene and close the gaps in these methods.⁵⁴⁵ These methods include DNA, hair, latent fingerprints, firearms and spent ammunition, tool marks and bite-marks, shoeprints and tire tracks, and handwriting.⁵⁴⁶ The PCAST found that there is a need for clear and precise scientific standards for the validity and reliability of forensic methods and there is a need

⁵³⁹ *Ibid* 181, organizational climate is defined as, “the structure of the organization includes the chain of command, delegation of authority and responsibility, communication channels, and formal accountability for actions”.

⁵⁴⁰ *Ibid* 181.

⁵⁴¹ *Ibid* 182.

⁵⁴² *Ibid*.

⁵⁴³ *Ibid* 186.

⁵⁴⁴ Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods Report by President’s Council of Advisors on Science and Technology (PCAST Report) 2016 <https://www.whitehouse.gov/blog/2016/09/20/pcast-releases-report-forensic-science-criminal-courts> (accessed 01-12-2016).

⁵⁴⁵ *Ibid* 1.

⁵⁴⁶ *Ibid* 3.

to evaluate specific forensic methods to determine whether they have been scientifically established to be valid and reliable.⁵⁴⁷

3 6 2 Challenges raised against fingerprint evidence

The fingerprint analysts follow the ACE-V methodology and this method requires them to make a series of subjective assessments to select particular regions of a latent print for analysis.⁵⁴⁸ The report found that latent fingerprint analysis is a foundationally valid subjective methodology.⁵⁴⁹ To add to that the report stipulated that the verification stage, that is the last step of the fingerprint comparison methodology, is problematic because it is not done blindly.⁵⁵⁰ Often the second examiner knows the first examiner's conclusion which creates the potential for confirmation bias.⁵⁵¹ Hence the report highlights that currently, "testimony asserting any specific level of increased accuracy (beyond that measured in the studies) due to blind independent verification would be scientifically inappropriate, as speculation unsupported by empirical evidence."⁵⁵²

The report elaborates further that the ACE-V methodology lacks significant studies to evaluate and determine its error rate.⁵⁵³ In addition, lack of empirical testing is a sign that the method does not conform to the scientific culture of forensic science because validity is assumed and is not proven.⁵⁵⁴ The PCAST states that to test foundational validity of a subjective method, independent black-box studies must be conducted. With regard to this, the report refers to studies conducted by Evett and Williams,⁵⁵⁵ Langenburg,⁵⁵⁶ Langenburg *et al*,⁵⁵⁷ Tangen *et al*,⁵⁵⁸ FBI studies and

⁵⁴⁷ *Ibid* 2.

⁵⁴⁸ *Ibid* 90, the report emphasized that the subjective methods must be carefully and critically evaluated because they heavily rely on human judgment means they are especially vulnerable to human error, inconsistency across examiners, and cognitive bias.

⁵⁴⁹ *Ibid* 9. The issue of the subjectivity of the methodology has been raised in the above reports and even in other academic articles and journals.

⁵⁵⁰ *Ibid* 90.

⁵⁵¹ *Ibid* 91, the aspect of confirmation bias has been dealt with in the Mayfield Report, NAS Report and NIST Report.

⁵⁵² *Ibid* 96.

⁵⁵³ *Ibid* 87.

⁵⁵⁴ *Ibid*.

⁵⁵⁵ Evett and Williams "Review of the 16 point Fingerprint Standard in England and Wales" 1996 *Forensic Science International* 49-73.

⁵⁵⁶ Langenburg "A performance study of the ACE-V Process: A Pilot Study to Measure the Accuracy, Precision, Reproducibility, Repeatability, and Biasability of Conclusions Resulting from the ACE-V Process" 2009 *Journal of Forensic Identification* 219-257.

⁵⁵⁷ Langenburg *et al* "Testing for Potential Contextual Bias Effects during the Verification Stage of the ACE-V Methodology When Conducting Fingerprint Comparisons" 2009 *Journal of Forensic Sciences* 571-582.

⁵⁵⁸ Tangen *et al* "Identifying Fingerprint Expertise" 2011 *Psychological Science* 995-997.

Pacheco *et al*⁵⁵⁹ of which two studies only are recent and appropriately designed black-box studies.⁵⁶⁰ It discovered that latent fingerprint analysis is a foundationally valid subjective methodology.⁵⁶¹ The studies show false positive rates that are as high as 1 error in 306 cases in one study and 1 error in 18 cases in the other.⁵⁶² In these studies the examiners knew that they were tested, hence the report states “that the actual false positive rate in casework may be higher.”⁵⁶³ Therefore, the representations by fingerprint examiners of higher accuracy are not warranted or scientifically justified and the report suggests that more black-box studies must be conducted to establish the reliability of the method.⁵⁶⁴ In short the report states that validity as applied, requires that a fingerprint examiner:

(1) has undergone appropriate proficiency testing to ensure that he or she is capable of analyzing the full range of latent fingerprints encountered in casework and reports the results of the proficiency testing; (2) discloses whether he or she documented the features in the latent print in writing before comparing it to the known print; (3) provides a written analysis explaining the selection and comparison of the features; (4) discloses whether, when performing the examination, he or she was aware of any other facts of the case that might influence the conclusion; and (5) verifies that the latent print in the case at hand is similar in quality to the range of latent prints considered in the foundational studies.⁵⁶⁵

In summary, the report echoed the same sentiments expressed in the above-mentioned reports with regard to fingerprint evidence. The report emphasised that caution and scrutiny should be exercised in respect of fingerprint identification evidence because of its heavy reliance on human judgment.⁵⁶⁶

3 6 3 A summary of the recommendations

The PCAST Report provides a comprehensive analysis of the current state of fingerprint evidence. Over and above, the report gives direction to judges in determining the scientific validity as a foundation for expert testimony. The report recommends that judges scrutinize false positive rates, the method’s sensitivity, the sufficiency of validation studies, the appropriateness of proficiency

⁵⁵⁹ Pacheco *et al* “Miami-Dade Research Study for the Reliability of the ACE-V Process: Accuracy & Precision in Latent Fingerprint Examinations” 2014. Available at www.ncjrs.gov/pdffiles1/nij/grants/248534.pdf.

⁵⁶⁰ Ulery *et al* “Accuracy and Reliability of Forensic Latent Fingerprint Decisions” 2011 *Proceedings of the National Academy of Sciences* 7733-7738.

⁵⁶¹ PCAST Report 101.

⁵⁶² *Ibid.*

⁵⁶³ *Ibid.* The PCAST advises that when testifying the examiners must inform the court that errors do occur at a detectable frequency. This will give jurors and the judges an opportunity to weigh the probative value of the evidence before admitting it.

⁵⁶⁴ *Ibid* 102.

⁵⁶⁵ *Ibid.*

⁵⁶⁶ *Ibid* 6.

testing, the adequacy of the procedures and documentation used and whether appropriate limits were placed on reporting language.⁵⁶⁷ The report also suggests that best practice materials and training on scientific evidence must be made available for judges.⁵⁶⁸ The PCAST Report furthermore recommends that for each field, the forensic science expert must (1) show the ability of the analyst through routine, and blinded proficiency testing, (2) display that the techniques were reliably utilized in the case by giving a full and a complete description of the procedures, results and laboratory notes, and (3) use thorough and precise reporting and testimony, including from the available empirical studies of false positive rates and sensitivity provide, data on the similarity between the types of samples employed in these empirical studies and the samples available in a specific case, and give a precise depiction of the probative value of the observed features, for instance how common or rare the features are, based on empirical studies.⁵⁶⁹

3 7 CONCLUSION

The prominent five reports referred to above, all critically discuss various problems regarding fingerprint evidence. Despite the fact that the reports were compiled with regard to other jurisdictions, many of the problems are applicable in the South Africa system. This is so because South Africa is not exceptional in its production, presentation and treatment of fingerprint evidence. Although there are differences in the manner in which the evidence is admitted, in the evidentiary rules and procedures, in the traditions of practice including accreditation and certification, the problems regarding fingerprint evidence highlighted in the reports do have serious implications for South Africa. The issues emerging from these reports are crucial in that they bring an insight regarding the problems associated with fingerprint evidence generally and the need for the courts to be more cautious when dealing with such evidence. As a result of the problems raised in these reports, jurisdictions in the United States of America and Scotland have embarked on a journey to reform the rules for the admissibility of fingerprint evidence and it is in the reliability requirement for admissibility as required in the USA, that lessons can be learnt by South Africa. A summary of the findings and recommendations of the reports is given below.

⁵⁶⁷ *Ibid* 142.

⁵⁶⁸ *Ibid*.

⁵⁶⁹ *Ibid* 145.

3 7 1 The accuracy and reliability of the uniqueness and permanence of friction ridges

The reports recognise that uniqueness and persistence are necessary conditions for friction ridge identification to be feasible, but that those conditions do not imply that anyone can reliably discern whether two friction ridge impressions were made by the same person. Uniqueness does not guarantee that prints from two different people are always sufficiently different to the extent that they cannot be confused, or that two impressions made by the same finger will also be sufficiently similar to be discerned as coming from the same source. Furthermore, the reports concede that no peer reviewed scientific studies have been done to prove the basic assumption that every person's fingerprint is unique. The NIST Report, in particular, avers that because fundamental research is lacking, it is quite difficult to validate these premises and validation cannot be derived from the fact that the fingerprint expert is experienced. Hence the reports submit that it is imperative that studies be conducted to demonstrate the validity and reliability of these premises.

3 7 2 Bias

As highlighted above, the fingerprint comparison methodology followed by fingerprint examiners is too broad and it lacks protocols that guard against bias. Therefore, the reports encourage research programs on human observer bias and sources of human error in forensic examinations. Studies to determine the effects of contextual bias in forensic practice, the sources of error and the development of standard operating procedures to minimize as far as reasonably possible, potential bias and sources of human error in fingerprint identification, are urgently needed.

3 7 3 Error rate

The reports found that errors do occur when following the fingerprint comparison methodology. The PCAST Report in particular finds that latent fingerprint analysis is a foundationally valid subjective methodology coupled with a false positive rate that is substantial and is likely to be higher than expected by many jurors based on longstanding claims about the infallibility of fingerprint analysis. It follows that it is unrealistic to maintain that fingerprint identification has a zero error rate. Thus, recognition by forensic service providers that some human error is inevitable and that openness about errors leads to improvements in practice, is essential.

3 7 4 Training, education, certification and accreditation

Requirements for a person to be a fingerprint expert, differ from jurisdiction to jurisdiction and from country to country and formal education is not mandatory. The reports, therefore, emphasized that to establish quality assurance, laboratory and individual certification of forensic science professionals should be compulsory. Continuing education, mentoring and accreditation/certification programs and implementing comprehensive testing programs to ensure examiner competency and proficiency are strongly recommended. The training must include recent empirical information and examiners should be educated about probabilistic reasoning in using the said information. Furthermore, the reports find that the judges must also be educated on forensic science as this will enable them to comprehend the processes, techniques and approaches by forensic science disciplines and the degree of reliability of such evidence tendered in court.

3 7 5 Reporting results and testifying in courts

Usually fingerprint examiners report and testify about a positive identification in absolute terms including, “consistent with”, match, identical, “similar in all respects tested” and “cannot be excluded as a source of”. On the other hand, in most cases, if not all, the presiding officers and defence lawyers, may not have an in- depth knowledge of how fingerprints works, and what examiners consider to determine a match or an exclusion and what constitutes a match. This has a negative effect on the weight to be given to the evidence, in that undue weight may be given to unreliable evidence. As a result, the reports suggest that fingerprints experts must testify in a manner that will make it possible for lay persons to understand their observations and conclusions. This is also applicable to South African courts, however it must be noted that there is no jury system in South Africa. In addition, the reports highlight that agencies that employ latent print examiners must establish requirements and guidelines for reporting, documentation and testimony that are reviewed for each examiner at least annually and that agencies should require fingerprint experts to give credible and accurate testimony in trials, stressing skills such as using lay language, creating visuals that can easily be understood, and thinking clearly under cross-examination.

3 7 6 Documentation

For fingerprint evidence to be used fully, properly and fairly, there must be documentation. The documentation must provide details on how the fingerprint examiner lifted the latent print, the selection of details, limitations of the technique and how the conclusion was arrived at. In the

reports discussed above it is contended that there is a lack of documentation and that at present, it is not a requirement. The reports echo the same sentiments in as far as documentation is concerned by stating that there is a need to document latent print examinations at a detailed level that would permit another examiner to assess the accuracy and validity of the work and in doing so, to increase transparency.

3 7 7 The subjective nature of fingerprint evidence

The reports find that there are no objective standards that guide the fingerprint examiner to determine how much details suffices for a match or exclusion. There is no standard threshold to determine feature selection and weighting. Rather it is based on the examiner's personal judgment and it varies from jurisdiction to jurisdiction and laboratory to laboratory. As a measure to address this deficiency, the reports recommend the drafting of objective standards or protocols, to replace subjective determinations by examiners. By following these protocols, the examiner can show that all procedures were followed.

3 7 8 Codes of ethics

The reports recognize that there are comprehensive codes of ethics with different content in existence. However, there are no measures to enforce the said codes of ethics and it is not clear whether and to what extent adherence must be made to a condition of employment. Thus, the reports recommend that forensic service providers must adopt a code of ethics that require testifying in a nonpartisan manner, answering questions from both prosecution and defence lawyers directly, accurately and fully and provide appropriate scientific information before and after the trial.

3 7 9 IAFIS

Unlike the ACE-V methodology, when using the IAFIS, the examiner makes use of only part of the data that is gathered during the analysis phase, specifically the location and orientation of the chosen minutiae. IAFIS was found wanting in that many searches do not result in identification because the known print of the suspect may not be in any of the databases. Furthermore, with IAFIS, even if a person is not a suspect, but has prints similar to the latent print found on the crime scene, he or she is at risk of being arrested. Hence the reports require that an examiner should conduct a complete analysis before conducting a database search.

CHAPTER 4

THE RELIABILITY OF FINGERPRINT EVIDENCE

4 1 INTRODUCTION

South Africa, like England and Wales, does not have clear scientific standards to monitor the admissibility of scientific evidence.⁵⁷⁰ There is no admissibility requirement that scientific evidence should be valid or reliable. In most cases scientific evidence in South Africa is admissible and requires judicial consideration.⁵⁷¹ In this context, the South African law of evidence shares the English common law rule that “opinions, inferences or beliefs of witnesses are generally inadmissible as evidence to prove material facts.”⁵⁷² There are exceptions for some kinds of opinion evidence especially those that involve expert evidence.⁵⁷³ Because of its potential to assist the tribunal of fact, most common law jurisdictions maintain an exception for the opinions of “experts” or for opinions based on “specialized knowledge.”⁵⁷⁴

As mentioned above, there are a number of supplementary rules that have been developed in the South African common law to regulate the way expert opinion evidence is admitted in South African courts.⁵⁷⁵ These rules are meant to reduce the problem of presiding officers being tempted to put undue emphasis on expert opinions and abandoning their duty to draw their own conclusions on all the relevant facts in dispute.⁵⁷⁶ These general rules apply in both criminal and civil proceedings in South Africa and one of the rules which govern expert testimony is found in section 210 of the CPA⁵⁷⁷ and section 2 of the CPEA.⁵⁷⁸ Section 210 reads as follows:

No evidence as to any fact, matter or thing shall be admissible which is irrelevant or immaterial and which cannot conduce to prove or disprove any point or fact in issue in criminal proceedings.

⁵⁷⁰ Under the common law, South Africa and England and Wales apply general rules of admissibility (such as relevance) to scientific evidence.

⁵⁷¹ Redmayne *Expert Evidence and Criminal Justice* (2001) 25.

⁵⁷² Schwikkard and Van der Merwe *Principles of Evidence* 3ed (2009) 90.

⁵⁷³ Meintjes-van der Walt “Science Friction: The Nature of Expert Evidence in general and Scientific Evidence in particular” 2000 117 *South African Law Journal* 778.

⁵⁷⁴ Steinman “Appellate Courts as First Responders: The Constitutionality and Propriety of Appellate Courts’ Resolving Issues in the First Instance” 2012 *Notre Dame Law Review* 1521.

⁵⁷⁵ Schwikkard and Van der Merwe *Principles of Evidence* 3ed (2009) 90.

⁵⁷⁶ *S v Gokool* 1965 3 SA 461 (N) at 457G: “The law of evidence is based foundationally on the principle that evidence is admissible if it is relevant to an issue in the case.” See also *S v Engelbrecht* 2005 2 SACR 41 (W).

⁵⁷⁷ Criminal Procedure Act 51 of 1977.

⁵⁷⁸ Civil Proceedings Evidence Act 25 of 1965.

Section 2 of the CPEA contains a substantially similar provision.⁵⁷⁹ These sections serve as statutory confirmation of the South African common law and state the rule in its negative form “irrelevant evidence is inadmissible.” Relevant evidence may be described as evidence that has “any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence.”⁵⁸⁰

The first part of this chapter differentiates between the admissibility of expert opinion evidence, on the one hand, and the weight that should be attached to expert opinion evidence, on the other hand. Secondly the chapter discusses the factors that courts could take into consideration to test the reliability of fingerprint evidence in South African courts. In this respect it is proposed that South African courts can learn from the reliability requirements set out in *Daubert*.⁵⁸¹ The third part of the chapter provides an analysis of why it is important to test the reliability of expert evidence. The chapter further indicates how South African courts accept *prima facie* fingerprint evidence which is not challenged or rebutted as evidence of identification, despite the emerging challenges raised against fingerprint evidence in the five international forensic reports discussed above. The chapter then considers how knowledge of these issues could assist South African lawyers when determining the weight to be given to fingerprint evidence. The fourth part of the chapter recommends possible cross-examination questions that the defence could ask fingerprint experts to test the reliability of fingerprint evidence. In conclusion, the chapter summarises the importance of and the recommendations given to courts and laboratories, in the reports.

4 2 THE DIFFERENCE BETWEEN THE ADMISSIBILITY AND THE WEIGHT OF EXPERT EVIDENCE

Admissibility of evidence and weight of evidence can be clearly distinguished.⁵⁸² In the Anglo-American legal systems like the USA, South Africa and England and Wales, admissibility is basically a “matter of law”, whilst weight is a “question of fact.”⁵⁸³ If evidence can be lawfully adduced during trial, it is admissible.⁵⁸⁴ Weight of evidence can be defined as the “degree of probability which is attached to it by the tribunal of fact once it is established to be relevant and

⁵⁷⁹ Schwikkard and Van der Merwe *Principles of Evidence* 3ed (2009) 45.

⁵⁸⁰ E du Toit *et al Commentary on the Criminal Procedure Act* (1997) 24.

⁵⁸¹ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993.

⁵⁸² See *S v Fourie* 1973 1 SA 100 (D) 102 H.

⁵⁸³ Schwikkard and Van der Merwe *Principles of Evidence* 3ed (2009) 12.

⁵⁸⁴ Nokes *An Introduction to Evidence* 4ed (1967) 81.

admissible in law.”⁵⁸⁵ It is only once it has been or could be admitted that “its persuasiveness, alone or in conjunction with other evidence, in satisfying the court as to the *facta probanda*, has to be considered.”⁵⁸⁶ Evidence can be either admissible or inadmissible and once evidence is admissible, it may carry more or less weight. Thus, the weight of the evidence is considered only after the evidence has been admitted.⁵⁸⁷

In South Africa, admissibility of evidence is based on the degree of relevance of that evidence. In terms of South African law, opinion evidence of an expert will be deemed admissible if it is relevant in the sense that the expert by reason of skill is better qualified to draw an inference from the particular set of facts than the court.⁵⁸⁸ Fingerprint evidence as opinion evidence is relevant if it can assist the court in drawing inferences on a particular issue and if the fingerprint examiner as a witness is better qualified to form such an opinion.⁵⁸⁹ The acceptance of fingerprint evidence can be said to be dependent on its relevance. Fingerprint evidence could assist the court as a tool of identification and as a result become relevant.⁵⁹⁰

However, since the *Daubert*⁵⁹¹ decision, courts in the USA are required to accept evidence that is not only relevant but also reliable. Evidence can be relevant but it does not necessarily mean that it has been derived from a reliable source or by using reliable techniques. *Daubert* requires judges to undertake the duty of gatekeeping, and expect judges to separate good science from poor science.⁵⁹² Consequently, in the USA, expert evidence that is not reliable is not admissible.

⁵⁸⁵ Hatchard and Ndulo *The Law of Evidence in Zambia: Cases and Materials* (1991) 2.

⁵⁸⁶ Schwikkard and Van der Merwe *Principles of Evidence* 3ed (2009) 20.

⁵⁸⁷ *Ibid.*

⁵⁸⁸ *Holtzhauzen v Roodt* 1997 4 SA 766 (W), *Schneider v AA* 2010 5 SA 203 (WCC), *Mathembula v RAF* 2006 ZAGPHC 261, *S v Gouws* 1967 4 SA527 (EC) and *Nicholson v RAF* (07/11453) 2012 ZAGPJHC 137. See also Zeffertt *et al The South African Law of Evidence* (2003) 290.

⁵⁸⁹ S210 of the Criminal Procedure Act 51 of 1977 states that no evidence will be accepted if it is irrelevant only relevant evidence should be accepted. Also under South African Law the court must be satisfied that the witness has specialist knowledge, training, skill or experience. Secondly the expert is a witness called to express an opinion. Thirdly a witness will express an opinion not on hypothetical facts.

⁵⁹⁰ Faurie *Admissibility and Evaluation of Scientific Evidence in Court* (LLM, University of South Africa, 2000) 62.

⁵⁹¹ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993.

⁵⁹² Pipoly “*Daubert* Rises: The (Re)applicability of the *Daubert* Factors to the Scope of Forensics Testimony” 2012 *Minnesota Law Review* 1590. See also Cooley and Oberfield “Increasing Forensic Evidence’s Reliability and Minimising Wrongful Convictions: Applying *Daubert* Isn’t the only Problem” 2007 *Tulsa Law Review* 288. See also “Admitting Doubt: A New Standard for Scientific Evidence” 2010 *Harvard Law Review* https://harvardlawreview.org/wp-content/uploads/pdfs/vol123_admitting_doubt.pdf (accessed 28-10-2017) 2023.

As South Africa does not have a jury system, the judge does not have to exercise a “gate keeping” role, as the judge is the final arbiter as to whether the evidence is reliable.⁵⁹³ The presiding officer should therefore rather allow all evidence, as is the current practice in South Africa and England and Wales, but, finally, decide what weight should be attached to the evidence.⁵⁹⁴ The decision determining the weight of the evidence, could well benefit from and gain scientific substance, by the presiding officer taking cognizance of the standards set out in *Daubert* and by being aware of the cautions set out in the reports discussed in this dissertation above. Scientific reliability, in South Africa, should therefore not be a criterion for admissibility, but should rather be a central factor in deciding what weight should be attached to the expert evidence given in a particular case.⁵⁹⁵ This means that the presiding officer can exercise his/her discretion in determining the weight of the evidence at the stage when a final judicial decision is reached.

4 3 FACTORS THAT COULD RELIABLY DETERMINE THE WEIGHT OF FINGERPRINT EVIDENCE IN SOUTH AFRICAN COURTS

4 3 1 The Daubert criteria

In the *Daubert* case,⁵⁹⁶ the plaintiff submitted *in vitro* studies of animals, reanalysis of existing studies, and pharmacological studies to establish that the drug Bendectin could cause birth defects.⁵⁹⁷ At the trial stage, the defendants were granted summary judgment in the district court because, under *Frye*, the plaintiff’s experts’ methods for arriving at their conclusion were not generally accepted.⁵⁹⁸ The Supreme Court held that “(n)othing in the text of Rule 702 establishes ‘general acceptance’ as an absolute prerequisite to admissibility,” consequently *Frye* was overruled.⁵⁹⁹ The court stated that the role of the judge is that of gatekeeping expert testimony.⁶⁰⁰ In order to assist the judges to perform this role, the court formulated five non-exhaustive factors

⁵⁹³ Meintjes-van der Walt *Expert Evidence in the Criminal Justice Process: A Comparative Approach* (2001) 202.

⁵⁹⁴ *Ibid.*

⁵⁹⁵ *Ibid* 202-203.

⁵⁹⁶ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993.

⁵⁹⁷ *Ibid* 582-583.

⁵⁹⁸ *Ibid* 584.

⁵⁹⁹ *Ibid* 588.

⁶⁰⁰ *Ibid* 597.

that allow judges to check whether the evidence of the expert witness is both scientifically valid and legally reliable.⁶⁰¹ These factors include:

Whether the technique or theory at issue can be tested, whether the theory or technique has been subjected to peer review and publication, whether the technique or theory at issue has a known error rate, whether standards controlling the technique's operation exist and whether the theory had achieved general acceptance in the relevant scientific community.⁶⁰²

The factors mentioned above, are considered in the following paragraphs below.

4 3 2 Testability

Testing a premise to establish whether it is capable of doing what the expert claims it does, is crucial as this will enable judges to see whether the said premise can be falsified.⁶⁰³ A technique or methodology must be empirically tested and not judicially tested.⁶⁰⁴ In *Daubert* it was stated that:

A testimony based on scientific knowledge must be scrutinized for its scientific validity: [I]n order to qualify as 'scientific knowledge' an inference or assertion must be derived by the scientific method. Proposed testimony must be supported by appropriate validation-i.e., 'good grounds,' based on what is known.⁶⁰⁵

As is elaborated in the *Daubert* case, the verification of claims is what differentiates science from other fields of human inquiry.⁶⁰⁶ In the case of fingerprints, there are two key premises that fingerprints proponents rely on: the uniqueness of friction ridges and the permanence of such uniqueness.⁶⁰⁷ Nevertheless, no research has been done to test the validity or reliability of such claims.⁶⁰⁸ Moreover, Rea states that:

⁶⁰¹ Pipoly "Daubert Rises: The (Re)applicability of the *Daubert* Factors to the Scope of Forensics Testimony" 2012 *Minnesota Law Review* 1589-1590.

⁶⁰² *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 593-595.

⁶⁰³ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 593.

⁶⁰⁴ Giannelli "Daubert Challenges to Fingerprints" 2006 *Criminal Law Bulletin* 628. Also, the article makes reference to the case of *US v Havvard* 260 F.3d 597 56 Fed. R. Evid. Serv. 900 (7th Cir. 2001), wherein the court found that "that latent print identification had been 'tested' for nearly 100 years in adversarial proceedings with the highest possible stakes-liberty and sometimes life."

⁶⁰⁵ Giannelli "Daubert Challenges to Fingerprints" 2006 *Criminal Law Bulletin* 628-629. See also *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 590.

⁶⁰⁶ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 593.

⁶⁰⁷ Wertheim and Maceo "The Critical Stage of Friction Ridge and Pattern Formation" 2002 *Journal of Forensic Identification* 45. See also Wertheim "Embryology and Morphology of Friction Ridge Skin" in Holder *et al* *Fingerprint Sourcebook* (2011) 3-5, 20-21.

⁶⁰⁸ NAS Report 143-144. See also Cole and Roberts "Certainty, Individualization and the Subjective Nature of Expert Fingerprint Evidence" 2012 *Criminal Law Review* 826 (stating that such claims of uniqueness and permanence does not prove accuracy); Pagea *et al* "Uniqueness in the Forensic Identification Sciences: Fact or Fiction" 2011 *Forensic Science International* 12-18; Cole "Forensic without Uniqueness, Conclusions without Individualization: the New Epistemology of Forensic Identification" 2009 *Law, Probability and Risk* 239-246; Kaye "Probability, Individualization and Uniqueness in Forensic Science Evidence: Listening to the Academies" 2010 *Brooklyn Law Review* 1167; and Cole "Who Speaks for Science? A Response to the National Academy of Sciences Report on

Our review of the scientific literature found that there is no scientific way to estimate the number of people in some community—a city, a state, the country, the world—who share the characteristics found, and hence [there is] no scientific basis for identification.⁶⁰⁹

By conducting research in response to the *Daubert* challenge, as pointed out in *United States v Mitchell*⁶¹⁰, an effort was made by the FBI in 2000 to ascertain the proposition of uniqueness. The methodology used was substantially flawed to establish the concept of uniqueness and consequently the findings of the experiment were not published.⁶¹¹

While fingerprint proponents claim that prints are unique and permanent, the ability to make identifications accurately depends on the examiner.⁶¹² Recently the American Association for the Advancement of Science (hereafter the AAAS) compiled a report with the aim of restoring confidence in the criminal justice system, interrogating the validity of forensic practice and to establish where the forensic practice is well founded and where it is not.⁶¹³ The report acknowledges that the existing scientific literature shows that fingerprints from different individuals are unique, but that it does not provide an adequate basis for evaluating the rarity of features that might be found in a print.⁶¹⁴

The report explains that “while latent fingerprint examiners can successfully rule out most of the population from being the source of a latent fingerprint based on observed features, insufficient data exist to determine how fingerprint features really are unique.”⁶¹⁵ This makes it scientifically baseless to claim that an analysis has enabled examiners to narrow the pool of sources to a single person.⁶¹⁶ Therefore, in as much as *Daubert* requires judges to check the testability of a technique,

Forensic Science” 2010 *Law, Probability and Risk* 25-46. See also Haber and Haber *Challenges to Fingerprints* (2009) 20-22.

⁶⁰⁹ Rea “Fingerprints Lack Scientific Basis for Legal Certainty” 2017 <https://phys.org/news/2017-10-fingerprints-lack-scientific-basis-legal.html#nRlv> (accessed 28-10-2017).

⁶¹⁰ *United States v Mitchell* 199 F. Supp. 2d 262 E.D. Penn. 2002. See also National Institute of Justice, Forensic Friction Ridge (Fingerprint) Examination Validation Studies (Mar. 2000), <http://www.ncjrs.org/txtfiles1/nij/sl000386.txt> (accessed 25-09-2017).

⁶¹¹ See National Institute of Justice “Forensic Friction Ridge (Fingerprint) Examination Validation Studies” 2000 <http://www.ncjrs.org/txtfiles1/nij/sl000386.txt> (25-09-2017).

⁶¹² The American Association for the Advancement of Science “Forensic Science Assessments: A Quality and Gap Analysis - Latent Fingerprint Examination” September 2017 at 20 states that the ability to identify or individualise depends on the experience and training of fingerprint examiner.

⁶¹³ The American Association for the Advancement of Science “Forensic Science Assessments: A Quality and Gap Analysis - Latent Fingerprint Examination” September 2017. Available at DOI: 10.1126/srhl.aag 2874.

⁶¹⁴ *Ibid* 21.

⁶¹⁵ *Ibid*.

⁶¹⁶ Rea “Fingerprints Lack Scientific Basis for Legal Certainty” 2017 <https://phys.org/news/2017-10-fingerprints-lack-scientific-basis-legal.html#nRlv> (accessed 28-10-2017).

the methodology and or a premise of particular scientific evidence, fingerprint propositions of uniqueness and permanence may be difficult to test or are untestable and this can affect the reliability of fingerprint identification evidence.

From the discussion above it is clear that “validity” and “reliability” require that a method should undergo some empirical testing, in a situation “appropriate to its intended use that provides valid estimates of how often the method reaches an incorrect conclusion.”⁶¹⁷ The focus must not only be on the empirical measurement of error rates, but it must be tested whether a method is “foundationally valid.”⁶¹⁸ If an examiner suggests that a method of proposed identification is foundationally valid, based on proper empirical studies, he or she should make claims about its accuracy and its probative value based on such empirical studies. In other words, there must be no other claims implying greater certainty than results shown by empirical evidence.⁶¹⁹ The fact that a method is foundationally valid, does not mean that examiners will always get the correct results.⁶²⁰ As noted above, the only scientific way to ascertain whether an examiner can apply a foundationally valid method, is through appropriate empirical testing which basically involves measuring the frequency of getting accurate answers by an examiner.⁶²¹

4 3 3 Peer review and publication

As was pointed out in the *Daubert* case, it is important to check whether the theory has been subjected to peer review and publication.⁶²² Peer review may be described as the formal submission of research to a scientific board or journal carefully to evaluate and to certify the

⁶¹⁷ *Ibid* 143.

⁶¹⁸ Meintjes–van der Walt “The Proof of the Pudding: The Presentation and Proof of Expert Evidence in South Africa” 2003 *Journal of African Law* 103: “Foundational validity means that a method can in principle be reliable.”

⁶¹⁹ In the case of *United States v Monteiro* 407 F. Supp. 2d 351 (D. Mass. 2006) the court stated that the decision of identification by examiners is subjective and that there is no empirical data that support the claims made by examiners as such they are not allowed to testify or express their results with absolute certainty.

⁶²⁰ Koehler “Forensics or *Fauxrensics*? Ascertaining Accuracy in the Forensic Sciences” 2016 http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2773255 (accessed 25-04-2017) 29. Koehler enumerates that a number of possible problems that could, in principle, occur are: “features may be mis-measured; samples may be interchanged, mislabelled, miscoded, altered, or contaminated; equipment may be mis-calibrated; technical glitches and failures may occur without warning and without being noticed; and results may be misread, misinterpreted, mis-recorded, mislabelled, mixed up, misplaced, or discarded.”

⁶²¹ PCAST Report 56.

⁶²² *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 593. The court however stated that publication is not a “*sine qua non* of admissibility; it does not necessarily correlate with reliability” because sometimes a well-grounded and innovative theories will not have been published, and in some instances theories maybe too particular, too new, or of too limited interest to be published.

correctness of procedures and results of a particular scientific field.⁶²³ Peer review of a technique or proposition is crucial as it assists in detecting the flaws and/or limitations associated with a technique, theory or proposition thereof.⁶²⁴ With regard to fingerprint evidence, besides the publications on how prints are unique, how they are lifted and developed from crime scenes and the classification thereof, there is no meaningful peer reviewed literature on the challenges against the methodology or techniques applied by fingerprint examiners to reach a conclusion.⁶²⁵ A lack of data regarding the limitations of fingerprint evidence, does not imply that it is infallible or reliable because the accuracy of the conclusion is in the data and is not ultimately determined by the practitioner's abilities or confidence level.⁶²⁶ In this regard Mnookin, at the 9th Circuit Judicial Conference stated "(i)t must take scientific study to make a field scientifically reliable. Experience, no matter how extensive, could not be a substitute for scientific study."⁶²⁷

The lack of substantial information or research regarding the limitations associated with fingerprint evidence, as well as following the fingerprint comparison methodology, make it difficult to check whether in practical situations the evidence, technique or premise is flawed or not.⁶²⁸ Verification of results by a second examiner is what fingerprint proponents construe to constitute peer review. Nevertheless, Giannelli criticizes this, stating that it is a misconception of peer review as applied in *Daubert*.⁶²⁹ According to Giannelli, "peer review refers to refereed scientific journals. It is a screening mechanism and only the first step, followed by publication and then replication by other

⁶²³ Benedict "Fingerprints and the *Daubert* Standard for Admission of Scientific Evidence: Why Fingerprints Fail and a Proposed Remedy" 2004 *Arizona Law Review* 531.

⁶²⁴ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 593. See also Benedict "Fingerprints and the *Daubert* Standard for Admission of Scientific Evidence: Why Fingerprints Fail and a Proposed Remedy" 2004 *Arizona Law Review* 530-531 (describing how the peer review element applies to fingerprint evidence).

⁶²⁵ NAS Report 141.

⁶²⁶ Triplett "The Invincible Fingerprint: Understanding the Basics, Defeating The Myths" NYSBA Criminal Justice Section Fall Meeting. 25 October 2013
<http://www.fprints.nwlean.net/2013%20THE%20INVINCIBLE%20FINGERPRINT,%20UNDERSTANDING%20THE%20BASICS,%20DEFEATING%20THE%20MYTHS.pdf> (accessed 28-10-2017) 3.

⁶²⁷ Dinzeo "Skepticism of Forensic Methods Urged at 9th Circuit Conference" 18 July 2017
<https://www.courthousenews.com/skepticism-forensic-methods-urged-9th-circuit-conference/> (accessed on 27-10-2017).

⁶²⁸ Cole "Out of the *Daubert* Fire and into the Fryeing Pan? Self-Validation, Meta-Expertise and the Admissibility of Latent Print Evidence in *Frye* Jurisdictions" 2008 *Minnesota Journal of Law, Science & Technology* 491-493.

⁶²⁹ Giannelli "*Daubert* Challenges to Fingerprints" 2006 *Criminal Law Bulletin* 629.

scientists.”⁶³⁰ He further states that “review by a second expert is simply a quality control procedure, albeit an important one.”⁶³¹

4 3 4 Objective standards

There must be governing standards that are agreed-upon to guide the expert when following a particular methodology, as having such standards in place, assists in ensuring the accuracy and fair application of evidence.⁶³² In the fingerprint community the whole process depends on the examiner. This includes the determination of whether or not there are sufficient details to consider the print for comparison or not, the consideration of what features are necessary to declare a match or non-match and how many points are sufficient for a match.⁶³³ Furthermore, when following the fingerprint comparison methodology, there are no objective standards or guiding protocols to govern the manner in which the fingerprint examiners should proceed stage by stage.⁶³⁴

4 3 5 Known or potential error rate

The court in *Daubert* held that the known or potential rate of error should be considered when evaluating expert evidence.⁶³⁵ Knowing the error rate may not be considered as an end in itself, but knowledge of this is of great importance as it assists to establish whether the method is sufficiently accurate, in order to help the trier of fact to evaluate the reliability of the expert evidence in the USA. According to the PCAST Report, “without an appropriate estimate of accuracy, a metrological method is useless because one has no idea how to interpret its results.”⁶³⁶ The NAS Report on forensic science emphasised the importance of knowing a method’s accuracy.⁶³⁷ Furthermore, the NAS Report noted that:

⁶³⁰ *Ibid.*

⁶³¹ *Ibid.*

⁶³² *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 594.

⁶³³ See NAS Report 101-102, 140-142. See also Cole “Out of the *Daubert* Fire and into the Fryeing Pan? Self-Validation, Meta-Expertise and the Admissibility of Latent Print Evidence in Frye Jurisdictions” 2008 *Minnesota Journal of Law, Science & Technology* 487-491.

⁶³⁴ PCAST Report 9, the report found that ACE-V is foundationally valid subjective methodology. See also Cole “Out of the *Daubert* Fire and into the Fryeing Pan? Self-Validation, Meta-Expertise and the Admissibility of Latent Print Evidence in Frye Jurisdictions” 2008 *Minnesota Journal of Law, Science & Technology* 487-491.

⁶³⁵ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 594.

⁶³⁶ PCAST Report 48

⁶³⁷ NIST Report 9.

The insistence by some forensic practitioners that their disciplines employ methodologies that have perfect accuracy and produce no errors has hampered efforts to evaluate the usefulness of the forensic science disciplines.⁶³⁸

Additionally, black-box studies⁶³⁹ where examiners make decisions about independent tests and determine error rates, are also needed for measuring the accuracy of forensic feature-comparison methods. These studies, typically, involve decisions made on questioned samples and one or more “known” samples to determine the accuracy rate of a method.⁶⁴⁰ Thus, according to Kaushal and Kaushal, “proficiency tests do not validate a procedure per se, but they can provide some insight into error rates.”⁶⁴¹ In the PCAST Report proficiency testing means an on-going empirical test to “evaluate the capability and performance of analysts.”⁶⁴² Making claims about a particular fact, proposition or technique is meaningless if they cannot be objectively verified.⁶⁴³

According to the PCAST Report:

From the standpoint of scientific validity, experts should never be permitted to state or imply in court that they can draw conclusions with certainty or near-certainty (such as ‘zero,’ ‘vanishingly small,’ ‘essentially zero,’ ‘negligible,’ ‘minimal,’ or ‘microscopic’ error rates; ‘100 percent certainty’ or ‘to a reasonable degree of scientific certainty,’ or identification ‘to the exclusion of all other sources.’⁶⁴⁴

The error rate of fingerprint evidence is unknown.⁶⁴⁵ Fingerprint evidence proponents maintain that when the fingerprint comparison methodology is followed properly, the error rate is zero.⁶⁴⁶ Nevertheless, they are silent about practitioner error rates.⁶⁴⁷ The available research as highlighted

⁶³⁸ NAS Report 47.

⁶³⁹ *Ibid.* “By a ‘black-box study,’ we mean an empirical study that assesses a subjective method by having examiners analyze samples and render opinions about the origin or similarity of samples.”

⁶⁴⁰ Organization of Scientific Area Committees “Study to Assess the Accuracy and Reliability of Firearm and Tool mark” 2015 http://www.nist.gov/forensics/osac/upload/FATM-Research-Needs-Assessment_Blackbox.pdf (accessed 11/07/2017).

⁶⁴¹ Kaushal and Kaushal “Human Identification and Fingerprints: A Review” 2011 *Journal of Biometrics & Biostatistics* 4.

⁶⁴² *Ibid.* “We note that proficiency testing is not intended to estimate the inherent error rates of a method; these rates should be assessed from foundational validity studies. Proficiency testing should also be distinguished from competency testing, which is the evaluation of a person’s knowledge and ability prior to performing independent work in forensic casework.”

⁶⁴³ Pipoly “*Daubert* Rises: The (Re)applicability of the *Daubert* Factors to the Scope of Forensics Testimony” 2012 *Minnesota Law Review* 1586. Beecher-Monas, *Evaluating Scientific Evidence: An Interdisciplinary Framework for Intellectual Due Process* Cambridge University Press (2007) 40–44 (describing the relationship between empirical testing and falsifiability). See also Benedict N “Fingerprints and the *Daubert* Standard for Admission of Scientific Evidence: Why Fingerprints Fail and a Proposed Remedy” 2004 *Arizona Law Review* 527-528.

⁶⁴⁴ PCAST Report 54.

⁶⁴⁵ NAS Report 143.

⁶⁴⁶ *Ibid.*

⁶⁴⁷ Practitioner error is concerned with the likelihood an examiner would mistakenly identify two fingerprints from the same individual as not matching or two fingerprints from two different people as matching.

in the prominent reports discussed in chapter 3 of this dissertation, as well as other academic articles indicate that examiners can and do make mistakes.⁶⁴⁸ Hence the reports advise that when testifying, the examiner must disclose the error rate and that it is improper for the examiner to testify to absolute certainty.⁶⁴⁹ There are a number of wrongful convictions based on fingerprint identification evidence which indicate that erroneous misidentifications do occur. For instance, in 1997 Stephan Cowans⁶⁵⁰ was convicted of attempted murder for the non-fatal shooting of a police officer. The conviction was largely based on the evidence of eye-witness and latent print evidence. However, in 2004, after DNA exoneration, he was discharged on the basis of wrongful conviction “in which fingerprint evidence was a contributing factor.”⁶⁵¹

In 1999 Shirley Mckie,⁶⁵² as is discussed above, was identified by fingerprint evidence and arrested in connection with the death of Miss Marion Margaret Campbell Ross.⁶⁵³ Though she was not charged with murder, she was found guilty of perjury because she denied ever being in the house of the deceased beyond the porch. However, she was later released after issues were raised against the fingerprint evidence and it transpired that she was erroneously identified.⁶⁵⁴

Moreover, in 2004, Mayfield⁶⁵⁵ as is indicated above, was arrested as a material witness with respect to a federal grand jury’s investigation into the bombing that took place in Madrid, Spain.⁶⁵⁶

⁶⁴⁸ See PCAST Report 101, referring to research conducted by Evett and Williams “Review of the 16 point Fingerprint Standard in England and Wales” 1996 *Forensic Science International* 49-73; Langenburg “A performance study of the ACE-V Process: A Pilot Study to Measure the Accuracy, Precision, Reproducibility, Repeatability, and Biasability of Conclusions Resulting from the ACE-V Process” 2009 *Journal of Forensic Identification* 219–257; Langenburg *et al* “Testing for Potential Contextual Bias Effects during the Verification Stage of the ACE-V Methodology When Conducting Fingerprint Comparisons” 2009 *Journal of Forensic Sciences* 571-582; Tangen *et al* “Identifying Fingerprint Expertise” 2011 *Psychological Science* 995-997; Ulery *et al* “Accuracy and Reliability of Forensic Latent Fingerprint Decisions” 2011 *Proceedings of the National Academy of Sciences* 7733-7738 and Pacheco *et al* “Miami-Dade Research Study for the Reliability of the ACE-V Process: Accuracy & Precision in Latent Fingerprint Examinations” 2014 www.ncjrs.gov/pdffiles1/nij/grants/248534.pdf . See also NAS report 139, which refers to research conducted by Dror and Charlton “Why Experts make Errors” 2006 *Journal of Forensic Identification* 600-616. See also Reese “Techniques for Mitigating Cognitive Biases in Fingerprint Identification” 2012 *UCLA Law Review* 1252-1290 (stating that errors do occur as a result of human cognitive bias and that it is impossible to state that the error rate of fingerprint identification is zero).

⁶⁴⁹ The American Association for the Advancement of Science “Forensic Science Assessments: A Quality and Gap Analysis- Latent Fingerprint Examination” September 2017 45-60.

⁶⁵⁰ *Commonwealth v Cowans* 756 N.E.2d 622 (Mass. App. Ct. 2001).

⁶⁵¹ Cole “Prevalence and Potential Causes of Wrongful Conviction by Fingerprint Evidence” 2006 *Golden Gate University Law Review* 41.

⁶⁵² *HM Advocate v Mckie* 1999 (Unreported).

⁶⁵³ See Chapter 3 (part 3 4 1) above.

⁶⁵⁴ SFI Report 132.

⁶⁵⁵ *Mayfield v US* No. 07-35805 D.C.NO. CV-04-01427-AA.

⁶⁵⁶ Chapter 3 (part 3 2 1) above.

He was connected to the terrorist attack because it was alleged that his fingerprints had been found on a bag in Spain containing detonation devices similar to those used in the bombings.⁶⁵⁷ After its evaluation of the fingerprints, the SNP informed the FBI that the FBI had made a mistake in identifying Brandon Mayfield as a material witness. Consequently, the FBI withdrew its identification of Mayfield and he was released.⁶⁵⁸

In addition to the above, Lana Canen, was found guilty of being an accomplice to the murder of Helen Sailor in 2002 and sentenced to 55 years in prison.⁶⁵⁹ She was connected to the crime scene by fingerprint evidence. However, her conviction was later reversed when another independent fingerprint examiner did an analysis and a comparison of the latent print from the scene and a known print of Canen.⁶⁶⁰ The results by the independent examiner excluded Canen. An evidentiary hearing was conducted and it was discovered that Mr Chapman who testified to the identification of Canen, had made an error. Chapman admitted that he had made an error, that he “lacked training” and that he “overstated his expertise to the jurors”.⁶⁶¹ Cole, in 2005, in an article “More than Zero: Accounting for Error in Latent Fingerprint Identification”, indicated that he investigated a number of cases where fingerprint evidence was accepted to secure conviction but later it was discovered that the individuals were erroneously identified.⁶⁶²

The cases discussed above, show that errors can and do occur and if an error occurred once, there is no guarantee that it would not happen again because humans are prone to make mistakes.⁶⁶³ The number of individuals wrongfully convicted as a result of erroneous fingerprint identification may be even higher than expected and Cole thinks that “(t)he high-profile cases are the tip of an iceberg of wrongfully accused.”⁶⁶⁴ Upon analysing the events of the Cowans case, Cole said that “[t]he

⁶⁵⁷ *Ibid.*

⁶⁵⁸ *Ibid.*

⁶⁵⁹ Fingerprint Expert’s Mistake Leads to Wrongful Conviction in Indiana <https://californiainnocenceproject.org/2012/10/fingerprint-experts-mistake-leads-to-wrongful-conviction-in-indiana/> (accessed 27-11-2017).

⁶⁶⁰ *Ibid.*

⁶⁶¹ *Ibid.*

⁶⁶² Cole “More than Zero: Accounting for Error in Latent Fingerprint Identification” 2005 *Journal of Criminal Law & Criminology* 985-1078. See also Forensic Science Technician <http://www.forensicsciencetechnician.net/25-wrongly-convicted-felons-exonerated-by-new-forensic-evidence/> (accessed 27-11-2017).

⁶⁶³ Are Innocent People Ever Convicted Based on Fingerprint Evidence? 2009 <https://whereismydata.wordpress.com/.../are-innocent-ever-convicted-based-on-fingerprint-evidence/> (accessed 27-11-2017)

⁶⁶⁴ Live Science Staff “The Real Crime: 1,000 Errors in Fingerprint Matching Every Year” 2005 <https://www.livescience.com › Strange News> (accessed 27-11-2017).

Cowans case not only provided dramatic additional support for the already established proposition that wrongful conviction by fingerprint was possible, it also demonstrated why the exposure of such cases, when they do occur, is exceedingly unlikely.”⁶⁶⁵ Socka and Wright note that “once a person is wrongly convicted based on latent print evidence, it is unlikely that the wrongful conviction will ever be exposed. This is largely due to the widespread perception of the infallibility of latent print identification.”⁶⁶⁶ Therefore, Cole maintains that instead of insisting that zero error exists in fingerprint matching, forensic scientists should rather acknowledge the errors and “find constructive ways to prevent faulty evidence from being used to convict innocent people.”⁶⁶⁷

4 3 6 General acceptance

Even though general acceptance as propounded in *Frye*⁶⁶⁸ was eliminated as the sole test for the admissibility of expert evidence, *Daubert* conceded that it was still a relevant factor. The court stated that “a known technique which has been able to attract only minimal support within the community, may properly be viewed with skepticism.”⁶⁶⁹ When considering admissibility of expert opinion evidence in the USA, and the reliability of such evidence, judges must establish whether the evidence is generally or widely accepted by a relevant scientific community. Fingerprint evidence is widely accepted by fingerprint technicians themselves, but forensic experts who have extensively interrogated the technique, have reached negative conclusions.⁶⁷⁰ Nevertheless, the criticism levelled against fingerprint evidence does not stop the fingerprint technicians to state that such evidence is infallible.⁶⁷¹

⁶⁶⁵ *Ibid.*

⁶⁶⁶ Socka and Wright “Prints on Trial: Wrongful Convictions and the ‘Science’ of Fingerprints” 2014 <https://www.aidwyc.org/blogfingerprints/> (accessed 27-11-2017).

⁶⁶⁷ Cole “More than Zero: Accounting for Error in Latent Fingerprint Identification” 2005 *Journal of Criminal Law & Criminology* 1064.

⁶⁶⁸ *Frye v United States* 293 F. 1013 D.C. Cir. 1923.

⁶⁶⁹ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 595.

⁶⁷⁰ Benedict “Fingerprints and the *Daubert* Standard for Admission of Scientific Evidence: Why Fingerprints Fail and a Proposed Remedy” 2004 *Arizona Law Review* 537. Generally, see chapter 3 of this dissertation which deals thoroughly with the criticisms against fingerprint evidence. Even though the literature reveals the dangers associated with using fingerprint as a tool of identification, proponents of fingerprint evidence continue to state that it is infallible.

⁶⁷¹ See Plumtree “A Perspective on the Appropriate Weight to be given to the National Academy of Sciences’ Report on Forensic Evidentiary Hearings: The Significance of Continued Court Acceptance of Fingerprint Evidence” 2013 *Southwestern Law Review* 605-660.

4 4 OTHER FACTORS THAT CAN IMPACT ON THE RELIABILITY OF FINGERPRINT EVIDENCE IN SOUTH AFRICA

4 4 1 Training and Education

The NAS Report criticized the guild-like systems operating in many areas of forensic science. In this regard the report explained that “training should move beyond apprentice-like transmittal of practices to education based on scientifically valid principles.”⁶⁷² The report is concerned about the lack of “formal and systematically applied standards or standardization requirements for forensic science education programs, making the quality and relevance of existing programs uncertain.”⁶⁷³ In South Africa, fingerprint experts usually are police officials who undergo training⁶⁷⁴ and no basic or formal education is required for one to be a fingerprint expert.⁶⁷⁵ The training may be likened to an apprenticeship, that is, it only focuses on the transmittal of practices and is not based on education based on scientifically valid principles.

The NAS Report maintains that apprenticeship cannot replace the need for a scientific basis of education and of the practice of forensic science.⁶⁷⁶ In South Africa, when an expert testifies, much emphasis tends to be placed on the experience of the expert. Nevertheless, it must be borne in mind that experience cannot replace validation studies.⁶⁷⁷ Moreover, Socka and Wright mention that “misattributions occur for a variety of reasons, including but not limited to inadequate training and expertise of fingerprint examiners, pressure on these experts to help close the case and clerical

⁶⁷² NAS Report 26-27 and 217.

⁶⁷³ *Ibid* 237.

⁶⁷⁴ Red-Leaf <http://red-leaf.co.za/facilitators/bierman-ja-mr/> (accessed 01-11-2017). The police officials receive in practice training at the South African Criminal Bureau (Criminal Record Centre) in the theoretical and practical application of the fingerprint science. The training is divided into the following categories: viz Fingerprinting History, Basic Fingerprint Theory, Classification and Categorizing of Finger-, Palm-, and Footprints, Identification and Searching Techniques, Identifying of Fingerprints, Approaching of Crime Scenes, The Searching and Retrieval of Latent Skin Prints on Crime Scenes, Powders and Reagents, Age of Crime Scene prints, Transplants And Forgeries, Handling of Exhibits, Preparation of Court Charts, Presentation of Evidence, Standard Operating Procedures Regarding Fingerprints, Criminal Procedure Investigation and Reconstruction of the Crime Scene, Recording of the Crime Scene (plan drawing, photography, documenting, notes and video recording) and Crime Scene Management.

⁶⁷⁵ In South Africa for a police official to be trained as a fingerprint expert, he or she must have at least a minimum of 10 years of working experience at the Criminal Record Centre.

⁶⁷⁶ NAS Report 26-27, 195-200 and 217. The report went further to say that certification requirements must be based at minimum on written examinations, supervised practice, proficiency testing, continuing education, rectification procedures, adherence to a code of ethics and effective disciplinary procedures.

⁶⁷⁷ Dinzeo “Skepticism of Forensic Methods Urged at 9th Circuit Conference” 18 July 2017 <https://www.courthousenews.com/skepticism-forensic-methods-urged-9th-circuit-conference/> (accessed on 27-10-2017).

errors.”⁶⁷⁸ Therefore it is crucial for fingerprint experts to be trained extensively because “an expert who lacks the proper qualifications increases the chances of a wrongful conviction.”⁶⁷⁹ This shows how important training and education for fingerprint experts are. The training of fingerprint experts must not only include the technicality of the fingerprints and the fingerprint identification method, but should also include the scientific method, inform them about the substantial scientific literature, educate them with regard to communicating and with regard to how reasonably to advance decisions and how to explain their observations.⁶⁸⁰

When questioned, fingerprint experts mostly stress their training and experience.⁶⁸¹ However, “training and experience are factors of ability but not factors of accuracy.”⁶⁸² The NIST Report further stipulates that when answering questions from both prosecution and defence attorneys, experts must do so directly, accurately, fully and give appropriate scientific information before, during and after trial.⁶⁸³ The fact that a fingerprint expert giving evidence is experienced, does not mean that the conclusions are reliable. The expert is expected to answer the question to prove the reliability of his or her conclusions. Thus, the reports maintain that the premises on which fingerprint experts rely, must be tested to establish their accuracy and reliability and this can only be done through conducting research.⁶⁸⁴ The findings of the reports show that no research has to date been done to validate the premise of uniqueness and permanence.⁶⁸⁵

4 4 2 The independence of a fingerprint laboratory

The NAS Report stipulates that, in order “to promote the development of forensic science into a mature field of multidisciplinary research and practice, founded on the systematic collection and

⁶⁷⁸ Socka and Wright “Prints on Trial: Wrongful Convictions and the ‘Science’ of Fingerprints” 2014 <https://www.aidwyc.org/blogfingerprints/> (accessed 27-11-2017).

⁶⁷⁹ Fingerprint Expert’s Mistake Leads to Wrongful Conviction in Indiana <https://californiainnocenceproject.org/2012/10/fingerprint-experts-mistake-leads-to-wrongful-conviction-in-indiana/> (accessed 27-11-2017).

⁶⁸⁰ NIST Report 166-167. See also SFI Report 750-751.

⁶⁸¹ Triplett “The Invincible Fingerprint: Understanding The Basics, Defeating The Myths” NYSBA Criminal Justice Section Fall Meeting. 25 October 2013 <http://www.fprints.nwlean.net/2013%20THE%20INVINCIBLE%20FINGERPRINT,%20UNDERSTANDING%20THE%20BASICS,%20DEFEATING%20THE%20MYTHS.pdf> (accessed 28-10-2017) 3.

⁶⁸² *Ibid.*

⁶⁸³ NIST Report 200.

⁶⁸⁴ NAS Report 15-19. See also NIST Report 86, 96, 198, 203-204. See also PCAST Report 145. See also SFI Report 559, 734.

⁶⁸⁵ *Ibid.*

analysis of relevant data” an independent institute must be established.⁶⁸⁶ The institute must be comprised of, “persons who are skilled and experienced in developing and executing national strategies and plans for standard setting; managing accreditation and testing processes; and developing and implementing rulemaking, oversight, and sanctioning processes.”⁶⁸⁷ The NRC committee, when recommending this, was conscious of the proximity of and/ or relationship between forensic science practitioners and law enforcement. Hence it insists on distance and autonomy because “the best science is conducted in a scientific setting as opposed to a law enforcement setting.”⁶⁸⁸

The South African Criminal Bureau (Criminal Record Centre) where police officials receive training to be fingerprint experts, cannot be described as an independent, science-driven institution. It is effectively part of law enforcement, funded by the state and dominated by individuals who are or were in the police service. Apart from the fact that the Bureau is dominated by police officials, the fingerprint experts work hand in hand with the investigator and prosecution.⁶⁸⁹ When investigators work hand in hand with the prosecution and fingerprint experts, it could result in contextual bias. Contextual information plays a role in the outcomes of fingerprint analysis in that the fingerprint examiner may just make a conclusion that the fingerprints belong to the suspect based on the information received from the investigator. According to Edmond *et al*⁶⁹⁰ “exposure to this domain-irrelevant information (e.g. about the suspect, police suspicions and other aspects of the case) threatens the interpretation and value of their opinion evidence.”⁶⁹¹ They further contend that:

The problem is not only that forensic science evidence can be biased (by what the detective tells the examiners, the context of the case, and so on), but that it can bias other lines of evidence. For example, if one piece of forensic evidence (biased or not) is known to other forensic examiners who are analyzing other forensic evidence, then their examination may be affected and biased by their knowledge of the results of the other piece of evidence (for example, a forensic examiner looking at bite marks may be influenced and biased in their examination if they know that fingerprint evidence shows the suspect is guilty). Forensic evidence can also bias other lines of evidence. For example, eyewitnesses can be affected.....When they affect and influence one another, then their value and reliability is diminished. Furthermore, because one piece of

⁶⁸⁶ NAS Report 19.

⁶⁸⁷ *Ibid* 18-19.

⁶⁸⁸ *Ibid* 23.

⁶⁸⁹ *S v Van der Vyver* (SS 190/06) 2007 ZAWCHC 69 (29 November 2007).

⁶⁹⁰ Edmond *et al* “Contextual Bias and Cross-Contamination in the Forensic Sciences: The Corrosive Implications for Investigations, Plea Bargains, Trials and Appeals” 2015 *Law, Probability and Risk* 1-25.

⁶⁹¹ *Ibid* 2.

evidence influences another, then greater distortive power is gathered as more evidence is affected (and affecting) other lines of evidence, causing an increasing snowball of bias.⁶⁹²

The effect of contextual bias can be seen in the research that has been done by Dror *et al* in 2006.⁶⁹³ Fingerprint examiners who were unaware of the Mayfield prints were tasked to analyse and compare the latent print to the known print.⁶⁹⁴ Before the comparison started, the examiners were informed that the pair of prints was the one that was erroneously matched by the FBI as that of the Madrid bomber.⁶⁹⁵ The prints that the examiners were given to compare, in fact, were from cases that each of the participating examiners had previously matched.⁶⁹⁶ Only one examiner came to the conclusion of a match as before, whereas the other four contradicted their previous decisions of a match and reached a conclusion of inconclusive.⁶⁹⁷ The results of the research clearly show that:

It is possible to alter identification decisions on the same fingerprint, solely by presenting it in a different context. This does not imply that fingerprint and other forensic identifications are not a science, but it does highlight problems of subjectivity, interpretation, and other psychological and cognitive elements that interact and may distort any scientific inquiries.⁶⁹⁸

Proximity between the investigators and fingerprint experts has a negative impact on the results to be produced by fingerprint experts. Fingerprint experts may just end up confirming a positive identification based on the information they received prior to the analysis and comparison of the prints. Moreover, due to the fact that, in adversarial jurisdictions, trials are like a competition, this lack of independency by fingerprint experts could make them feel inclined to further the case of the prosecution which has called them to prove the guilt of an accused person. In *S v Van der Vyver* the fingerprint evidence proffered by the prosecution was highly controversial and in dispute.⁶⁹⁹ The establishment of an independent institute could support independence and where there is independence, experts might, to a larger extent, be impartial and unbiased when giving their evidence in court.

⁶⁹² *Ibid* 3.

⁶⁹³ Dror *et al* "Contextual Information Renders Experts Vulnerable to Making Erroneous Identifications" 2006 *Forensic Science International* 74-78.

⁶⁹⁴ *Ibid* 76.

⁶⁹⁵ *Ibid*.

⁶⁹⁶ *Ibid*.

⁶⁹⁷ *Ibid*.

⁶⁹⁸ *Ibid* 77.

⁶⁹⁹ *S v Van der Vyver* (SS 190/06) 2007 ZAWCHC 69 (29 November 2007) paragraphs 113-143, and paragraph 184. Also see Bamford "Fingerprints Can Tell Lies- Forensic Experts" 2006 <https://www.iol.co.za/news/south-africa/fingerprints-can-tell-lies-forensic-experts-297550> (accessed 28-11-2017).

4 4 3 Points of similarity and the existence of dissimilarity

A minimum of seven points of similarity is required for a fingerprint identification in South Africa.⁷⁰⁰ If the fingerprint expert provides the court with enough evidence that there are 7 points of resemblance between the known print of the alleged perpetrator and an unknown print, it would constitute a positive identification. In *S v Nala*⁷⁰¹, Wessels JA noted that:

Where comparison revealed seven points of correspondence, the identity of the disputed fingerprint was positively established. In such a case the existence of dissimilarities could not affect the identity of the disputed fingerprint, and would be explained upon some other basis, such as ... distortion through movement of the finger ... the presence of minute particles of dirt, etc.⁷⁰²

Compared to other jurisdictions, seven points of similarity may be considered to be too few, even though there is no standard number of points of similarity required to determine a match.⁷⁰³ Meintjes-van der Walt states that “(h)istorically most of the countries have required between eight to sixteen matching characteristics”.⁷⁰⁴ Nevertheless the number of points of similarity required varies from jurisdiction to jurisdiction, for example in Australia 12 points are required, in Italy and France 16 points are required and in Brazil and Argentina 30 points are required. Other jurisdictions do not apply the numeric standard. These include the United States of America, Canada, Scotland and England and Wales. In England and Wales 12 points of similarity were initially required, but was abandoned after the research by Evett and Williams in 1996,⁷⁰⁵ wherein

⁷⁰⁰ See *S v Blom* 1992 1 SACR 649; *S v Kimimbi* 1963 3 SA 250 (C); *S v Nala* 1965 4 SA 360 (A); *S v Van Wyk* 1982 2 SA 148 (NC); *S v Gumede* 1982 4 SA 561; *S v Nyate* 1988 2 SA 211; *S v Zibi* 2012 JDR 0376 (ECM); *S v Congola* 2002 2 SACR 383 (T) and *S v Kanyile* 1984 3 SA 756 (N). Even though in some of these cases seven points of similarity were accepted to suffice for identity, fingerprints experts have found more than seven points of similarities. For example, in *R v Smit* 1952 3 SA 447 (A) the expert referred to eleven points of similarity, in *R v Nksatlala* 1960 3 SA 543 (A) the expert found eight points of similarity. In *S v Segai* 1981 4 SA 906 (O) the expert identified ten points of similarity; in *S v Van Wyk* 1982 2 SA 148 (NC) the fingerprint enlargement indicated eleven points of similarity; in *S v Gumede* 1982 4 SA 561 the fingerprint expert indicated nine ridge details which corresponded with the fingerprint of the accused person; in *S v Khanyile* 1984 3 SA 756 (N) eight points of similarity were found, in *S v Nyate* 1988 2 SA 211 the expert witness testified that he marked ten points of similarity between the latent print and the known print of the accused person. In *S v Zibi* 2012 JDR 0376 (ECM) the fingerprint expert testified that he found eleven points of similarity and in *S v Congola* 2002 2 SACR 383 (T) the expert found similarities in excess of seven points and therefore testified the identity of the perpetrator must be that of the accused before court.

⁷⁰¹ *S v Nala* 1965 4 SA 360 (A).

⁷⁰² *Ibid* 361H. Dissimilarities may be as a result of uneven pressure which caused distortion or blurring, the surface may have been dirty, or the skin may have been dirty or contaminated.

⁷⁰³ See Meintjes-van der Walt “Fingerprint Evidence: Probing Myth and Reality” 2006 *South African Journal of Criminal Justice* 152.

⁷⁰⁴ *Ibid* 166.

⁷⁰⁵ Evett and Williams “A Review of the Sixteen Point Fingerprint Standards in England and Wales” 1996 *Journal of Forensic Identification* 49. See also SFI Report 115 paragraphs 33.1- 33.2.

they found that there was no statistical, logical or scientific basis for the use of a numeric standard. In Scotland the numeric standard was abandoned in September 2006.⁷⁰⁶

A positive identification would not be affected where the expert can explain the dissimilarities between the fingerprint and the crime scene print. In *S v Malindi*⁷⁰⁷ the following was stated:

The court in *S v Nala* was clearly referring to explicable dissimilarities (and not to inexplicable dissimilarities which would make the identification unacceptable and which would invalidate any comparison between the two points). It is not necessary to meticulously examine both the similarities and dissimilarities, because if there are sufficient points of similarity, the apparent dissimilarities are unimportant.⁷⁰⁸

The usual practice by fingerprint experts in South African courts, differs from other Anglo-American jurisdictions, where the practice is that the presence of one unexplained point of dissimilarity requires the examiner to make a conclusion that the impressions come from different individuals.⁷⁰⁹ According to Thornton “the one- dissimilarity doctrine was first enunciated by a court in India in 1904 which maintained that if just one dissimilarity was noted in the comparison of fingerprints, it would be assumed the prints were made by different fingers.”⁷¹⁰ In *Potgieter v Minister of Police*⁷¹¹ three points of similarity were found between the latent prints on the docket and that of the small fingers of Potgieter. However, Luus who conducted the analysis of the two prints, stated in her report that no inference can be drawn from the observation. Although Luus said no inference could be drawn from the observation of three points of similarity, the report was used as evidence in court to support the case of the prosecution. The court held that:

It is well known that seven points of similarity are needed in our criminal law to make any finding beyond reasonable doubt.....To some extent one must rely on one’s own experience of expert evidence in this regard. It is not only the similarity between fingerprints that is relevant. Unexplained differences are also important.⁷¹²

The court in this case however, found that the obtaining and use of the fingerprint evidence against the Plaintiff was unprofessional and lacked objectivity; as such the Defendants were ordered to compensate the Plaintiff for malicious prosecution.⁷¹³

⁷⁰⁶ *Ibid.*

⁷⁰⁷ *S v Malindi* 1983 4 SA 99 (T).

⁷⁰⁸ *Ibid* at 105A-B and 106F.

⁷⁰⁹ Tarantino *Strategic Use of Scientific Evidence* (1988) 67.

⁷¹⁰ Thornton “One-Dissimilarity Doctrine in Fingerprint Identification” 1977 *International Criminal Police Review* 89-95.

⁷¹¹ *Potgieter v Minister of Police* (80233/2014) 2017 ZAGPPHC 172 (20 April 2017).

⁷¹² *Ibid* paragraphs 54 and 55.

⁷¹³ *Ibid* paragraphs 65 and 71.

The culture in South African courts of accepting fingerprint evidence even when there are points of dissimilarity, is a sign of heavy reliance on fingerprint evidence and is potentially disastrous in that it may lead to innocent individuals wrongfully identified, as, in actual fact, the dissimilarity may mean that the print was made by a different person.

4 4 5 Verification

It is problematic that verification of the results (positive identification) by an independent examiner is not a requirement in South Africa and customarily verification is done by the same examiner who made the conclusion by taking the prints of the accused person at court and comparing them with the latent prints he or she lifted at the crime scene just to confirm the previous made conclusion.⁷¹⁴ Although fingerprint experts in South Africa argue that comparing known prints taken on the day of trial to a latent print by the same examiner is adequate verification, it is highly problematic in the light of criticism raised in the five international reports scrutinised above. The verification of results by the same examiner who initially compared the prints, may result in confirmation bias and according to the Mayfield Report it is a contributing factor to erroneous identifications.⁷¹⁵ On the international terrain, though done differently,⁷¹⁶ verification of fingerprint identification conclusions is crucial and it must be done blindly and by an independent examiner.

In the case of South Africa, the examiner who initially examined and analysed the prints, is the same examiner who verifies the results. A question to be asked is how often examiners verify their conclusions? If they verify, how likely is it that they would reach a different conclusion and change their initial decisions of positive identification? The answers to these questions are unknown as there is no data or information indicating instances where examiners would change their decisions to the contrary of what they initially found. Self-verification by fingerprint examiners in South

⁷¹⁴ De Villiers "Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the last number of years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?" 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016). See also Faurie *Admissibility and Evaluation of Scientific Evidence in Court* (LLM-Thesis, University of South Africa, 2000) 62.

⁷¹⁵ Mayfield Report 115.

⁷¹⁶ De Villiers "Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the last number of years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?" 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016). In the USA an identification is verified by one other examiner and in Scotland and England and Wales the identification must be verified by two other examiners. In the Netherlands verification of an ordinary print is done by one other examiner.

Africa is not satisfactory as the inadequacies which resulted in mistakes in the initial identification, are most likely to be repeated at the verification stage and to complicate the matter even further, the examiner is not necessarily neutral.⁷¹⁷ However, it should be noted that in jurisdictions where verification of conclusions is done, erroneous identifications still occur.⁷¹⁸

It is trite that if a fingerprint expert's evidence is clear and convincing, a conviction could be based solely on the fingerprint without any additional evidence connecting the accused to the offence.⁷¹⁹ However, where fingerprint evidence is the sole or major evidence linking the accused person to the crime, an erroneous fingerprint identification would have disastrous consequences. Sangero and Halpert contend that "there is no longer any reason to doubt that innocent persons are actually convicted of crimes, or that, in some of these cases, the wrongful conviction is based upon a single piece of evidence."⁷²⁰ They further allude to the fact that:

When there is a single piece of identification evidence for a conviction, the prior probability could be very low, because, apart from this single piece of evidence, any other person could be the perpetrator.⁷²¹ Counterintuitively, an error rate of only one mistake in every ten thousand tests in a specific laboratory could lead to a wrongful conviction in *most* cases where a conviction is based on a single piece of evidence. The situation is even worse regarding fingerprint evidence. Not only is there a tendency, as with DNA testing, to ignore the possibility of an error, there is also a tendency to ignore the possibility of a random match between fingerprints.⁷²² With scientific evidence alone, in the overwhelming majority of cases, a false conviction will result.⁷²³

Therefore, when an accused person is linked to the crime scene solely by fingerprint evidence, the courts should treat the evidence with caution. For example, in *S v Nzimande*, fingerprints were lifted from a wall above the deceased and it was the only evidence linking the accused to the murder charge. The accused chose to remain silent and consequently he did not furnish the court with an explanation as to how his fingerprints could have been found on the said wall.

⁷¹⁷ *Ibid.*

⁷¹⁸ Mayfield Report 2006 (evaluating the cause of erroneous identification of Brandon Mayfield as a material witness to bombing in Madrid Spain by FBI). See also the SFI Report 2011 (Discussing the causes of erroneous identification of Shirley Mckie by the SCRO). See also Cole "Prevalence and Potential Causes of Wrongful Conviction by Fingerprint Evidence" 2006 *Golden Gate University Law Review* 41 (discussing the erroneous identification of Stephen Cowans)

⁷¹⁹ *S v Arendse* 1970 2 SA 367 (C).

⁷²⁰ Sangero and Halpert "Why a Conviction should not be based on a Single Piece of Evidence: A Proposal for Reform" 2007 *Jurimetrics* 44.

⁷²¹ *Ibid.*

⁷²² *Ibid* 45.

⁷²³ *Ibid* 53.

Consequently, the fingerprint evidence became conclusive proof and he was convicted.⁷²⁴ In the case of *Nduna v S*⁷²⁵ the appeal was concerned with the probative value of fingerprint evidence which formed the basis for the conviction of the appellant. Fingerprint evidence was the only evidence linking the appellant to the crime. During cross-examination no questions were put to the fingerprint experts challenging the authenticity of the prints lifted by them and the accused was convicted.

4 4 6 Scrutiny of the evidence

In the case of *Sibeko v S*⁷²⁶ the appellant was convicted on one count of housebreaking with intent to steal and theft and on one count of theft and sentenced to five years imprisonment on each count. The appellant was linked to the crime scene by the evidence of two fingerprint experts. The fingerprint experts identified the palm- and fingerprint lifted at the two crime scenes, respectively, as unquestionably those of the appellant.⁷²⁷ Nevertheless, the appellant in respect of Count 1 argued that “his palm-print could have been left on the television screen when he helped to carry two television screens into the complainant’s house while working for the latter as a casual labourer during renovations to his house in November 2009.”⁷²⁸ With regard to Count 2 he alleged “that his fingerprint could have been left on the vehicle door while he worked as a temporary car-guard at Pick-and-Pay in September 2009 since he frequently touched cars while assisting women with small children to close their car doors.”⁷²⁹ The court in *Sibeko*, however, held that:

Likewise, I cannot fault the court *a quo*’s unconditional acceptance of both fingerprint experts’ testimony as ‘straightforward’. The value of fingerprint evidence as evidential material to connect an accused to a crime is well-known. (*S v Legote en ‘n Ander* 2001 2 SACR 179 (SCA) at 182b)... Even though Teepa, the fingerprint expert, did not give evidence as to the age of the palm-print, the court states that probability of the palm-print having been on the screen for any significant length of time is so remote as to justifiably be rejected as a reasonable possibility.⁷³⁰

Ngaye v S,⁷³¹ a robbery case involved two accused namely the appellant (accused 2 at trial) and another (accused 1). Fingerprint evidence connected them to the crime scene. The court held that

⁷²⁴ *S v Nzimande* 2003 (1) SACR 280 (O). See also Meintjes-van der Walt “Fingerprint Evidence: Probing Myth and Reality” 2006 *South African Journal of Criminal Justice* 158.

⁷²⁵ *Nduna v S* (076/2010) 2010 ZASCA 120; 2011 1 SACR 115 (SCA); 2011 2 All SA 177 (SCA) (30 September 2010).

⁷²⁶ *Sibeko v S* (ASH44/11) 2013 ZAFSHC 133 (1 August 2013).

⁷²⁷ *Ibid* 2.

⁷²⁸ *Ibid* 6.

⁷²⁹ *Ibid* 7.

⁷³⁰ *Ibid* 14.

⁷³¹ *Ngaye v S* (A567/10) 2010 ZAWCHC 341 (3 December 2010).

it is well known that a fingerprint is normally of considerable value. In this case there was even an explanation as to how the print could have been left on the counter. The appellant alleged that he at some point visited the complainant's shop to buy a phone charger and that he probably could have left his fingerprints on the counter on that day. The question as to whether the fingerprint examiner was able to tell the age of the said fingerprints was however, not asked. Despite this, the evidence was accepted by the court.

4 4 7 A Lack of cross-examination by the defence

What happens when the fingerprint evidence is not disputed by the defence? In *S v Nyate*⁷³², the fingerprint expert testified that there were ten points of similarity between the latent fingerprints lifted from the crime scene and that of the accused. In this case the police official who lifted the fingerprints from the scene of the crime was not called to give evidence in court, and the expert gave evidence without supporting reasons, as to how he reached the conclusion that the prints matched. The full bench of the Orange Free State Provincial Division found that the expert's opinion with regard to the identity of the fingerprints was admissible and therefore accepted as prima facie evidence without any basis of his opinion being given. The court referred to the case of *R v Smit*⁷³³ wherein the court found that, "in the absence of any doubts being cast upon the fingerprint expert testimony and especially given the probative value of the comparison made by the expert between the latent prints from the scene and that of the accused person", there was no reason to depart from the magistrate's finding that the fingerprints found at the scene of the crime were those of the accused.

In the case of *Lekgau v S*⁷³⁴ the appeal was concerned with the probative value of fingerprint evidence which formed the basis for the conviction of the appellant on various counts of housebreaking and theft, kidnapping and robbery with aggravating circumstances. The appellant argued that the explanation by the fingerprint expert (Captain David Nkai) as to why the same fingerprints initially linked Aaron Phasha to the crime, was unsound. In the trial Captain Nkai said that upon comparison of the said fingerprints, he formed the opinion that Aaron Phasha and the

⁷³² *S v Nyate* 1988 2 SA 211 (O). See also Faurie *Admissibility and Evaluation of Scientific Evidence in Court* (LLM-Thesis, University of South Africa, 2000) 63.

⁷³³ *R v Smit* 1952 3 SA 447 (A) at 452.

⁷³⁴ *Lekgau v S* (A191/15) 2016 ZAGPPHC 281 (9 March 2016).

appellant was the same person. Reasons as to how, what and why Captain Nkai reached this conclusion, were not stated before court, because the appellant did not cross-examine Captain Nkai. Based on the testimony of Captain Nkai, the court accepted the fingerprint evidence as incriminating evidence against the appellant. The court referred to the case of *S v Ndlovu*,⁷³⁵ wherein the court held “that cross-examination is an integral part of the armoury placed at the disposal of an accused person to test, challenge and discredit evidence tendered against him or her.”⁷³⁶ Because the appellant failed to challenge or criticize fingerprint evidence in the trial court, the evidence was accepted by the court as incriminating evidence against him. The question as to how Captain Nkai reached the conclusion that the appellant and Aaron Pasha was the same person, was never considered. The question as to what method the captain employed to reach the opinion expressed, or questions with regard to the possibility of identifying two different persons as one person, were not asked in this trial.

Moreover, in the case of *Seyisi*⁷³⁷ the court accepted the evidence of fingerprint expert, Mr Stassen, that he found seven points of similarities on the appellant’s fingerprints and that which were found on the vouchers. Fingerprint evidence was the main evidence linking the appellant to the alleged wrongful activities in that she facilitated unauthorized payments of social welfare grants to bogus persons by affixing or attaching her own thumb or toe print to payment vouchers. These activities were allegedly committed whilst the appellant was employed as a paymaster by the Department of Social Development, Bisho, Eastern Cape. The appellant denied participating in these illegal activities, but because the fingerprint evidence was not properly challenged by the defence, it was accepted as prima facie evidence. The court held that:

⁷³⁵ *S v Ndlovu* 2002 2 SACR 325 SCA.

⁷³⁶ The court further made reference to the case of *President of Republic of South Africa v South African Rugby Football Union* 1999 ZAAC 11; 2000 1 SA (CC). In this case the court stated that cross-examination imposes certain obligations, that is if it is suggested that the witness is not telling the truth on a particular point to direct the witness’s attention to the fact by questioning him or her during cross-examination, to prove that the imputation is intended to be made and to afford the witness an opportunity while still in the witness box, of giving any explanation open to witness and of defending his or her character. If a point in dispute is left unchallenged in cross-examination, the party calling the witness can assume that the unchallenged witness’s testimony is accepted as true and correct. Moreover, the words of Claassen J in the case of *Small v Smith* 1954 3 SA 434 (SWA) that “it is grossly unfair and improper to let a witness’ evidence go unchallenged in cross-examination and afterwards argue that he must be disbelieved. Failure to cross-examine may therefore prevent a party from later disputing the truth of the witness’ evidence.”

⁷³⁷ *Seyisi v S* (117/12) 2012 ZASCA 144 (28 September 2012). In this case the appellant was charged in the Mdantsane Regional Court, Eastern Cape, with 1025 counts of fraud, alternatively with theft. The appellant was linked to the fraud through an investigation conducted at the instance of the department by a fingerprint expert, Mr Stassen, who was the main State witness at the trial.

In the absence of a challenge to expert evidence that *prima facie* establishes the relevant facts a court is entitled to rely upon it to convict. In this case there was no challenge to his expertise, or to the grounds upon which he expressed the opinion that the prints corresponded.⁷³⁸

The court disregarded the fact that during cross examination when Mr Stassen was asked to explain how he reached the seven points of similarity, he could not respond with an immediate answer. He said “he could not do so there and then but would be able to do so if he was given an opportunity to stand down.”⁷³⁹ The defence, however, did not press the matter further. This shows that he was not prepared enough immediately to furnish the court with all necessary explanations of his conclusions. Nevertheless, the court overlooked this aspect and proceeded to accept the fingerprint evidence because there were seven points of similarity. In this regard the court stated that:

If we have an expert, he is conceded to be an expert and his evidence is credible before the Court then the Court must at the very least accept his evidence as being *prima facie* proved and this is where then an onus rests on the defence to dispute facts that are *prima facie* proved before the Court. So if the expert tells the Court here are seven points and these are similar seven points on this next photograph and one can see that they are pointing to exactly the same area as the specific points on them then there at least rests a duty on the defence to have asked the witness what are these points, if he wanted to know what they were so that he could place them in dispute at some stage. It is quite clear that the witness told the Court that he is able to tell the Court what they are and the witness told us that he is able to point out the seven points of similarity on all the 1 025 vouchers that have been presented to the Court. This has not been done by the defence so therefore the evidence must stand then as undisputed evidence. Our law is quite clear that if evidence is *prima facie* evidence and it is not discredited or placed in dispute by the defence in any manner then it must be accepted as proven evidence.⁷⁴⁰

In *S v Kimimbi*⁷⁴¹, Watermeyer J stated that:

On the one hand, a mere layman who comes to court and alleges a fact which he has learned only by reading a medical or mathematical book cannot be heard. But on the other hand, to reject a professional physician or mathematician because the fact or some of the facts to which he testifies are known to him only upon the authority of others, would be to ignore the accepted methods of professional work and to insist on impossible standards.⁷⁴²

The cases discussed immediately above, show how fingerprint evidence to a large extent secured a conviction and how the court readily accepted such evidence even though it was the single evidence or main evidence linking the accused person to the crime scene. As elaborated above, accepting untested evidence, and more particularly fingerprint evidence, may lead to wrongful convictions. Over and above the challenges and problems that have been raised with regard to fingerprint evidence, as discussed in this dissertation above, a number of DNA exonerations depict

⁷³⁸ *Ibid* 8.

⁷³⁹ *Ibid* 5.

⁷⁴⁰ *Ibid* 7-8.

⁷⁴¹ *S v Kimimbi* 1963 3 SA 250 (C).

⁷⁴² *Ibid* 251F – H.

that a substantial number of wrongful convictions have been based on fingerprint evidence.⁷⁴³ If the defence does not cross-examine the fingerprint expert witness, it implies that the reliability of the evidence remain uncontested in that particular case. In this regard Edmond argues that “the inability to consistently focus on the reliability of forensic science evidence means that there are probably many more miscarriages of justice and wrongful convictions.”⁷⁴⁴ With regard to South Africa, De Villiers states that “(u)nfortunately it is fair to say that the South African Police Service is not up to a first world standard and cannot be trusted with the task of performing accurate and unbiased procedures.”⁷⁴⁵ Fingerprint laboratories should therefore devise means or procedures by which results can be verified blindly by an independent examiner before presented in court.⁷⁴⁶

Limited cross examination regarding expert evidence in courts by the defence is not only faced in South Africa, but even in leading forensic jurisdictions.⁷⁴⁷ The reason could be that the evidence may be too technical to such an extent that the defence lawyers, due to lack of in-depth knowledge of that particular area of science, cannot comprehend such evidence and any limitations raised or not raised.⁷⁴⁸ Edmond states that:

Cross-examination tends to be of limited value where defense lawyers are not resourced or prepared, sufficiently proficient or confident in their ability to persuade trial judges and jurors about the significance of dangers. In too many cases defense lawyers do not fully appreciate the significance of limitations and dangers.⁷⁴⁹

Defence counsel may also not cross-examine the expert witness because they may not be well equipped with knowledge of the field of expertise of the witness and as result most of their questions would not probe whether the opinion falls under the scientific field and whether it has been validated or tested for its reliability.⁷⁵⁰ This indicates that, in some cases, even if the defence counsel cross-examine experts, the questioning might not be effective enough to the extent of revealing or exposing potential flaws in the methodology, data and reasoning behind the expert

⁷⁴³ Cole “More than Zero: Accounting for Error in Latent Fingerprint Identification” 2005 *Journal of Criminal Law & Criminology* 1067-1067.

⁷⁴⁴ Edmond “The ‘Science’ of Miscarriages of Justice” 2014 *University of New South Wales Law Journal* 401.

⁷⁴⁵ De Villiers “Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the last number of years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?” 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016).

⁷⁴⁶ NIST Report 181-182. See also Mayfield Report 204. See also SFI Report 655 and 744.

⁷⁴⁷ Edmond “What Lawyers should know about Forensic Sciences” 2015 *Adelaide Law Review* 33-100.

⁷⁴⁸ Edmond “Expert Evidence in Reports and Courts” 2013 *Australian Journal of Forensic Sciences* 5.

⁷⁴⁹ Edmond “The ‘Science’ of Miscarriages of Justice” 2014 *University of New South Wales Law Journal* 398. See also Edmond and Mehera “The Cool Crucible: Forensic Science and the Frailty of the Criminal Trial” 2012 *Current Issues in Criminal Justice* 51.

⁷⁵⁰ *Ibid.*

evidence.⁷⁵¹ Edmond and his colleagues contend that when cross-examining the expert witness, defence counsel must ask questions that test the validity⁷⁵² and reliability⁷⁵³ of the evidence and the proficiency of the expert.⁷⁵⁴

A further complicating factor is the fact that the defence may not always be able to afford to call rebuttal expert witnesses⁷⁵⁵ to challenge the evidence of the state expert witness called by the prosecution.⁷⁵⁶ To cater for this problem, the reports analyzed above, recommend that legal practitioners must receive basic education regarding scientific evidence, as this will enable them to be familiar with the practices, principles, methodologies, limitations and the terms applied in a specific forensic science field.⁷⁵⁷ It has also been recommended that funds must be made available to both the prosecution and defence. By doing this, the defence would be able to call expert witnesses to challenge the evidence tendered by the prosecution.⁷⁵⁸

The other factor that contributes to limited questioning of fingerprint evidence in courts, is the fact that fingerprint experts called by the prosecution in most cases only testify to what is known and appropriate.⁷⁵⁹ They more than often do not disclose the existence of criticisms of their current practices such as methodological flaws, lack of validation studies and unknown error rate.⁷⁶⁰ In rare circumstances where some of these factors are disclosed, according to Edmond, they often are not explained in a manner that helps the triers of fact to evaluate such evidence.⁷⁶¹ Where there is no disclosure of such disadvantages and where the evidence is not tested by cross examination, a

⁷⁵¹ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australian Bar Review* 176. See also Edmond “Expert Evidence in Reports and Courts” 2013 *Australian Journal of Forensic Sciences* 5

⁷⁵² *Ibid* 194-195, stating that testing the validity of a method or technique the purpose to establish whether the forensic analyst able to do what they claim they can do?

⁷⁵³ *Ibid* 195-196, stating that testing the reliability of a method or technique the purpose to establish whether the method used by the forensic analyst consistently or repeatedly produce the same results when applied to the same materials?

⁷⁵⁴ *Ibid* 196-197, stating that testing the validity of a method or technique the purpose to establish whether the forensic analyst or laboratory perform the method and/or draw conclusions to an acceptable standard of performance?

⁷⁵⁵ Rebuttal expert witness are usually academics and occasionally retired forensic analysts, drawn from different disciplines and often in possession of little, if any, forensic experience. Hence their evidence is mostly considered to be irrelevant as it is portrayed to as abstract, theoretical and even partisan.

⁷⁵⁶ Edmond “The ‘Science’ of Miscarriages of Justice” 2014 *University of New South Wales Law Journal* 399.

⁷⁵⁷ NAS Report 25-27 and 217. See also NIST Report 115. See also PCAST Report 162. See also SFI Report 750-751.

⁷⁵⁸ NIST Report 203 and 210.

⁷⁵⁹ Edmond “The ‘Science’ of Miscarriages of Justice” 2014 *University of New South Wales Law Journal* 382.

⁷⁶⁰ *Ibid* 391. See also Edmond “[Ad]ministering Justice: Expert Evidence and the Professional Responsibilities of Prosecutors” 2013 *University of New South Wales Law Journal* 921, 936-937.

⁷⁶¹ Edmond “Expert Evidence in Reports and Courts” 2013 *Australian Journal of Forensic Sciences* 6-7.

South African court is bound to accept evidence that might be unreliable. This situation is further complicated by the fact that some presiding officers might have little or no knowledge of how fingerprint identification evidence works, yet they are expected to give probative value to the evidence. Meintjes-van der Walt contends that “(t)here is an inherent contradiction in that expert witnesses are required in matters that go beyond the ordinary understanding of lay people,” and yet it is expected of judges to adjudicate on this expert evidence.⁷⁶² Therefore, as elaborated in the reports, the expert witness should inform the court about the limitations of fingerprint methodology, error rates and any changes and advances in the field as this could assist the trier of facts to evaluate the evidence fully, properly and fairly.⁷⁶³

In contrast to the shortcomings of fingerprint evidence highlighted in the reports and discussed above, the validity of the alleged uniqueness of fingerprints has not yet been challenged in South Africa and the issues raised in the reports are rarely found in relevant South African jurisprudence. South African courts tend to accept fingerprint evidence even without knowing whether the technique applied by the expert actually works and, if so, how accurate it is. This could be inferred from the findings of the cases discussed in this dissertation above. If the South African fingerprint community would embark on a journey to conduct research to test the accuracy and reliability of the underlying premises of fingerprint evidence, and, in addition to that, conduct empirical studies to determine the error rate of fingerprint identification evidence as recommended in the reports discussed above, the South African fingerprint jurisprudence would be significantly strengthened. The USA has already started adopting and applying this recommendation made in the reports.⁷⁶⁴ This kind of research would empower fingerprint experts to be up to date with the changes and scientific advancements in the discipline. However, South African lawyers do not have to wait for the research recommended above, as appropriate and effective cross-examination could go a long way in challenging suspect expert evidence and, ultimately in assisting the court appropriately to

⁷⁶² Meintjes-van der Walt “Science Friction: The Nature of Expert Evidence in General and Scientific Evidence in Particular” 2000 *South African Law Journal* 771.

⁷⁶³ Edmond “The ‘Science’ of Miscarriages of Justice” 2014 *University of New South Wales Law Journal* 404.

⁷⁶⁴ The American Association for the Advancement of Science “Forensic Science Assessments: A Quality and Gap Analysis- Latent Fingerprint Examination” September 2017. Available at DOI: 10.1126/srhl.aag2874. Cooper “Challenges to Fingerprints Identification: Why the Courts Need a New Approach to Finality” 2016 *Mitchell Hamline Law Review* 756-790. See also Champod “Fingerprint Identification: Advances since the 2009 National Research Council Report” 2015 *Philosophical Transactions of the Royal Society B: Biological Sciences* 1-10.

deal with fingerprint evidence. In the section below, possible cross examination questions are provided.

4 5 CROSS-EXAMINATION QUESTIONS TO TEST FINGERPRINT EVIDENCE

Cross-examination is an important stage of a trial as it gives the defence counsel an opportunity to test the relevance, reliability and validity of the evidence presented in court by the state. According to Edmond *et al* when cross-examining “[f]actors relating to experimental validation, measures of reliability and proficiency are key because they, rather than conventional legal admissibility heuristics (e.g. field, qualifications, experience, common knowledge, previous admission, etc.) provide information about actual ability and accuracy that enable expert evidence to be rationally evaluated by judges and jurors.”⁷⁶⁵ Defence counsel faced with fingerprint evidence may ask the following questions in order to “point out the subjective nature of the process, the expert’s lack of training, a lack of studies to validate the claims of uniqueness and permanence of friction ridges, possible bias, and should cross-examine on all relevant problems with the fingerprint comparison methodology itself.”⁷⁶⁶ The possible cross-examination questions provided in cursive script in the sub-sections below, might be useful in interrogating fingerprint expert evidence. Most of the questions suggested below, have been borrowed from other sources. In some instances, the questions have been taken verbatim from the original sources and in some instances the questions have been edited and/or adapted for the purposes of this dissertation. Where possible, credit is given to the original authors and the sources of the questions. Some questions were formulated by the author of this dissertation.

4 5 1 Relevance

During cross-examination defence counsel must ask questions that are aimed at probing whether or not the evidence can “rationally influence the assessment of facts in issue.”⁷⁶⁷ In this regard the following questions might be useful:

⁷⁶⁵ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 175.

⁷⁶⁶ White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁷⁶⁷ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 177.

- *I accept the fact that you have the experience and necessary training but how do we know that your level of performance regarding matching and comparing of latent prints to known prints is actually better than that of a lay person?*⁷⁶⁸
- *Could you please direct us to independent evidence like published studies of fingerprint identification technique and its accuracy?*⁷⁶⁹
- *What independent evidence confirms that the fingerprint identification technique works?*⁷⁷⁰

4 5 2 Validation

To establish whether the technique used by the fingerprint examiner “does what it purports to, and how well” validation studies must be conducted.⁷⁷¹ Validation studies also establish whether the technique is reliable enough to produce accurate and correct results. The answers to the following cross-examination questions might be illuminating in this regard:

- *Do you accept that the premises of uniqueness and permanence of fingerprints should be validated?*⁷⁷²
- *Do you further accept that the fingerprint comparison methodology should also be validated?*
- *Have the premises of uniqueness and permanence been validated?*

⁷⁶⁸ *Ibid* 178.

⁷⁶⁹ *Ibid.*

⁷⁷⁰ *Ibid.*

⁷⁷¹ *Ibid.*

⁷⁷² *Ibid.*

- *Has the methodology been validated?*
- *Can you direct us to specific studies that have validated the fingerprint identification technique?*⁷⁷³
- *What was the basis of these studies and is the methodology or technique you have applied the same as that used in the studies you referred to?*⁷⁷⁴
- *Can another fingerprint examiner following the same methodology or applying the same technique reach the same conclusion as yours or might he or she produce different results?*⁷⁷⁵
- *Considering that the fingerprint comparison methodology is highly subjective, do you agree that it is possible for examiners to come to different conclusions?*⁷⁷⁶
- *Could you tell the court if you have ever disagreed with another fingerprint examiner about sufficiency of details in a latent print for examination?*⁷⁷⁷
- *Have you ever disagreed with another fingerprint examiner about whether two fingerprint impressions are from the same source or not?*⁷⁷⁸

⁷⁷³ *Ibid.*

⁷⁷⁴ *Ibid.*

⁷⁷⁵ *Ibid.*

⁷⁷⁶ Graham "Fingerprints and Expert Identification Evidence: Markers of Unreliability" 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 8, 18-19

⁷⁷⁷ *Ibid* 24.

⁷⁷⁸ *Ibid.*

- *Are there written standards or protocols in place that fingerprint examiners follow when applying the fingerprint comparison methodology?*⁷⁷⁹
- *Can you direct us to the standards in place to guide the fingerprint examiner when following the fingerprint comparison methodology?*⁷⁸⁰
- *Is it your experience that the fingerprint examiners at your laboratory are normally in agreement when it comes to the examination and identification of fingerprints?*⁷⁸¹
- *Do you know the false positive rate and sensitivity of the fingerprint comparison methodology?*⁷⁸²
- *Did you develop your opinions expressly for the purpose of testifying in this court or did you conduct your research independent of litigation?*⁷⁸³
- *What criteria did you use in interpreting individualisation/identification results?*⁷⁸⁴
- *Apart from your experience and training, what other criteria did you rely on in articulating resemblances of comparisons?*⁷⁸⁵

⁷⁷⁹ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 178.

⁷⁸⁰ *Ibid.*

⁷⁸¹ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 24.

⁷⁸² White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁷⁸³ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 178.

⁷⁸⁴ White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁷⁸⁵ *Ibid.*

- *Have you, yourself, conducted an empirical test for the fingerprint examination methodology?*⁷⁸⁶
- *What were the results and have you documented the said results?*⁷⁸⁷
- *Are there any other ways of improving this technique or methodology?*⁷⁸⁸

4 5 3 Limitations and errors

According to Edmond *et al* “Limitations and information about potential sources of error should be included in reports and testimony. Limitations may extend beyond the technique to include the process, such as where the analyst is exposed to potentially biasing *domain, irrelevant information* or where the quality of the trace is low (e.g. a fragmentary latent fingerprint...).”⁷⁸⁹In this regard the following cross-examination questions could be put to the fingerprint expert for the prosecution:

- *What is known print?*⁷⁹⁰
- *Do you agree with me that normally, to a larger extent than in the case of an unknown print, a known print is very clear and that minutiae are visible?*⁷⁹¹
- *What is a latent print, and elaborate on how it is lifted from a crime scene?*⁷⁹²
- *Do latent prints have clear and visible details like known prints?*⁷⁹³

⁷⁸⁶ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 24.

⁷⁸⁷ White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁷⁸⁸ *Ibid.*

⁷⁸⁹ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 180.

⁷⁹⁰ White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁷⁹¹ *Ibid.*

⁷⁹² *Ibid.*

⁷⁹³ *Ibid.*

- *Do you accept that only part of a fingerprint is transferred to a surface and that they can be blurred?*⁷⁹⁴
- *Do you agree that the blur may be as a result of the manner in which the print was left on the surface and how the person moved his or her hand?*⁷⁹⁵
- *Do you further accept that the blur could be caused by how the print was lifted from the crime scene?*⁷⁹⁶
- *Do you agree that factors like variations in pressure and skin elasticity may distort impression of a fingerprint?*⁷⁹⁷
- *Do you agree that as a result of these variations fingerprints that have been made by the finger from the same source will typically exhibit some differences each time the impression is left on a surface?*⁷⁹⁸
- *Do you agree that because of the uniqueness of fingerprints, the existence of any dissimilarity results in the conclusion that prints were not made by the same source?*⁷⁹⁹

⁷⁹⁴ *Ibid.*

⁷⁹⁵ *Ibid.*

⁷⁹⁶ *Ibid.*

⁷⁹⁷ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 22.

⁷⁹⁸ *Ibid.*

⁷⁹⁹ *Ibid.*

- *Do you sometimes decide that there are differences between the two and don't call an exclusion?*⁸⁰⁰
- *Is that because you decide they do not indicate a "real difference"?*⁸⁰¹
- *Is the decision that they are not real differences at your decision?*⁸⁰²
- *Is there no computer or machine that makes the determination?*⁸⁰³
- *Could there be a smudge, or dust on a surface?*⁸⁰⁴
- *How much information do you have about the comparison of the latent print to the known print?*
- *Could you explain the limitations of the fingerprint identification technique?*
- *Is it correct that the level of details in a fingerprint impression is classified into 3 categories that is Level 1, Level 2 and Level 3 details, respectively?*⁸⁰⁵
- *Do all fingerprint impressions contain all three levels of detail with clarity?*⁸⁰⁶

⁸⁰⁰ Friedman "Model Cross-Examination: Fingerprint Examiner" 2011 [http://www.mtacdl.org/attachments/CPE/Nelson/CROSSEXAMINATION_\(FINGERPRINT_EXAMINER\).pdf](http://www.mtacdl.org/attachments/CPE/Nelson/CROSSEXAMINATION_(FINGERPRINT_EXAMINER).pdf) (accessed on 09-01-2018) 6.

⁸⁰¹ *Ibid.*

⁸⁰² *Ibid.*

⁸⁰³ *Ibid* 7.

⁸⁰⁴ *Ibid* 6.

⁸⁰⁵ Graham "Fingerprints and Expert Identification Evidence: Markers of Unreliability" 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 19.

⁸⁰⁶ *Ibid.*

- *Is it possible that another fingerprint examiner will come to a different conclusion about whether they can observe sufficient Level 2 or Level 3 detail to proceed to the comparison stage of the ACE-V methodology?*⁸⁰⁷
- *How do you select what to examine?*
- *Can two fingerprint examiners differ about characteristics observed during the comparison stage?*⁸⁰⁸
- *Are you familiar with the criticisms that are raised against fingerprint comparison methodology in particular and fingerprint evidence in general by the science community?*
- *Do you agree that the conclusion whether or not the latent print matched the known print depends on the ability of the examiner to analyze and compare the fingerprint impressions, to identify similarities and observe differences?*⁸⁰⁹
- *Is it correct that some examiners have better powers of observation than others?*⁸¹⁰
- *When evaluating and comparing latent print to known print, as a fingerprint examiner do you decide whether the differences between prints are true differences*

⁸⁰⁷ *Ibid.*

⁸⁰⁸ *Ibid* 23.

⁸⁰⁹ *Ibid* 21.

⁸¹⁰ *Ibid.*

*or whether they are as a result of distortion upon transfer to the surface and that they can be explained away?*⁸¹¹

- *It is correct to say that the conclusion of identification relies on the examiner's tolerance of variation between the impressions?*⁸¹²
- *Do you agree that tolerance of differences between impressions is subjective?*
- *Do you accept that the conclusion of a match is reached when the examiner is satisfied that there is a sufficient level of similarity between the latent print and the known print?*
- *It is commonly called "sufficiency", is that right?*
- *Is it correct that factors like clarity of the impressions, number of similarities you have detected between the impressions, a sense of the degree to which differences can be explained, a sense of how to distinguish ridge detail from "background noise", the rarity of certain features or patterns in the impressions, frequency of certain characteristics in fingerprints, generally determine the sufficiency of details?*⁸¹³
- *Besides these factors, are there any other factors you take into account to determine sufficiency?*

⁸¹¹ *Ibid.*

⁸¹² *Ibid.*

⁸¹³ *Ibid* 22.

- *What are they?*
- *Can you explain to the Court when you are satisfied that there is sufficient matching detail?*
- *How much detail is required to declare a match?*
- *Do you agree that there is no universally applied standard number of points of similarity needed to declare a match?*
- *Can you give evidence about the frequency of loops on fingers generally or arches on thumbs?*⁸¹⁴
- *Do you agree that there is no statistical foundation for the conclusion of “sufficiency”?*⁸¹⁵
- *Would it be correct to say that you only compared the latent print from the crime scene to that of the accused?*
- *Do you agree that you cannot look at both impressions at the same time and that you have to go from one image to the other and back again?*⁸¹⁶

⁸¹⁴ Friedman “Model Cross-Examination: Fingerprint Examiner” 2011 [http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_\(FINGERPRINT_EXAMINER\).pdf](http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_(FINGERPRINT_EXAMINER).pdf) (accessed on 09-01-2018) 6.

⁸¹⁵ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 22.

⁸¹⁶ *Ibid* 7.

- *Is it correct that when your eyes leave the images, your brain depends on the memory to make the comparison?*⁸¹⁷
- *When you conducted the comparison of the accused's fingerprint(s) to the latent print, did you observe any differences which were ultimately discounted?*⁸¹⁸
- *If no, are you saying that the two impressions were identical?*⁸¹⁹
- *Has it ever happened that one of the differences you discounted was really a true and genuine difference between the impressions?*⁸²⁰
- *What is the error rate for fingerprint examination?*⁸²¹
- *Do you claim that there is a zero chance of error in fingerprint examination?*
- *Do you accept that according to many fingerprint examiners errors do not occur when the methodology is followed properly?*⁸²²
- *Do you agree that there are actually a number of potential sources of error associated with your technique of fingerprint examination and identification?*⁸²³

⁸¹⁷ *Ibid.*

⁸¹⁸ *Ibid* 29.

⁸¹⁹ *Ibid.*

⁸²⁰ *Ibid.*

⁸²¹ *Ibid.*

⁸²² White "Cross-Examination of Friction Ridge Experts" Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁸²³ *Ibid.*

- *Do you accept that fingerprint examination and identification is prone to human error?*⁸²⁴
- *In this case, have you ever made an erroneous positive identification?*⁸²⁵
- *It is possible that your conclusion of a match between the accused and the crime scene impression is in error?*⁸²⁶
- *So, do you contend that your evaluations are 100% accurate?*⁸²⁷
- *Are you are aware of the United States National Academy of Science Report “Strengthening the Forensic Sciences in the United States: A Path Forward”, published in 2009?*⁸²⁸
- *The Report states that by merely following the stages of the fingerprint comparison methodology it does not mean that the fingerprint examiner is proceeding in a scientific manner*⁸²⁹ *or that reliable results will be produced? Do you agree with this statement in the report?*

⁸²⁴ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 29.

⁸²⁵ *Ibid.*

⁸²⁶ White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁸²⁷ *Ibid.*

⁸²⁸ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 30.

⁸²⁹ NAS Report 144.

- *After the NAS Report there was a review carried out by the US National Institute of Standards and Technology in relation to latent fingerprint evidence, are you aware of that?*⁸³⁰
- *The report “Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach” was released in 2012 and made a number of recommendations, are you aware of them?*⁸³¹ *Could you tell the court about some of these recommendations?*
- *Are you aware of the 2011 “Fingerprint Inquiry” by Lord Campbell in Scotland*⁸³²*and could you elaborate on this report?*
- *Could you please address the court on “Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods” Report by President’s Council of Advisors on Science and Technology (2016)?*
- *Are you familiar with the Mayfield case?*⁸³³ *Could you explain the implications of this case to the court?*

⁸³⁰ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 30.

⁸³¹ *Ibid* 31.

⁸³² *Ibid*.

⁸³³ *Ibid* 32.

- *What are your views on the fact that 3 FBI examiners and an examiner hired by the court all erroneously identified Mayfield?*⁸³⁴
- *Could you comment on Mayfield's print as having been left on a bag that held the detonator to the bomb that went off at the Madrid train?*⁸³⁵
- *Have you perhaps conducted research on how 3 top FBI trained examiners with over 30 years total training could make such a mistake?*⁸³⁶
- *Could you tell the court about some of the theories about how the Mayfield mistake was made?*⁸³⁷
- *Are you aware of the fact that one theory was that examiners knew that Mr Mayfield was a Muslim?*⁸³⁸
- *Are you aware that this was a high-profile mistake but not the only mistake ever made?*
- *Could you refer the court to big mistakes LAPD has made?*⁸³⁹

⁸³⁴ Friedman "Model Cross-Examination: Fingerprint Examiner" 2011 [http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_\(FINGERPRINT_EXAMINER\).pdf](http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_(FINGERPRINT_EXAMINER).pdf) (accessed on 09-01-2018) 8.

⁸³⁵ *Ibid.*

⁸³⁶ *Ibid.*

⁸³⁷ *Ibid.*

⁸³⁸ *Ibid.*

⁸³⁹ *Ibid.*

- *Could you comment on “The American Association for the Advancement of Science, Forensic Science Assessments: A Quality and Gap Analysis- Latent Fingerprint Examination (2017)”?*
- *Have you read these reports?*
- *Are you aware that the reports heavily criticize the fingerprint examination and identification field?⁸⁴⁰*
- *The reports show that a number of experienced fingerprint examiners made erroneous identifications, is that right?⁸⁴¹*
- *Are you aware of the fact that a number of them made the same mistake?*
- *Are you aware of these mistakes and if so, what were they?*
- *Could you refer the court to the Cowans case, where a man was exonerated by DNA evidence but was connected to crime scene by fingerprint evidence?⁸⁴²*
- *Are you aware of the Shirley McKie’s case?⁸⁴³*
- *Are there any studies done to establish the error rate of the methodology?⁸⁴⁴*

⁸⁴⁰ Friedman “Model Cross-Examination: Fingerprint Examiner” 2011 [http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_\(FINGERPRINT_EXAMINER\).pdf](http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_(FINGERPRINT_EXAMINER).pdf) (accessed on 09-01-2018) 12.

⁸⁴¹ *Ibid.*

⁸⁴² White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁸⁴³ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 31.

⁸⁴⁴ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 181.

- *Are you aware of black box studies and could you briefly explain to the court what they are?*
- *Have you conducted such studies?*
- *How did you go about in order to carry out these studies?*
- *Can you direct us to similar such studies and the outcome thereof?*⁸⁴⁵
- *Have you ever made an erroneous positive identification?*
- *Are there any measures taken to reduce the occurrence of erroneous identification?*

4 5 4 Bias

According to the NAS Report, the ACE-V methodology is a subjective methodology that lacks protocols to guard against bias (cognitive, contextual and experiential bias). However, bias may not be intentional but it is undeniable that it occurs. Edmond et al argue that the existence of contextual and confirmation biases “undermine the independence of the analyst’s opinion and threaten the validity of their conclusions.”⁸⁴⁶ Therefore, fingerprint examiners must be familiar with the negative effects of bias and take measures to prevent such occurrence. The following cross-examination questions could interrogate the element of bias:

- *Is it correct that you are a member of South African Police Services (hereafter the SAPS) and that as a fingerprint expert you work exclusively for SAPS?*
- *Are you familiar with cognitive bias and contextual effects?*⁸⁴⁷

⁸⁴⁵ *Ibid.*

⁸⁴⁶ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 185.

⁸⁴⁷ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 28.

- *Could you explain to the court your understanding of the terms?*⁸⁴⁸
- *Do you accept that cognitive bias and other contextual effects could have a negative impact to the reliability of fingerprint evidence?*⁸⁴⁹
- *Do you accept that contextual effects can operate unconsciously to such an extent that even an examiner who is carrying out the examination sincerely may be influenced but may not know it?*⁸⁵⁰
- *Are there measures taken by you to guard against the occurrence of making biased conclusions, if so can you explain to the court what are those measures?*
- *Can you tell us what you knew about the accused and the circumstances of this case before you were asked to analyze the evidence, and before you produced your conclusion?*⁸⁵¹
- *Were you told anything about the suspect when asked to undertake your analysis?*
- *Are you aware about the studies conducted by Dror et al wherein he took prints that fingerprint examiners who performed the test had previously looked at and declared a match, sent them back to them and informed them that the prints were*

⁸⁴⁸ *Ibid.*

⁸⁴⁹ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 185.

⁸⁵⁰ *Ibid.*

⁸⁵¹ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 26.

*from the Brandon Mayfield case, and subsequently half of the examiners who previously declared a match, this time concluded that there was an exclusion?*⁸⁵²

- *Do you agree that outside information has influence on subjective determinations?*

4 5 5 Verification and peer review

Verification and peer reviewing of results by an independent reviewer is crucial and, as is highlighted above, it must be done blindly or done by an individual who is unaware of the original results for it to be effective.⁸⁵³ While independent verification is not a requirement in South Africa, adequate verification could greatly assist the court in deciding the weight that should be attached to the evidence. Likewise, verifying and peer reviewing of results of an invalid technique may be of no use and could result in uncertainty. The following cross-examination questions could be useful with regard to verification and peer review:

- *Was your identification of the fingerprint verified?*
- *Did the verification stage involve a second examiner reviewing results of the initial examiner?*
- *Does the second examination only verify results of a declared match by the initial examiner?*
- *Are you aware of the term “blind” verification and that it means that a second examiner to review the results is unaware of the original results?*⁸⁵⁴

⁸⁵² Dror *et al* “Cognitive Issues in Fingerprint Analysis: Inter-and Intra-Expert Consistency and the Effect of a Target Comparison” 2011 *Forensic Science International* 10-17.

⁸⁵³ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 184.

⁸⁵⁴ *Ibid.*

- *Do you agree that in South Africa verification of results by a second examiner is not a requirement?*
- *Do you further accept that the same examiner who declared a match proceeds to verify his or her decision?*
- *Do you agree that this means that in South Africa the standard process of verifying results is not “blind”?*
- *How often does an examiner reach a different conclusion to the original results?*
- *If the examiner disagrees with his or her initial results, what is the standard procedure?*
- *Does he or she present the disagreement in his or her report?*⁸⁵⁵
- *Do you agree that if there is a disagreement it could mean that there is a mistaken identification?*⁸⁵⁶
- *Has the fingerprint comparison methodology been published in a professional peer reviewed journal?*⁸⁵⁷
- *Is the journal available in the major scientific services and research libraries across the country?*⁸⁵⁸

⁸⁵⁵ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 184.

⁸⁵⁶ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 26.

⁸⁵⁷ *Ibid.*

⁸⁵⁸ *Ibid.*

- *Has the work been peer reviewed by other analysts other than fingerprint examiners?*⁸⁵⁹
- *Do you agree that despite seven points of similarity, if you found one unexplained discrepancy, you would still maintain that you have a match?*
- *Indicate whether you have what is called a standard operating procedures (SOP) manual or protocol.*⁸⁶⁰
- *Indicate whether your unit has one.*⁸⁶¹
- *Standard operating procedures set out the steps that everyone in the unit should follow when examining prints. Is this the practice in your unit?*⁸⁶²
- *Do you take proficiency tests each year as required? If not, state why this is not the case?*⁸⁶³

4 5 6 Expressions of opinion and the presentation of evidence in reports and in court

The reports examined in this dissertation contend that the expression of the fingerprint examiner's interpretation must be derived from a validated technique.⁸⁶⁴ The following cross-examination questions may be useful in this regard:

- *How did you select the terminology that you use to express your opinion?*

⁸⁵⁹ Edmond *et al* "How to Cross-examine Forensic Scientists: A Guide for Lawyers" 2014 *Australia Bar Review* 184.

⁸⁶⁰ Friedman "Model Cross-Examination: Fingerprint Examiner" 2011 [http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_\(FINGERPRINT_EXAMINER\).pdf](http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_(FINGERPRINT_EXAMINER).pdf) (accessed on 09-01-2018) 3.

⁸⁶¹ *Ibid.*

⁸⁶² *Ibid.*

⁸⁶³ Edmond *et al* "How to Cross-examine Forensic Scientists: A Guide for Lawyers" 2014 *Australia Bar Review* 182.

⁸⁶⁴ *Ibid.*

- *Does the terminology rely on a scale or some calculation?*⁸⁶⁵
- *How and why did you select the expression?*⁸⁶⁶
- *Would others analyzing the same material produce similar conclusions, and a similar strength of opinion?*⁸⁶⁷
- *Could you substantiate your answer to the previous question?*⁸⁶⁸
- *Is the use of this terminology derived from validation studies?*⁸⁶⁹
- *Did you report all of your results?*
- *Do you agree that as an expert witness you have a duty to help the court?*
- *What are the implications of this duty?*
- *Are you aware of the fact that you must testify impartially and in non-partisan manner?*
- *Is it correct that you must disclose the existence of uncertainty and criticisms associated with your area of expertise?*⁸⁷⁰

⁸⁶⁵ White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁸⁶⁶ *Ibid.*

⁸⁶⁷ *Ibid.*

⁸⁶⁸ *Ibid.*

⁸⁶⁹ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 183.

⁸⁷⁰ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 32.

- *Can you explain to the court any uncertainty, criticisms or concerns associated with fingerprint examination and identification that have been raised or are being raised by the scientific community?*⁸⁷¹
- *As a certified fingerprint expert you must be aware of the NAS Report, NIST Report, SFI Report, PCAST Report, AAA Report? Have you read these reports and if so, could you briefly refer the court to some of the most important issues raised by the reports and to some of the pertinent recommendations made in these reports?*
- *Are you aware that the reports contend that fingerprint examiners must not testify with 100% certainty and in absolute terms?*⁸⁷²
- *Do you confirm that your report and evidence today are consistent with the recommendation referred to in the previous question?*⁸⁷³
- *In light of the recommendations in these reports, do you stand by the opinion you have given that the crime scene fingerprint impression can be attributed to the accused exclusively?*⁸⁷⁴

⁸⁷¹ *Ibid.*

⁸⁷² NAS Report 22, 142 and 186. See also NIST Report 94, 113 and 199. See also SFI Report 679-680 and 748.

⁸⁷³ White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁸⁷⁴ Graham “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017) 32.

4 5 7 Personal proficiency

It is important for techniques to be validated because “where techniques have not been validated, claims to personal proficiency are questionable.”⁸⁷⁵ The following cross-examination questions could be of assistance with regard to probing personal proficiency:

- *Do you work in this particular scientific field of forensic science?*
- *Have you ever had your skills of fingerprint identification tested when the source of both fingerprints in the comparison is known?*⁸⁷⁶
- *If not, how can we be confident that you are proficient?*⁸⁷⁷
- *If so, can you provide independent empirical evidence of your performance?*⁸⁷⁸

4 5 8 Education, training, accreditation and certification

It is important to cross-examine about training and education and qualifications of the fingerprint expert because it could reveal how minimal the requirements are for one to qualify as a fingerprint expert.⁸⁷⁹ The following cross-examination questions could be useful in probing the fingerprint expert’s level of education, training, accreditation and certification:

- *State the duration of your training?*⁸⁸⁰
- *Where you supervised by senior fingerprint experts during your training?*

⁸⁷⁵ Edmond *et al* “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australia Bar Review* 181.

⁸⁷⁶ *Ibid* 182.

⁸⁷⁷ *Ibid*.

⁸⁷⁸ *Ibid*.

⁸⁷⁹ White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁸⁸⁰ Friedman “Model Cross-Examination: Fingerprint Examiner” 2011 [http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_\(FINGERPRINT_EXAMINER\).pdf](http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_(FINGERPRINT_EXAMINER).pdf) (accessed on 09-01-2018) 2.

- *Are you aware of the SWGFAST (Scientific, Working Group on Friction Ridge Analysis, Study and Technology) and the guidelines it provides for fingerprint examiners?*⁸⁸¹
- *Is it correct that the SWGFAST recommends that the training must be for two or more years of full-time latent print work?*⁸⁸²

4 6 CONCLUSION

The five international forensic reports reviewed in this dissertation above, critically evaluated and analysed the issues associated with the use of fingerprint evidence as a tool for identification. The reports do not merely highlight problems of the evidence, they also provide recommendations with regard to what the examiners, courts, prosecution and defence should consider in order to enhance the reliability and validity of fingerprint evidence in courts. One might, however, ask what relevance or importance the issues raised in these reports have for South Africa, and why they should be seriously considered in the South African legal system. South Africa follows the adversarial system just like the Anglo-American jurisdictions wherein the reports were compiled and these jurisdictions are considered as leading forensic jurisdictions. The findings and recommendations inevitably must be relevant to South African law, particularly when fingerprint evidence is involved. This is so because South Africa is not exceptional in its production, presentation and treatment of fingerprint evidence. Despite differences in the manner in which the evidence is admitted, in the evidentiary rules and procedures, in the traditions of practice, such as accreditation and certification, the scientific, and therefore legal, problems presently raised by fingerprint evidence as is highlighted in the reports, must logically also pertain to South Africa.

Knowledge of the issues and recommendations provided for in the reports is crucial to South African lawyers particularly with regard to determining whether fingerprint evidence is reliable and what weight should be given to fingerprint evidence. The fact that in South Africa, fingerprint

⁸⁸¹ White “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015 <https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

⁸⁸² *Ibid.*

evidence has been accepted for a long time and that, to date, no wrongful convictions have been exposed, as has been the case in other jurisdictions like the US, and Scotland⁸⁸³, is not a sound reason to ignore the substantial scientific issues raised against fingerprint evidence on the international terrain. Many of the problematic issues regarding fingerprint evidence are not normally exposed or credibly explored at trial in South Africa. Furthermore, these complex issues are normally not adequately explained in judicial summaries and directions. The analyzed cases in this chapter reveal that the courts in South Africa accept and give significant weight to fingerprint evidence often without indications of being conscious of the complex issues surrounding fingerprint evidence, as long as there are seven points of similarity and if it is not challenged during cross-examination. This practice of accepting fingerprint evidence even if the fingerprint expert upon testifying does not effectively provide the court with the range of complex issues surrounding the discipline, may be disastrous to the justice system as it may cause wrongful convictions and/or undermine public confidence in the legal system.

Furthermore, the acceptance of fingerprint evidence as *prima facie* evidence merely because the defence fails to cross-examine, could have a detrimental effect on the South African justice system as incriminating evidence that might be unreliable could be given undue weight and this could result in a miscarriage of justice. In South Africa, there is a need to improve the manner in which fingerprint evidence is presented in courts because the accuracy of such evidence is, in the light of the reports discussed above, habitually exaggerated and often goes unquestioned. The reports, in line with the *Daubert* approach, advocate for reliability to be a condition for admissibility in the comparative jurisdictions discussed above. These reliability factors could be taken into consideration when South African courts determine the weight that should be attached to fingerprint identification evidence. Courts might not always have the means by which it can verify the reliability of the witness's conclusions.⁸⁸⁴ Presiding officers taking due cognizance of the reliability factors emphasised in the reports discussed and accordingly insisting on scientifically verifiable fingerprint evidence and appropriate cross-examination by the defence as set out in the proposed questions above, could be of enormous value in determining the reliability of the evidence and consequently the appropriate weight that should be attached to the evidence proffered. Fingerprint evidence has enjoyed general acceptance in South African courts even if its reliability

⁸⁸³ See generally the five international forensic reports analysed in chapter 3 of this dissertation.

⁸⁸⁴ Zeffertt *et al* 305.

and validity is unknown. In the light of the analysis of how fingerprint evidence is accepted in South African courts, as compared to how it is interrogated in America, Scotland and England and Wales, one must conclude that there is a need for a drastic change in the way in which fingerprint evidence in South Africa is accepted, which, in turn, will assist the court to determine the weight which should be given to such evidence.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5 1 INTRODUCTION

The purpose of this study is to gain insight into the problems that are associated with fingerprint evidence as well as to examine judicial investigations in comparator jurisdictions regarding the reliability of fingerprint evidence, more particularly by reviewing the five international forensic reports and thereafter to establish lessons and guidelines for the South African criminal justice system. The question whether fingerprint evidence is reliable enough to be used in court and accepted as *prima facie* evidence, has evolved from being a mere academic issue to a practical one.⁸⁸⁵ It is undeniable that fingerprints are a valuable tool for identification and it has been used for criminal identification purposes since 1877.⁸⁸⁶ It has been used in the justice system to identify suspects of crime and is considered to be of significant evidential value in cases where fingerprint evidence is applicable.⁸⁸⁷ However, this study argues that in as much as fingerprint evidence is an important tool for identification, its reliability and validity must be tested to avoid admitting and giving undue weight to unreliable evidence. This is more specifically important in South Africa where fingerprint evidence has not traditionally been challenged. In order to determine what weight should be given to fingerprint evidence in South Africa, this study reviews five international forensic reports compiled in leading forensic jurisdictions which also have the adversarial system used in South Africa.⁸⁸⁸ The five international reports reviewed in this dissertation include a report on a review of the FBI's handling of the Brandon Mayfield case (Mayfield Report);⁸⁸⁹ the report compiled by the National Research Council (NAS Report) in 2009;⁸⁹⁰ The Scottish Fingerprint Inquiry report (SFI Report) in 2011⁸⁹¹, the National Institute of

⁸⁸⁵ Mayfield report 2006 showing how the FBI made an erroneous identification of Brandon Mayfield. See also the SFI report 2011 revealing how an erroneous identification of Shirley Mckie was done. See Cole "Prevalence and Potential Causes of Wrongful Conviction by Fingerprint Evidence" 2006 *Golden Gate University Law Review* 39.

⁸⁸⁶ Barnes "History" in Holder *et al The Fingerprint Sourcebook* (2011) 11 <https://www.ncjrs.gov/pdffiles1/nij/225321.pdf> (accessed on 27-08-2016).

⁸⁸⁷ Edmond "Expert Evidence in Reports and Courts" 2013 *Australian Journal of Forensic Sciences* 6.

⁸⁸⁸ See generally Chapter 3 of this dissertation, pages 7-47.

⁸⁸⁹ Office of the Inspector General, United States Department of Justice *A Review of the FBI's handling of the Brandon Mayfield case* (2006).

⁸⁹⁰ Committee on Identifying the Needs of the Forensic Science Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (2009).

⁸⁹¹ Campbell *The Fingerprint Inquiry Report* (2011).

Science Technology Report (NIST Report) in 2012⁸⁹² and the Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods Report by President's Council of Advisors on Science and Technology (PCAST Report) in 2016.⁸⁹³ These reports rigorously interrogated and analyzed the issues associated with fingerprint evidence and suggested solutions to the identified problems. This dissertation takes note of the fact that admissibility rules and requirements of evidence in some of these jurisdictions differ from that of South Africa, but maintains that the issues emanating from the reports are relevant to South African courts. This chapter provides a recapitulation of the main arguments presented in and the conclusions drawn from the entire study above and offers recommendations for the possible reform of the current practice in South Africa and proposes solutions to the problems identified.

5 2 RECAPITULATION

Chapter one of this study provides an introduction and a general overview of the dissertation. It sets out the goals, the objectives, the main aim, the problem statement, the significance and the delimitation of the study, the research methodology and the sources. The first part of the chapter states the context of the research by providing the background of the study. The chapter further establishes that there are two basic premises that are at the heart of fingerprint evidence. These are uniqueness and permanence of friction ridges and they can be likened to a thread running through the entire research. The chapter also provides a brief summary of the content of the issues raised against fingerprint evidence in general, and particularly in the reports reviewed by this study in a concise literature review. The significance of the study is then justified. Finally, the organization of the chapters of the dissertation is indicated and with regard to ethical issues the chapter notes that the study raises no ethical issues as there is no person interviewed.

Chapter two of the study provides the historical background of fingerprint evidence. It further traces the historical circumstances from which the use of fingerprints emerged and indicates how it became a useful tool for identification in the justice system. The chapter also provides a theoretical discussion of what fingerprints are, when, where and how friction ridges are formed,

⁸⁹² Expert Working Group on Human Factors in Latent Print Analysis, *Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach* (2012).

⁸⁹³ *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods Report* by President's Council of Advisors on Science and Technology (2016). <https://www.whitehouse.gov/blog/2016/09/20/pcast-releases-report-forensic-science-criminal-courts> (accessed 01-12-2016).

how fingerprints are grouped and classified, how fingerprints are transferred to a surface, their development and the lifting thereof from the crime scene and the methodology followed by fingerprint examiners to analyze and compare an unknown print to known print. The chapter also indicates what details fingerprint examiners look at in order to arrive at a conclusion. The chapter notes that the assumption of the uniqueness of friction ridges is as a result of an unsystematic process in which the formation of fingerprints takes place and that the proposition of the permanence of fingerprints is derived from the fact that fingerprints are generated and imprinted in the dermis, the thick tissue underlying the epidermis, on which fingerprints are visible.

Chapter three of this dissertation provides a critical review of the five forensic international reports that presented challenges against fingerprint evidence. The chapter explores in detail the nature of the challenges raised against fingerprint evidence and indicates what needs to be done or what has been done since the emerging of such criticisms in order to curb the identified problems. The chapter presents an analysis of the recommendations and developments stemming from the reports. Both administrative and judicial remedies are critically discussed. It is noted in this chapter that in the United States, defence lawyers have already started challenging fingerprints based on the findings of the NAS Report. The chapter contends that the NAS Report was groundbreaking and influential, and refers to other reports which built on the foundations laid by the NAS Report. The chapter highlights why the findings of the reports are important and relevant to the criminal justice system, not only in the jurisdictions referred to in the reports, but also to South Africa.

Chapter four of this study interrogates the way in which South African courts accept fingerprint evidence as *prima facie* evidence when the evidence is not challenged or scrutinized, despite the emerging challenges raised against fingerprint evidence in the five international forensic reports. The chapter then establishes how knowledge of these issues can assist South African lawyers to determine the weight to be given to fingerprint evidence. The first part of this chapter differentiates between admissibility and the weight of expert evidence. In this regard, the chapter points out that the weight of the evidence is considered only after the evidence has been admitted. Secondly the chapter discusses the factors that courts should take into consideration in order to test the reliability of fingerprint evidence. The third part of the chapter provides an analysis of why it is important to test the reliability of expert evidence. Furthermore, the chapter contains a discussion on how fingerprint evidence is accepted in South Africa as compared to Anglo American jurisdictions

where the implications of the findings of the reports are beginning to impact on the criminal justice system. In order to achieve this, the third part of this chapter refers to relevant South African case law in which fingerprint evidence was accepted as reliable and relevant evidence without being challenged or scrutinized. The fourth part of the chapter presents possible cross-examination questions which the defence could ask to test the reliability of fingerprint evidence. This chapter concludes that the manner in which fingerprint evidence is accepted in South African courts, is not in accordance with the manner prescribed in the international reports discussed above. It further highlights that there is a need to improve the manner in which the experts testify, both in court and in reports, and the manner in which the proffered evidence is cross-examined. The chapter contends that ultimately the impulse for an overhaul of the way in which fingerprint evidence is dealt with in South African courts, will, inevitably be motivated by presiding officers who insist that fingerprint evidence be reliable and scientifically valid.

5 3 THE MAIN FINDINGS OF THIS INVESTIGATION

In this study it emerges that fingerprint evidence has become commonplace, both in criminal trials and in investigations and that it was used for more than a century without its reliability being tested or scrutinised.⁸⁹⁴ It further emerges that recently fingerprint evidence has been increasingly challenged in many jurisdictions, both regarding its validity concerning the premises of uniqueness and permanence and the reliability of the methodology and techniques applied to reach conclusions by fingerprint examiners.⁸⁹⁵ The public's faith in fingerprint evidence has become an important part of the reality of the way in which the system works, in spite of the challenges being raised against such evidence.⁸⁹⁶ As stated above, the number of challenges of fingerprint evidence increased after the NAS Report in 2009.⁸⁹⁷ The reports reviewed by this study were prepared and compiled in leading forensic jurisdictions.⁸⁹⁸ The issues raised in the said reports are relevant and

⁸⁹⁴ See Chapter 1 (part 11) above.

⁸⁹⁵ See generally Chapter 3 above.

⁸⁹⁶ Lord Thomas of Cwmgiedd (Lord Chief Justice of England and Wales) "Expert Evidence: The Future of Forensic Science in Criminal Trials" The 2014 Criminal Bar Association Lecture (14 October 2014) 7.

⁸⁹⁷ The reports were compiled in United States of America and Scotland. See generally Plumtree "A Perspective on the Appropriate Weight to be given to the National Academy of Sciences' Report on Forensics in Evidentiary Hearings: The Significance of Continued Court Acceptance of Fingerprint Evidence" 2013 *Southwestern Law Review* 607-608.

⁸⁹⁸ See Cole and Roberts "Certainty, Individualisation, and the Subjective Nature of Expert Fingerprint Evidence" 2012 *Criminal Law Review* 824-849. See also De Villiers "Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the last number of years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?" 2014

applicable to South Africa because South Africa does not exist in isolation and the presentation, production and treatment of fingerprint evidence in particular and forensic evidence in general, is no exception. The research points out that the dominant issues in these reports are rarely raised in trials and appeals in South Africa and consequently they do not feature prominently in the relevant literature. The main findings of the study are dealt with seriatim in the paragraphs below.

5 3 1 Uniqueness and permanence premises

The premises of uniqueness and permanence lie at the core of fingerprint evidence. It is argued in this dissertation that even if fingerprint supporters maintain that friction ridges are unique to such an extent that even identical twins are alleged not to have the same prints, no research has been done to validate such claims.⁸⁹⁹ As a result of a lack of research, the chance of two individuals sharing any given number of identifying characteristics is unknown. Furthermore it is pointed out above that uniqueness and permanence per se do not guarantee accuracy and the reliability of the results arrived at by fingerprint examiners.⁹⁰⁰ It is also emphasised above that even if the relevant literature talks about uniqueness, it however, does not provide a sufficient basis for assessing the rarity of any particular feature, or set of features, that might be found in a fingerprint.⁹⁰¹ An important finding of this study is that examiners may well be able to exclude one individual from others, but there is no scientific basis for estimating the number of people who could not be excluded and there are no scientific criteria for determining when the pool of possible sources is limited to a single person.⁹⁰²

5 3 2 Proficiency testing

Proficiency testing is done to test the ability of a technique, a methodology or an examiner to see whether what it claims to do, can in actual fact be done.⁹⁰³ It is stressed above that validation and performance studies give the proper framework to evaluate the abilities, capacity and levels of

<http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016). See also Edmond "What Lawyers Should Know about Forensic Sciences" 2015 *Adelaide Law Review* 33-100.

⁸⁹⁹ NAS Report 139.

⁹⁰⁰ *Ibid* 144. See also Cole "Forensics without Uniqueness, Conclusions without Individualization: The new Epistemology of Forensic Identification" 2009 *Law, Probability and Risk* 239. See also Haber and Haber *Challenges to Fingerprints* (2009) 20-22.

⁹⁰¹ The American Association for the Advancement of Science "Forensic Science Assessments: A Quality and Gap Analysis- Latent Fingerprint Examination" September 2017 20.

⁹⁰² *Ibid* 17-21.

⁹⁰³ *Daubert v Merrell Dow Pharmaceuticals* 509 U.S. 579 1993 593.

performance that can generate relevant information about procedures and performances.⁹⁰⁴ It is contended above that when it comes to fingerprint evidence, in most jurisdictions, there is no data to show how well the fingerprint comparison methodology and examiners perform and, in rare circumstances, where proficiency testing is done, to evaluate the validity and reliability of procedures or the proficiency of the examiner who apply them.⁹⁰⁵ In addition, the studies provide little insight into whether examiners showed performance superior to that of lay persons and whether their opinions were based on their training or expertise. Nevertheless, this does not mean that untested examiners possess no abilities, instead it is contended above that in the absence of this testing, it remains unknown how well examiners perform.⁹⁰⁶ In the case of South Africa, there is no data regarding the proficiency testing of fingerprint examiners to show how well they perform. Thus, it is argued that unacknowledged uncertainty is likely to lead to over-valuation of fingerprint evidence, thereby compromising the fairness of proceedings and threatening the burden and standard of proof.

5 3 3 Unknown or potential error rate

It is of paramount importance for fingerprint examiners to disclose the error rate when they testify in courts and present their conclusions in reports. However, this study found that when giving evidence, the examiners tend to state that when the fingerprint comparison methodology is followed properly and as prescribed, the error rate is zero.⁹⁰⁷ From this it follows that there is no clear indication of limitations, uncertainties or a statement addressing the potential for error.⁹⁰⁸ After the analysis of the reports, it is concluded above that a zero error rate is unlikely because whenever humans are involved errors could occur.⁹⁰⁹ This is so because the decision whether there is a match or not, depends on human judgment and not a computer.⁹¹⁰ In trying to justify this, the study refers to the plethora of laboratory based experiments that have been conducted backdating from 2006 to 2016.⁹¹¹ These experiments show that errors do occur. Hence it is recommended

⁹⁰⁴ Edmond *et al* “Model Forensic Science” 2016 *Australian Journal of Forensic Sciences* 13.

⁹⁰⁵ *Ibid* 14.

⁹⁰⁶ *Ibid* 13.

⁹⁰⁷ See Chapter 3 (part 3 3 3 and 3 5 2) above.

⁹⁰⁸ Edmond *et al* “Model Forensic Science” 2016 *Australian Journal of Forensic Sciences* 17. See also the NAS Report 139.

⁹⁰⁹ See Chapter 3 (part 3 5 3) above.

⁹¹⁰ NIST Report 124.

⁹¹¹ Dror and Charlton “Why Experts Make Errors” 2006 *Journal of Forensic Identification* 600-616; Langenburg *et al* “Testing for Potential Contextual Bias Effects During the Verification Stage of the ACE-V Methodology when

above that when testifying, fingerprint experts should not use absolute terms because they cannot qualify that with valid data.⁹¹²

5 3 4 A Lack objective standards

This study finds that the fingerprint comparison methodology lacks objective and definite protocols to guide them when making a comparison between the known and unknown print. To this end the PCAST Report notes that the ACE-V methodology is foundationally subjective, in that the whole process takes place in the mind of the examiner.⁹¹³ Even if fingerprint examiners follow this methodology, they do not necessarily reach the same conclusions.⁹¹⁴ It emerges above that the decision regarding what details to consider to reach a conclusion or what details suffice as a match, depends on the examiner.⁹¹⁵ A further finding of this study is that fingerprint examiners use a “point-counting” method that entails counting the number of similar ridge characteristics on the prints and some use the non-numeric method.⁹¹⁶ This investigation also notes that there is no standard requirement as to how many points of similarity are needed to declare a match, whether it is seven, nine, twelve, sixteen or thirty-two points. It is contended above that there is simply no agreement among fingerprint examiners as to how many points of resemblance suffice as a match, as it differs across jurisdictions, and from laboratory to laboratory.⁹¹⁷

5 3 5 The presentation of fingerprint evidence in courts and reports

When presenting evidence in courts and in reports, fingerprint experts tend to do so with 100% certainty. It was found that testifying or presenting evidence in absolute terms has a negative impact on the decision to be arrived at by the trier of facts as he or she may feel inclined to accept the evidence and place undue weight on such evidence.⁹¹⁸ Furthermore it is pointed out above that the defence may not see the reason to cross-examine the expert witness and this will result in the

Conducting Fingerprint Comparisons” 2009 *Journal of Forensic Science* 571; Dror *et al* “Cognitive Issues in Fingerprint Analysis: Inter-and Intra-Expert Consistency and the Effect of a ‘Target Comparison’” 2011 *Forensic Science International* 10-17. See also PCAST Report 101.

⁹¹² NAS Report 22, 142 and 186. See also NIST Report 94, 113 and 199. See also SFI Report 679-680 and 748.

⁹¹³ PCAST Report 9

⁹¹⁴ See NAS Report 142 and NIST Report 124.

⁹¹⁵ NAS Report 140.

⁹¹⁶ Evett and Williams “A Review of the Sixteen Point Fingerprint Standards in England and Wales” 1996 *Journal of Forensic Identification* 49. See also SFI Report 115 paragraphs 33.1- 33.2. See Meintjes-van der Walt “Fingerprint Evidence: Probing Myth and Reality” 2006 *South African Journal of Criminal Justice* 166.

⁹¹⁷ See Chapter 3 (part 3 3 3) above.

⁹¹⁸ Edmond “The ‘Science’ of Miscarriages of Justice” 2014 *University of New South Wales Law Journal* 382. See also Edmond “Expert Evidence in Reports and Courts” 2013 *Australian Journal of Forensic Sciences* 6-7.

evidence, in South Africa, being accepted as *prima facie*. This study finds that the challenge regarding adequate cross-examination, is not only faced in South Africa alone as, even in those jurisdictions regarded as forensically leading, this remains a challenge.⁹¹⁹ Generally this study finds that there is little explanation of how a conclusion is reached, whether there was disagreement between examiners, whether it was subjected to a meaningful review and what was involved, and there is almost never any reference to the risk of error in reports or oral testimony.⁹²⁰

This study contends that the manner in which fingerprint experts testify, makes it difficult for the evidence to be understood by lay persons and presiding officers are in this respect not necessarily in a better position than lay persons. It is further contended by this study that even though the evidence is considered to be reliable and is based on known techniques and grounded on empirical data, it cannot be assumed that lay people understand the evidence.⁹²¹ Fingerprint examiners should testify in terms that make it easy for the trier of facts to understand as he or she will have to make a decision on what weight to give to the evidence. This is so because adversarial trials are based on the assumption that presiding officers, the defence and prosecution can comprehend all the evidence and any limitations raised or not raised.⁹²² This study concludes that testifying to absolute certainty is wrong, because, at this stage, it is scientifically unachievable.⁹²³

5 3 6 Bias

This study finds that when following the fingerprint comparison methodology, even in jurisdictions where the ACE-V methodology is used, there are no rules and principles put in place to guard against bias.⁹²⁴ It is stated above that contextual and confirmation bias are prevalent in the fingerprint community.⁹²⁵ However, bias may not be intentional and may be caused by several factors. Thus, it is proposed above that fingerprint examiners should not be exposed to suggestive information, for instance the religion,⁹²⁶ previous convictions and/or background of the suspect as this may affect the decision of the examiner. Moreover, it is recommended above that, in order to

⁹¹⁹ Edmond “What Lawyers Should Know about Forensic Sciences” 2015 *Adelaide Law Review* 33-100.

⁹²⁰ See Chapter 3 (part 3 5 2) above.

⁹²¹ Edmond “Expert Evidence in Reports and Courts” 2013 *Australian Journal of Forensic Sciences* 5-7.

⁹²² *Ibid.*

⁹²³ NIST Report 72-73.

⁹²⁴ See NAS Report 139; PCAST Report 91; NIST Report 18-19; Mayfield Report 115.

⁹²⁵ See Chapter 4 (part 4 4 1) above.

⁹²⁶ Chapter 3 (part 3 2 4) above.

avoid confirmation bias, the verification of the initial fingerprint examiner must be done blindly by an independent examiner because, if the examiner who has to verify the results, is aware of the initial examiner's results, he or she may feel compelled to confirm such identification, as was done in the Mayfield case.⁹²⁷ A further finding is that a contributing factor to confirmation bias, is the fact that when the verifying examiner reaches a different conclusion to that of the initial examiner, it is considered as a conflict and the verifier, in most cases, is expected to agree with the initial examiner.⁹²⁸

5 3 7 Training, education and funding

For one to be a fingerprint expert, no formal education is required. Substantial training by senior fingerprint experts is sufficient to qualify an individual as a fingerprint expert.⁹²⁹ On the other hand, a fundamental finding of this research project is that most, if not all, lawyers lack basic knowledge of the underlying principles of fingerprint evidence, the limitations associated with the use of the techniques and fingerprint comparison methodology as well as the IAFIS search.⁹³⁰ This may be as a result of a lack of education on the said aspects. Yet, the ability to question fingerprint evidence, depends on the level of technical literacy of the trier of fact and the defence. As a consequence of this, it is contended above that in most cases fingerprint evidence is accepted without being adequately scrutinized because the lawyers lack the relevant knowledge to challenge fingerprint evidence. This is why this research project finds the issues raised in the five international forensic reports crucial to the legal world as they brought an insight regarding what courts and lawyers should do to test the reliability fingerprint evidence.

The study further finds that most of the fingerprint laboratories are funded by the state and are, furthermore, understaffed.⁹³¹ This investigation contends that there are challenges associated with relying on such laboratories as in most instances the fingerprint examiners work hand in hand with the investigators and prosecutors. These fingerprint experts are further called by the state prosecutor to give evidence so as to help the court to reach a conclusion. This study warns that the fingerprint expert may not necessarily give the evidence independently and impartially and this

⁹²⁷ Mayfield Report 13.

⁹²⁸ SFI Report 383-384, 513-514. See also Mayfield Report 1.

⁹²⁹ NAS Report 26-27 and 217.

⁹³⁰ *Ibid* 28, 34 and 234-237.

⁹³¹ *Ibid* 33 and 81.

contradicts the requirement that an expert witness must give evidence in a non-partisan manner⁹³² and should be an impartial witness whose role is to assist the court.⁹³³ This also suggests the possibility that a fingerprint expert might, occasionally, not work independently to reach a conclusion, which is why the NAS Report emphatically suggested that state owned laboratories must be admonished.⁹³⁴

5 3 8 IAFIS search

The study notes above that the United States IAFIS is designed to select candidates whose known prints most closely resemble the unknown print and it is used not only to find the source of the print, but also the closest possible non-matches.⁹³⁵ The IAFIS system was found not to be ideal when searching prints in which points have been encoded in two or more clusters separated by a gap.⁹³⁶ If the ridge count between two clusters of points in the latent print is unclear, the system is most likely to fail to find the correct origin of the print. For instance, Mayfield was connected to the Madrid bombing by IAFIS.⁹³⁷ It is furthermore, pointed out above that with IAFIS many searches may not result in identification because the known print of the suspect may not be in any of the databases. Thus, with IAFIS, even if a person is not a suspect but has similar prints to the latent print found on the crime scene, he or she is at risk of being arrested. The study notes that the IAFIS used in America is more or less the same as the AFIS (Automated Fingerprint Identification System) system used in South Africa. AFIS records fingerprints with the use of an optical scanner and stores them as digital images.⁹³⁸ When looking for possible suspects, a fingerprint examiner enters the latent prints into the system and the AFIS will search its archives and provide a list of candidate matches.⁹³⁹ The study further points out that the disadvantages associated with the use of IAFIS in America are equally applicable to the use of AFIS in South Africa.

⁹³² See Macfarlane “Convicting the Innocent: A Triple Failure of the Justice System” 2006 *Manitoba Law Journal* 440-441.

⁹³³ See *S v Gouws* 1967 4 SA 527 (EC) 528D.

⁹³⁴ NAS Report 81.

⁹³⁵ Mayfield Report 137.

⁹³⁶ *Ibid* 119.

⁹³⁷ *Ibid* 3 and 137.

⁹³⁸ Matlala *The Use of Automated Fingerprint Identification System to Improve the Quality of Service rendered by South African Police Service on the East Rand* (Magister Technologiae University of South Africa November 2012) 2.

⁹³⁹ *Ibid*.

5 3 9 Codes of ethics

The research recorded in this dissertation recognizes that there are comprehensive codes of ethics regarding fingerprint identification in existence. Nevertheless, there are no measures to enforce the said codes of ethics and it is not clear whether, and to what extent, adherence must be made a condition of employment.⁹⁴⁰ However, the reports contend that forensic service providers must adopt a code of ethics that require testifying in a nonpartisan manner, answering questions from both prosecution and defence lawyers directly, accurately, fully and provide appropriate scientific information before and after trial.⁹⁴¹

5 3 10 Admissibility and weight of fingerprint evidence in South African courts

This study finds that in South Africa where fingerprint evidence is admitted whenever it is deemed to be relevant, ironically trials are not normally conducted in a way to expose and convey issues associated with fingerprint evidence. However, in the recent case of *S v Van der Vyver*⁹⁴², the fingerprint evidence provided by the prosecution, was controversial and disputed by the defence.⁹⁴³ Many of the issues or criticisms identified in the reports reviewed by this study, have not been and are not exposed or credibly explored at trial nor adequately explained in judicial summaries. Defence counsel rarely challenges fingerprint evidence⁹⁴⁴ and consequently, untested fingerprint evidence is admitted as *prima facie* evidence and could be given undue weight. Hence it is suggested above that the fact that fingerprint evidence has been used in South African courts without being questioned and that no wrongful convictions have been exposed, is not an answer to substantial issues raised against fingerprint evidence on the international terrain. In the light of the above, this dissertation contends that there is a need for a reform in the manner in which fingerprint evidence is handled in South African courts.

⁹⁴⁰ NAS Report 26.

⁹⁴¹ NIST Report 200, Recommendation 6.2.

⁹⁴² *S v Van der Vyver* (SS 190/06) 2007 ZAWCHC 69 (29 November 2007).

⁹⁴³ Also see Bamford "Fingerprints Can Tell Lies- Forensic Experts" 2006 <https://www.iol.co.za/news/south-africa/fingerprints-can-tell-lies-forensic-experts-297550> (accessed 28-11-2017).

⁹⁴⁴ Edmond "The Science of Miscarriage of Justice" 2014 *UNSW Law Journal* 399.

5 4 RECOMMENDATIONS

5 4 1 Education

As is clear from the above discussion, there is no formal education required for one to become a fingerprint expert in South Africa. In most cases fingerprint experts are police officials who undergo training for six months and the training is conducted by senior fingerprint experts. This kind of training has been heavily criticised in the reports reviewed by this dissertation, in particular in the NAS Report, stating that apprenticeship cannot replace the need for a scientific basis of education and of the practice of forensic science.⁹⁴⁵ Moreover, a lack of formal education on the science of fingerprints, as discussed above, may result in erroneous identifications.⁹⁴⁶ In order to tackle this challenge, certification requirements for fingerprint experts must be based, at a minimum, on written examinations for a forensic science degree; supervised practice; proficiency testing; continuing education and rectification of procedures.⁹⁴⁷ Continuing education could help the fingerprint expert to be up to date with the changes and advances surrounding the field. Over and above, in order to establish quality assurance, no person public or private, should be allowed to practice as a fingerprint expert without certification.

This challenge is not only faced by fingerprint experts. Often lawyers also are not familiar with the basic knowledge of the underlying principles of fingerprint evidence. As a result of this they could fail to comprehend the terms used to present evidence in court by fingerprint experts and might not be familiar with the limitations and challenges associated with the techniques used to evaluate and compare latent print to known print.⁹⁴⁸ It is noted above that a lack of basic knowledge of the science of fingerprints evidence limits the defence in challenging the evidence in courts and consequently it is accepted as a relevant and reliable tool of identification.⁹⁴⁹ In addition to this, for lawyers to be familiar with the underlying principles of fingerprints and the techniques used, ideally the curriculum for a degree in law, should include forensic science modules and, in this regard, the forensic discipline of fingerprinting. For instance, in-depth information on how fingerprints are formed, types of fingerprints, classification of the prints, methods for collection,

⁹⁴⁵ NAS Report 26-27, 195-200 and 217.

⁹⁴⁶ Socka and Wright “Prints on Trial: Wrongful Convictions and the ‘Science’ of Fingerprints” 2014 <https://www.aidwyc.org/blogfingerprints/> (accessed 27-11-2017).

⁹⁴⁷ NAS Report 217.

⁹⁴⁸ Edmond “Expert Evidence in Reports and Courts” 2013 *Australian Journal of Forensic Sciences* 5.

⁹⁴⁹ Edmond “What Lawyers should know about Forensic Sciences” 2015 *Adelaide Law Review* 33-100.

the methodology used to analyse and compare the latent print to the known print, what detail is required to determine a match, how much detail suffices a match, limitations of the methodology and premises and techniques used by fingerprint experts, should be part of the formal training of a defence lawyer. The main reason for educating lawyers with regard to fingerprint evidence, for instance defence counsel, is to enable them to have knowledge on how fingerprints work and to make them aware of the limitations and challenges associated with the techniques applied by fingerprint experts so that they would ask questions during the cross-examination stage to test the reliability of such evidence. In turn, if the presiding officer is aware of these aspects, he or she will know what weight should be given to fingerprint evidence. It is problematic for presiding officers to accept, without questions, the incriminating opinions of a fingerprint examiner. Moreover, voluntary seminars should be arranged for practising lawyers and presiding officers in which they are educated with regard to fingerprint evidence as well as current issues in the field.

5 4 2 The establishment of an independent fingerprint institute

The discussion above reveals that the fingerprint bureau comprises of police officials or retired police officials who work hand in hand with prosecution and that they are only accessible to the prosecution. It is highlighted above that a lack of independence affects the manner in which the fingerprint expert presents evidence in reports and courts, in that he or she may present evidence in a manner that furthers the case of the prosecution. The NAS Report emphasises that there is a need to establish a NIFS institute which is independent, which must be accessible to the defence as well, and which will establish and promote a culture that is rooted in science.⁹⁵⁰ In South Africa, for the very same reasons which prompted this NAS Report recommendation, there is also a need for the creation and establishment of this kind of institution. It must be noted that this may take time and be financially costly, but, from a legal and justice perspective, it is worth having. Funding for such an institution may be requested from the Ministry of Justice, or, alternatively an application for the funding of the project could be made at an international level. The establishment of an independent fingerprint institution would assist the defence to call their own fingerprint expert to challenge the evidence given against them, not unlike the Legal Aid Board which assists accused persons who cannot afford private attorneys to defend themselves. When fingerprint evidence is challenged, it may help the triers of fact to be familiar with the limitations associated

⁹⁵⁰ NAS Report 19, Recommendation 1.

with the field and as a result undue weight would not be attached to such evidence. Moreover, if an independent institution is established, it could be a remedy to biased conclusions as a result of dependency between investigators and fingerprint experts.

5 4 3 Presentation of fingerprint evidence in reports and courts

It is pointed out above that when testifying in courts or presenting evidence in reports, fingerprint experts tend to do so with absolute certainty.⁹⁵¹ For example, a fingerprint examiner in South Africa usually states that after having analysed and compared the latent print to the known print, he or she is a hundred percent certain that the fingerprint belongs to the accused person to the exclusion of every individual in this world and that he or she has found a minimum of seven points of similarity. As noted in the above discussion, this is a challenge associated with fingerprint evidence because there is no research that has been done to prove that fingerprint experts can, with a hundred percent certainty, exclude every other individual.⁹⁵² To add to this, fingerprint experts, when testifying, often or normally do not disclose the limitations and challenges associated with the technique of fingerprinting.⁹⁵³ Testifying or presenting evidence with absolute certainty, has a negative impact on the trier of fact as well as the defence in that the defence may not see any reason to challenge the evidence and the triers of fact may feel inclined to accept the evidence and put more weight on it.⁹⁵⁴ This is so because the trier of fact is not put in a position where he or she is able to evaluate the said evidence rationally.⁹⁵⁵ Therefore, as proposed with regard to other jurisdictions, by the reports interrogated by this dissertation, there is equally a need to change the manner in which fingerprint evidence is presented in courts and reports in South Africa. Fingerprint experts should testify in probabilistic terms and not in absolute terms.

5 4 4 The need for blind verification by a second independent examiner

The discussion above notes that in South Africa, verification of results is not mandatory and mostly the same examiner who initially conducted the analysis and comparison, verifies the results by taking the fingerprints of the accused on the day of trial and perform the fingerprint comparison.

⁹⁵¹ Chapter 3 (part 3 5 2) above.

⁹⁵² See NAS Report 22 and NIST Report 197.

⁹⁵³ Edmond “The ‘Science’ of Miscarriages of Justice” 2014 *University of New South Wales Law Journal* 391. See also Edmond “Administering Justice: Expert Evidence and the Professional Responsibilities of Prosecutors” 2013 *University of New South Wales Law Journal* 921, 936-937.

⁹⁵⁴ Edmond “Expert Evidence in Reports and Courts” 2013 *Australian Journal of Forensic Sciences* 6-7.

⁹⁵⁵ *Ibid.*

In accordance with what is suggested in the reports discussed in this dissertation above, verification of results should be done blindly by a second independent examiner. This dissertation, therefore, recommends that in South Africa, after the initial examiner has reached a conclusion, a second independent examiner who is not aware of the conclusion, should verify the results. Blind verification by a second examiner would assist in detecting whether a mistake was made and would ensure more accuracy.

5 5 CONCLUDING REMARKS

Based on the preceding discussion, it can be argued that in South Africa fingerprint evidence generally enjoys unquestioned acceptance and that the challenges that are internationally being raised against such evidence are not yet adequately exposed in South African courts. South African case law referred to in this study, reveals how South African courts readily accept fingerprint evidence as long as the fingerprint examiner testifies that he or she found a minimum of seven points of similarity and such opinion is normally not challenged by the defence through cross-examination. Furthermore, South African courts fail to demand from the fingerprint experts, information with regard to the science, and in essence, the underlying assumptions behind the claim that a certain numerical number of ridge details are adequate to prove identity. Fingerprint experts cannot provide a reliable answer as to why it can be proclaimed that seven points of similarity are sufficient proof. South African judges attach a considerably high value to fingerprint examiners' testimony of seven points of similarity, even though legal systems around the world continue to adjust their standard as new information surfaces regarding fingerprint evidence.

It can further be argued that accepting fingerprint evidence because it is not challenged, is problematic and may result in wrongful convictions. The fact that challenges against fingerprint evidence and erroneous identifications are not routinely raised in South African courts, does not necessarily mean that fingerprint evidence is reliable at all times. This dissertation therefore concludes that the forensic community should be educated with regard to the underlying principles of fingerprint evidence, the limitations of the technique used and whether it has been validated, as well as with regard to knowing the error and potential error rate. The proposed process of re-education will, however, in South Africa, pose significant financial, logistical and even academic challenges. Despite these obvious obstacles, there can, reasonably and jurisprudentially, not be

any impediment to the forensic community in South Africa in general, and presiding officers in particular, taking heed of the strong warnings sounded by the reports discussed in this dissertation.

BIBLIOGRAPHY

Books

Beecher-Monas E *Evaluating Scientific Evidence: An Interdisciplinary Framework for Intellectual Due Process* (2007) Cambridge University Press: New York.

Burchell JM *Principles of Criminal Law* 4ed (2013) Juta: Claremont: South Africa.

Cole S *History of Fingerprints Pattern Recognition* (2004) Springer: New York.

Cole S *Suspect Identities: A History of a Fingerprinting and Criminal Identification* (2001) Harvard University Press: Cambridge.

Coppock CA *An Investigator's Basic Reference Guide to Fingerprint Identification Techniques* (2001) Charles C Thomas: University of California.

David S *Measurement of Fingerprint Individuality in Advances in Fingerprint Technology* (2001) CRC Press: Boca Raton.

Douglas PL *Forensic Science* (2012) American Bar Association: California.

Du Toit E, de Jager FJ, Paizes A, Skeen A St Q and Vander Merwe S *Commentary on the South African Criminal Procedure Act* (2010) Juta & Company Ltd: Cape Town: South Africa.

Faigman DL, Blumenthal J, Edward KC, Mnookin J, Murphy EE and Sanders J *Modern Scientific Evidence: The Law and Science of Expert Testimony* (2012-2013 ed) West/Thomson Publishing Co: California.

Faigman DL, Kaye DH, Saks MJ and Sanders J *Modern Scientific Evidence: The Law and Science of Expert Testimony* 2ed (2002) West/Thompson Publishing Co: California.

Giannelli PC, Campbell JM, Imwinkelried JE and Roth *Scientific Evidence* 5ed (2012) LexisNexis: Newark.

Haber L and Haber R *Challenges to Fingerprints: A Guidebook for Prosecution and Defense and Examiners* (2009) Lawyers and Judges Publishing Co: Tucson Arizona.

Hatchard J and Ndulo M *The Law of Evidence in Zambia: Cases and Materials* (1991) James Currey: Oxford: United Kingdom.

Henry CL and Gaensslen RE *Advances in Fingerprint Technology* 2ed (2001) CRC Press: New York.

Hoffman LH, Paizes A, Skeen A St Q, and Zeffertt DT *The South African Law of Evidence* (2003) LexisNexis/Butterworth: Durban: South Africa.

Horswell J *The Practice of Crime Scene Investigation* (2004) CRC Press: Boca Raton.

Jackson A and Jackson J *Forensic Science* 3ed (2011) Prentice Hall: Harlow England.

Kaye DH, Bernstein DE and Mnookin JL *The New Wigmore, A Treatise on Evidence: Expert Evidence* 2ed (2004), Aspen: New York.

Lynch M, Cole S, Jordan K and McNally R *Truth Machine: The Contentious History of DNA Fingerprinting* (2008) The University of Chicago Press Ltd: United States of America.

Meintjes-van der Walt L *Expert Evidence in the Criminal Justice Process: A Comparative Approach* (2001) Amsterdam: Rozenberg.

Nokes GD *An Introduction to Evidence* 4ed (1967) Sweet and Maxwell Ltd: London.

Pavese F and Forbes AB (eds) *Data Modelling for Metrology and Testing in Measurement Science* (2009) Birkhauser Boston: New York.

Redmayne M *Expert Evidence and Criminal Justice* (2001) Oxford University Press: United Kingdom.

Schwikkard PJ and Van der Merwe SE *Principles of Evidence* 4ed (2016) Juta & Company Ltd: Wetton, Cape Town: South Africa.

Snyman CR *Criminal Law* 5ed (2008) LexisNexis: South Africa.

Stoney D *Measurement of Fingerprint Individuality in Advances in Fingerprint Technology* (2001) Boca Raton: New York.

Tarantino JA *Strategic Use of Scientific Evidence* (1988) Kluwer Law Book: New York.

Book Chapters

Barnes JG “History” in Holder EH, Robinson LO and Laub JH *The Fingerprint Sourcebook* (2011) U.S. Department of Justice, Office of Justice Programs, National Institute of Justice: Washington DC.

Champod C and Chamberlain P “Fingerprints” in *Handbook of Forensic Science* (2009) Routledge: United Kingdom.

Haber L Haber R “Error Rates for Human Fingerprint Examiners” in Rath NK and Bolle RM *Automatic Fingerprint Recognition Systems* (2004) Springer-Verlag: New York.

Hutchins LA “Systems of Friction Ridge Classification” in Holder EH, Robinson LO and Laub JH *The Fingerprint Sourcebook* (2011) U.S. Department of Justice, Office of Justice Programs, National Institute of Justice: Washington DC.

Maceo AV “Anatomy and Physiology of Adult Friction Ridge Skin” in Holder EH, Robinson LO and Laub JH *The Fingerprint Sourcebook* (2011) U.S. Department of Justice, Office of Justice Programs, National Institute of Justice: Washington DC.

Thompson WC “Determining the Proper Evidentiary Basis for an Expert Opinion: What Do Experts Need to Know and When Do They Know Too Much?” in Robertson CT, Kesselheim AS (Eds.) *Blinding as a Solution to Bias: Strengthening Biomedical Science, Forensic Science, and Law* (2016) Academic Press: Amsterdam.

Vanderkolk JR “Examination Process” in Holder EH, Robinson LO and Laub JH *The Fingerprint Sourcebook* (2011) U.S. Department of Justice, Office of Justice Programs, National Institute of Justice: Washington DC.

Journal Articles

Acree M “*People v Jennings*: A Significant Case in American Fingerprint History” 1998 *Southern California Association of Fingerprint Officers* 1-2.

Benedict N “Fingerprints and the *Daubert* Standard for Admission of Scientific Evidence: Why Fingerprints Fail and a Proposed Remedy” 2004 *Arizona Law Review* 519-549.

Bureau International des Poids et Mesures “International Vocabulary of Metrology—Basic and General Concepts and Associated Terms” 2008 *Joint Committee for Guides in Metrology* 1-104.

Champod C “Fingerprint Identification: Advances since the 2009 National Research Council Report” 2015 *Philosophical Transactions of the Royal Society B: Biological Sciences* 1-10.

Cherry M and Imwinkelried E “How We Can Improve the Reliability of Fingerprint Identification” 2006 *Judicature* 1-5.

Cherry M, Edward I and Manfred S “Another ‘View’ of Fingerprint Evidence” 2011 *Judicature* 334-338.

Cole S “The Prevalence and Potential Causes of Wrongful Conviction by Fingerprint Evidence” 2006 *Golden Gate University Law Review* 39-41.

Cole S “Comment on Scientific Validation of Fingerprint Evidence under *Daubert*” 2008 *Law, Probability and Risk* 119-126.

Cole S “Fingerprint Identification and the Criminal Justice System: Historical Lessons for the DNA Debate” 2004 *Department of Criminology, Law and Society* 63-90.

Cole S “Forensic without Uniqueness, Conclusions without Individualization: The New Epistemology of Forensic Identification” 2009 *Law, Probability and Risk* 239-246.

Cole S “Grandfathering Evidence: Fingerprint Admissibility Rules from *Jennings* to *Llera Plaza* and Back Again” 2004 *American Criminal Law Review* 1189-1276.

Cole S “Individualization is Dead, Long Live Individualization! Reforms of Reporting Practices for Fingerprint Analysis in the United States” 2014 *Law, Probability and Risk* 117-150.

Cole S “Is Fingerprint Identification Valid? Rhetorics of Reliability in Fingerprint Proponents’ Discourse” 2006 *Law and Policy* 109-135.

Cole S “More than Zero: Accounting for Error in Latent Finger Print Identification” 2005 *Journal of Criminal Law & Criminology* 985-1078.

Cole S “Out of the *Daubert* and into the Fryeing Pan? Self-validation, Meta-Expertise and Admissibility of Latent Print Evidence in *Frye* Jurisdictions” 2008 *Minnesota Journal of Law, Science and Technology* 453-542.

Cole S “Prevalence and Potential Causes of Wrongful Conviction by Fingerprint Evidence” 2006 *Golden Gate University Law Review* 39-105.

Cole S “Who Speaks for Science? A Response to the National Academy of Sciences Report on Forensic Science” 2010 *Law, Probability and Risk* 25-46.

Cole S and Roberts P “Certainty, Individualization and the Subjective Nature of Expert Fingerprint Evidence” 2012 *Criminal Law Review* 824-842.

Cooley CM and Oberfield GS “Increasing Forensic Evidence’s Reliability and Minimising Wrongful Convictions: Applying *Daubert* Isn’t the only Problem” 2007 *Tulsa Law Review* 285-380.

Cooper SL “Challenges to Fingerprint Identification Evidence: Why Courts Need a New Approach to Finality” 2016 *Mitchell Hamline Law Review* 756-790.

Cooper SL “The Collision of Law and Science: American Court Responses to Developments in Forensic Science” 2013 *Pace Law Review* 234-301.

Dror I, Charlton D, and Peron AE “Contextual Information Renders Experts Vulnerable to Making Erroneous Identifications” 2006 156 *Forensic Science International* 74-78.

Dror IE and Charlton D “Why Experts make Errors” 2006 *Journal of Forensic Identification* 600-616.

Dror IE, Champod C, Langenburg G, Charlton D, Hunt H and Rosenthal R “Cognitive Issues in Fingerprint Analysis: Inter-and Intra-Expert Consistency and the Effect of a ‘Target Comparison’” 2011 *Forensic Science International* 10-17.

Edmond G “(Ad)ministering Justice: Expert Evidence and the Professional Responsibilities of Prosecutors” 2013 *University of New South Wales Law Journal* 921-953.

Edmond G “Expert Evidence in Reports and Courts” 2013 *Australian Journal of Forensic Sciences* 1-15.

Edmond G “Forensic Science Evidence and the Conditions for Rational Jury Evaluation” 2015 *Melbourne University Law Review* 77-127.

Edmond G “The ‘Science’ of Miscarriages of Justice” 2014 *University of New South Wales Law Journal* 376-406.

Edmond G “What Lawyers should know about Forensic Sciences” 2015 *Adelaide Law Review* 33-100.

Edmond G and Mehera SR “The Cool Crucible: Forensic Science and the Frailty of the Criminal Trial” 2012 *Current Issues in Criminal Justice* 51-68.

Edmond G, Thompson MB and Tangen JM “A Guide to Interpreting Forensic Testimony: Scientific Approaches to Fingerprint Evidence” 2014 *Law, Probability and Risk* 1-25.

Edmond G, Kristy M, Kemp R, Hamer D, Hibbert B, Ligertwood A, Porter G, Roque MS, Searston R, Tangen J, Thompson M and White D “How to Cross-examine Forensic Scientists: A Guide for Lawyers” 2014 *Australian Bar Review* 174-197.

Edmond G, Tangen JM, Searston RA and Dror IE “Contextual Bias and Cross-Contamination in the Forensic sciences: The Corrosive Implications for Investigations, Plea Bargains, Trials and Appeals” 2015 *Law, Probability and Risk* 1-25.

Epstein R “Fingerprints meet *Daubert*: The Myth of Fingerprint ‘Science’ is Revealed” 2002 *California Law Review* 605-658.

Evetts IW and Williams RL “Review of the 16 point Fingerprint Standard in England and Wales” 1996 *Forensic Science International* 49-73.

Fraser-Mackenzie PAF, Dror IE, and Wertheim K “Cognitive and Contextual Influences in determination of Latent Fingerprint Suitability for Identification Judgments” 2013 *Science and Justice* 144-153.

Gabel JD “Realizing Reliability in Forensic Science from the Ground Up” 2014 *Journal of Criminal Law and Criminology* 283-352.

Garrett BL “Judging Innocence” 2008 *Columbia Law Review* 1-58.

Garrett BL and Mitchell G “Lay Interpretation of Fingerprint Examiner Testimony: The Relative Importance of Match Language, Method Information and Error Acknowledgement” 2013 *Journal of Empirical Legal Studies* 484-511.

Garrett BL and Neufeld PJ “Invalid Forensic Science Testimony and Wrongful Convictions” 2009 *Virginia Law Review* 1-97.

Gertner JN “National Academy of Sciences Report: A Challenge to the Courts” 2012 *Criminal Justice* 8-11.

Giannelli PC “Daubert Challenges to Fingerprints” 2006 *Criminal Law Bulletin* 624-642.

Giannelli PC “Scientific Evidence in Criminal Prosecutions - A Retrospective” 2010 *Brooklyn Law Review* 1137-1152.

Giannelli PC “The 2009 NAS Forensic Science Report: A Literature Review” 2012 *Criminal Law Bulletin* 378-393.

Groscup JL, Penrod SD, Studebaker CA, Huss MT, O’Neil KM “The Effects of *Daubert* on the Admissibility of Expert Testimony in State and Federal Criminal Cases” 2002 *Psychology, Public Policy, and Law* 339–372.

Haber L and Haber R “Scientific Validation of Fingerprint Evidence under *Daubert*” 2008 *Law, Probability and Risk* 87-109.

Ireland J and Beaumont J “Admitting Scientific Expert Evidence in the United Kingdom: Reliability Challenges and the Need for Revised Criteria - Proposing an Abridged *Daubert*” 2015 *Journal of Forensic Practice* 3-12.

Kassim SM, Dror IE, and Kakucka J “The Forensic Confirmation Bias: Problems, Perspectives, and Proposed Solutions” 2013 *Journal of Applied Research in Memory and Cognition* 42-52.

Kaushal N and Kaushal P “Human Identification and Fingerprints: A Review” 2011 *Journal of Biometrics & Biostatistics* 1-5.

Kaye D “Beyond Uniqueness: The Birthday Paradox, Source Attribution and Individualization in Forensic Science Testimony” 2010 *Law, Probability and Risk* 3-11.

Kaye D “Probability, Individualization, and Uniqueness in Forensic Science Evidence” 2013 *Brooklyn Law Review* 1163-1185.

Koehler J and Saks M “Individualization Claims in Forensic Science: Still Unwarranted” 2010 *Brooklyn Law Review* 1187-1208.

Langenburg G “A Performance Study of the ACE-V Process: A Pilot Study to Measure the Accuracy, Precision, Reproducibility, Repeatability, and Biasability of Conclusions Resulting from the ACE-V Process” 2009 *Journal of Forensic Identification* 219–257.

Langenburg G, Champod C, and Wertheim K “Testing for Potential Contextual Bias Effects during Verification Stage of ACE-V Methodology when Conducting Fingerprint Comparisons” 2009 *Journal of Forensic Science* 571-582.

Lawson FT “Can Finger Prints Lie? Re-weighing Fingerprint Evidence in Criminal Jury Trials” 2003 *American Journal of Criminal Law* 1-66.

Lyttle AJ “Return of Repressed: Coping with Post Conviction Innocence Claims in Wyoming” 2014 *Wyoming Law Review* 555-632.

Macfarlane B “Convicting the Innocent: A Triple Failure of the Justice System” 2006 *Manitoba Law Journal* 400-485.

Macfarlane B “Wrongful Convictions: The Effect of Tunnel Vision and Predisposing Circumstances in Criminal Justice System” 2005 *Manitoba Law Journal* 1-89.

Mcmurtrie J “Swirls and Whorls: Litigating Post-Conviction Claims of Fingerprint Misidentification after the NAS Report” 2010 *Utah Law Review* 267-297.

McMurtrie J “The Role of the Social Sciences in Preventing Wrongful Convictions” 2005 *American Criminal Law Review* 1271-1287.

Meintjes-van der Walt L “Fingerprint Evidence: Probing Myth and Reality” 2006 *South African Law Journal of Criminal Justice* 152-172.

Meintjes-van der Walt L “Science Friction: The Nature of Expert Evidence in General and Scientific Evidence in Particular” 2000 *South African Law Journal* 771-790.

Meintjes-van der Walt L “The Paradoxes and Dilemmas of Expert Evidence in the Criminal Justice Process” 2000 *Acta Criminologica* 58-63.

Meintjes-van der Walt L “The Proof of the Pudding: The Presentation and Proof of Expert Evidence in South Africa” 2003 *Journal of African Law* 88-106.

Mnookin J “Fingerprint Evidence in an Age of DNA Profiling” 2001 *Brooklyn Law Review* 13-71.

Mnookin J “The Validity of Latent Identification: Confessions of a Fingerprinting Moderate” 2008 *Law, Probability and Risk* 127-141.

Mnookin JL “Fingerprinting Evidence in an Age of DNA Profiling” 2001 *Brooklyn Law Review* 13-71.

Mnookin JL “Scripting Expertise: The History of Handwriting Identification Evidence and the Judicial Construction of Reliability” 2001 *Virginia Law Review* 101-226.

Mnookin JL “The Courts, the NAS and The Future of Forensic Science” 2010 *Brooklyn Law Review* 1209-1275.

Moenssens AA “Fingerprint Identification: A Valid, Reliable ‘Forensic Science’?” 2003 *Criminal Justice* 30-33.

Munia J “Overcoming *Daubert*’s Shortcomings in Criminal Trials: Making the Error Rate the Primary Factor in *Daubert*’s Validity Inquiry” 2010 *New York University Law Review* 2034-2064.

Neumann C “Fingerprints at the Crime Scene: Statistically Certain, or Probable?” 2012 *Significance* 21-25.

O'Brien E, Daeid NN and Black S "Science in the Court: Pitfalls, Challenges and Solutions" 2015 *Philosophical Transactions of the Royal Society B: Biological Sciences* 1-7.

Page M, Taylor J and Blenkin M "Uniqueness in the Forensic Identification Sciences: Fact or Fiction" 2011 *Forensic Science International* 12-18.

Pardo MS "Theory and NAS Report on Forensic Science" 2010 *Utah Law Review* 367-383.

Pipoly GM "*Daubert* Rises: The (Re)applicability of the *Daubert* Factors to the Scope of Forensics Testimony" 2012 *Minnesota Law Review* 1581-1605.

Plumtree WG "A Perspective on the Appropriate Weight to be given to the National Academy of Sciences' Report on Forensic Evidentiary Hearings: The Significance of Continued Court Acceptance of Fingerprint Evidence" 2013 *Southwestern Law Review* 605-660.

Reese EJ "Techniques for Mitigating Cognitive Biases in Fingerprint Identification" 2012 *UCLA Law Review* 1252-1290.

Reznicek M, Ruth RM and Schilens DM "ACE-V and Scientific Method" 2010 *Journal of Forensic Identification* 87-103.

Saks MJ "Merlin and Solomon: Lessons from the Law's Formative Encounters with Forensic Identification Science" 1998 *Hastings Law Journal* 1069-1141.

Saks MJ and Koehler J "The Coming Paradigm Shift in Forensic Identification Science" 2005 *Science* 892-895.

Saks MJ and Koehler JJ "The Individualization Fallacy in Forensic Science Evidence" 2008 *Vanderbilt Law Review* 199-219.

Saks MJ, Risinger DM, Thompson WC and Rosenthal R "Context Effects in Forensic Science: a Review and Application of the Science to Crime Laboratory Practice in the United States" 2003 *Science and Justice* 77-90.

Sangero B and Halpert M "Why a Conviction should not be based on a Single Piece of Evidence: A Proposal for Reform" 2007 *Jurimetrics* 43-94.

Schweitzer NJ and Saks MJ "The CSI Effect: Popular Fiction about Forensic Science Affects the Public's Expectations about Real Forensic Science" 2007 *Jurimetrics* 357-364.

Sombat JM “Latent Justice: *Daubert’s* Impact on the Evaluation of Fingerprint Identification Testimony” 2002 70 *Fordham Law Review* 2819-2868.

Steinman JE “Appellate Courts as First Responders: The Constitutionality and Propriety of Appellate Courts’ Resolving Issues in the First Instance” 2012 *Notre Dame Law Review* 1521-1620.

Stevens PG and Lubaale EC “ Revisiting the Historical Context of Surrounding the Development of the Ultimate-Issue Rule to Inform its Future in South African Law of Evidence” 2016 *Fundamina* 94-117.

Swofford HJ “Individualization using Friction Ridge Skin Impressions: Scientific Reliable, Legally Valid” 2012 *Journal of Forensic Identification* 62-79.

Tangen JM, Thompson MB and McCarthy DJ “Identifying Fingerprint Expertise” 2011 *Psychological Science* 995-997.

Thompson MB, Tangen JM and McCarthy DJ “Expertise in Fingerprint Identification” 2012 *Journal of Forensic Science* 1-5.

Thornton JI “One-Dissimilarity Doctrine in Fingerprint Identification” 1977 *International Criminal Police Review* 89-95.

Triplett M and Cooney L “The Etiology of ACE-V and Its Proper Use: An Exploration of the Relationship between ACE-V and Scientific Method of Hypothesis Testing” 2006 *Journal of Forensic Identification* 345-356.

Ulery BT, Hicklin RA, Buscaglia, J and Roberts MA “Accuracy and Reliability of Forensic Latent Fingerprint Decisions” 2011 *Proceedings of the National Academy of Sciences* 7733-7738.

Welch CH “Flexible Standards, Deferential Review: *Daubert’s* Legacy of Confusion” 2006 *Harvard Journal of Law & Public Policy* 1085-1105.

Wertheim K and Maceo A “The Critical Stage of Friction Ridge and Pattern Formation” 2002 *Journal of Forensic Identification* 35-85.

Zabell S “Fingerprint Evidence” 2005 *Journal of Law and Policy* 143-179.

Legislation:

South Africa

Civil Proceedings Evidence Act 25 of 1965.

Criminal Procedure Act 51 of 1977.

Law of Evidence Amendment Act 45 of 1988.

Case Law:

Canada

R v Mohan 1994 114 DLR 4th 419.

England and Wales

R v T 2010 All ER D 240 (Oct); 2010 EWCA Crim 2439.

R v Turner 1975 2 QB 834.

United States of America

Commonwealth v Gambora 933 N.E.2d50 2010.

Daubert v Merrell Dow Pharmaceuticals 509 U.S. 579 1993.

Frye v United States 293 F. 1013 D.C. Cir. 1923.

Kumho Tire Co. v Carmichael 526 US 137, 138 1999.

Mayfield v US No. 07-35805 D.C.NO. CV-04-01427-AA.

People v Jennings 252 Ill. 534.96 N.E 1077 1911.

State v Sheehan 273 P.3d 417 430 Utah Ct. App. 2012

United States v Aman 748 F.Supp.2d E.D.Va.2010.

United States v Cerna No. CR 08-0730 WHA12; 2010 U.S. Dist. LEXIS 144424 23 N.D. Cal. Sept. 1, 2010.

United States v Gutierrez-Castro 805F.Supp.2d1218 D.N.M 2011.

United States v Harvard 529 U.S. 598 2000.

United States v Havvard 117 F (SD Ind.) 2001.

United States v Herrera No. 13-1527 10th Cir. 2015.

United States v Llera Plaza 181 F. Supp.2d414 (ED Pa) 2002.

United States v Love No.10cr2418-MMM 2011.

United States v Mitchell 145 F.3d 572 (3d Cir. 1998) 2004.

United States v Mitchell 199 F. Supp. 2d 262 E.D. Penn. 2002.

United States v Mitchell 97-7541 526 U.S. 314 1999.

United States v Monteiro United 407 F. Supp. 2d 351 (D. Mass. 2006).

United States v Rose 672 F. Supp. 2d 723 D.Md.2009.

United States v Strayhorn 743 F.3d 917 923 4th 2014.

United States v McCluskey United States District Court, Tenth Circuit, Case 1:10CR02734-JCH 2013.

US v Anderson 2009 CF1 20672 (3 September 2010).

Scotland

HM Advocate v Mckie 1999 (Unreported).

South Africa

Genturico AG v Fireston SA (Pty) Ltd 1972 1 SA 589 (A).

Godi v S [2011] ZAWCHC 247.

Holtzhauzen v Roodt 1997 4 SA 766 (W).

Lekgau v S (A191/15) 2016 ZAGPPHC 281 (9 March 2016).

Makhubu v S (A475/2011) 2012 ZAGPJHC 89 (10 May 2012).

Mathembula v RAF 2006 ZAGPHC 261.

Nduna v S (076/2010) 2010 ZASCA 120; 2011 1 SACR 115 (SCA); 2011 2 All SA 177 (SCA) (30 September 2010).

Ngaye v S (A567/10) 2010 ZAWCHC 341 (3 December 2010).

Nicholson v RAF (07/11453) 2012 ZAGPJHC 137.

Potgieter v Minister of Police (80233/2014) 2017 ZAGPPHC 172 (20 April 2017).

President of the Republic of South Africa v South African Rugby Football Union 1999 ZAAC 11; 2000 1 SA (CC).

R v C 1949 2 SA 438 (SR).

R v Smit 1952 3 SA 447 (A).

S v Blom 1992 1 SACR 649 (E).

S v Calitz 1990 1 SACR 119 (A).

S v Congola 2002 2 SACR 383 (T)

S v Engelbrecht 2005 2 SACR 41 (W).

S v Fourie 1973 1 SA 100 (D).

S v Gokool 1965 3 SA 461 (N).

S v Gouws 1967 4 SA527 (EC).

S v Gumede 1982 4 SA 561.

S v Harris 1965 2 SA 340 (A).

S v Kanyile 1984 3 SA 756 (N).

S v Kimimbi 1963 3 SA 250 (C).

S v Laubscher 1988 1 SA 163 (A).

S v Legote 2001 2 SACR 179 (SCA).

S v Lesch 1983 1 SA 814 (EPD).

S v Malindi 1983 4 SA 99 (T).

S v Nala 1965 4 SA 360 (A).

S v Ndlovu 2002 2 SACR 325 (SCA).

S v Nyate 1988 2 SA 211 (O).

S v Nzimande 2003 1 SACR 280 (O).

S v September 1996 1 SACR 325 (A).

S v The State [2011] ZASCA 214.

S v Van der Vyver (SS 190/06) 2007 ZAWCHC 69 (29 November 2007).

S v Van Wyk 1982 2 SA 148 (NC).

S v Zibi 2012 JDR 0376 (ECM).

Schneider v AA 2010 5 SA 203 (WCC).

Seyisi v The State (117/12) 2012 ZASCA 144 (28 September 2012).

Small v Smith 1954 3 SA 434 (SWA).

Reports:

United States of America

Committee on Identifying the Needs of the Forensic Science Community, National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* National Academies Press (2009).

Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods Report by President's Council of Advisors on Science and Technology (2016).

Office of the Inspector General, United States Department of Justice *A Review of the FBI's Handling of the Brandon Mayfield case* Oversight and Review Division (2006).

The American Association for the Advancement of Science, Forensic Science Assessments: A *Quality and Gap Analysis- Latent Fingerprint Examination* (2017).

US Department of Commerce, National Institute of Standards and Technology *Expert Working Group on Human Factors in Latent Print Analysis, Latent Print Examination and Human Factors: Improving the Practice through a Systems Approach* (2012).

Scotland

Campbell *The Fingerprint Inquiry Report* APS Group Scotland (2011).

Internet sources and newspaper articles

A Review of the FBI's Handling of the Brandon Mayfield Case
<http://www.justice.gov/oig/special/s0601/exec.pdf> (accessed 15-09-2016).

Admitting doubt: A New Standard for Scientific Evidence 2010 *Harvard Law Review* 2021-2042
https://harvardlawreview.org/wp-content/uploads/pdfs/vol123_admitting_doubt.pdf (accessed 28-10-2017).

Antonio M “History of Fingerprints” 2012 <http://www.slideshare.net/wllanos/history-of-fingerprints> (accessed 23-08-2016).

Are Innocent People Ever Convicted Based on Fingerprint Evidence? 2009
<https://whereismydata.wordpress.com/.../are-innocent-ever-convicted-based-on-fingerprint-evidence/> (accessed 27-11-2017).

Arpin T “Faulty Fingerprints” <http://www.bu.edu/sjmag/scimag2005/opinion/fingerprints.htm>
(accessed on 03-05-2016).

ASCLD/LAB-International “Supplemental Requirements for Accreditation of Forensic Testing Laboratories” 2011 http://des.wa.gov/SiteCollectionDocuments/About/1063/RFP/Add7_Item4ASCLD.pdf (accessed 25/04/2017).

Ashbaugh DR “Ridgeology: Modern Evaluative Friction Ridge Identification” 1999
<http://onin.com/fp/ridgeology.pdf> (accessed 30-08-2016).

Bamford H “Fingerprints Can Tell Lies- Forensic Experts” 2006
<https://www.iol.co.za/news/south-africa/fingerprints-can-tell-lies-forensic-experts-297550>
(accessed 28-11-2017).

Burthorn DL and Reitnauer AR “ACE-V: Latent Print Examiners Scientific Method” 2014
https://az-forensics.com/docs/pdfs/ACE-V_for_Latent_Print_Examiners.pdf (accessed 28-08-2016).

Champod C. and Chamberlain P “Fingerprints” in *Handbook of Forensic Science* (2009)
<https://www.routledgehandbooks.com/doi/10.4324/9781843927327.ch3> (accessed 02-09-2016).

Chisum JW and Brent T “Evidence Dynamics: Locard’s Exchange Principle & Crime Reconstruction” 2000 *Journal of Behavioral Profiling*
http://www.profiling.org/journal/vol1_no1/jbp_ed_january2000_1-1.html (accessed 28-05-2016).

Cole S “Fingerprint Identification and the Criminal Justice System: Historical Lessons for the DNA Debate” 5 www.ksg.harvard.edu (accessed 01-04-2016).

Coppock C “Fingerprint Individualization/ Fingerprint Identification” 2012 <http://fingerprintindividualization.blogspot.co.za/2012/06/universal-definition-of-ace-v-updated.html> (accessed on 28-03-2016).

Cothron G “Fingerprint evidence Part 1: Tracing Friction Ridges through History” <http://ssrn.com/abstract=2130808> (accessed 27-08-2016).

Cothron GR “Using the National Academy of Science Report ‘Strengthening Forensic Science in the United States: A Path Forward as a Criminal Defense Tool in Florida’” <http://ssrn.com/abstract=1906715> (accessed on 25-08-2017).

Crime Scene Investigation Network “Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods” 2016 <http://www.crime-scene-investigator.net/forensic-science-in-criminal-courts-ensuring-scientific-validity-of-feature-comparison-methods.html> (accessed 12-04-2017).

Crime Scene Investigator Network “The Science of Fingerprints: Classification and Uses” 1984 <http://www.crime-scene-investigator.net/fbiscienceoffingerprints.html> 2016 (accessed 27-03-16).

Dass SC “Classification of fingerprints” Department of statistics and probability https://www.cse.msu.edu/~cse802/Papers/802_FPClassification.pdf (accessed 28-08-2016).

De Villiers PW “Fingerprint Comparison Evidence has been under Sustained Attack in the United States of America for the last number of years: Is the Critique with regard to Reliability Sufficiently penetrating to Warrant the Exclusion of this Valuable Evidence?” 2014 <http://repository.up.ac.za/handle/2263/39611> (accessed 25-05-2016).

Dinzeo M “Skepticism of Forensic Methods Urged at 9th Circuit Conference” 18 July 2017 <https://www.courthousenews.com/skepticism-forensic-methods-urged-9th-circuit-conference/> (accessed on 27-10-2017).

Edmond G, Cole S, Cunliffe E, and Roberts A “Admissibility Compared: The Reception of Incriminating Expert Opinion (i.e. forensic science) Evidence in Four Adversarial Jurisdictions” <http://www.law.du.edu/documents/criminal-law-review/issues/v03-1/Admissibility-Compared.pdf> (accessed on 24-04-2016).

Edwards HT “Solving the Problems that Plaque the Forensic Science Community: Keynote Address at Conference on Forensic Science for the 21st Century: the NAS Report and Beyond” 2009
Arizona State University

<http://lst.law.asu.edu/FS09/pdfs/H.T.%20Edwards,%20Solving%20the%20Problems%20That20Plague%20Forensic%20Science.pdf> (accessed on 12-03-2017).

Eric HH, Laurie OR, and John HL *The Fingerprint Sourcebook* National Institute of Justice (2011) <https://www.ncjrs.gov/pdffiles1/nij/225320.pdf> (accessed 24-08-2016).

Fascinating Ancient History of Fingerprints (March 2016) <http://www.messageoagle.com/fascinating-ancient-history-of-fingerprints> (accessed 23-08-2016).

Fingerprint Expert's Mistake Leads to Wrongful Conviction in Indiana <https://californiainnocenceproject.org/2012/10/fingerprint-experts-mistake-leads-to-wrongful-conviction-in-indiana/> (accessed 27-11-2017).

Fingerprint Guide <http://flash.lakeheadu.ca/~lubiote/Fingerprints%20Comparison%20Guide.pdf> (Accessed 26-09-2016).

Friedman J “Model Cross-Examination: Fingerprint Examiner” 2011 [http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_\(FINGERPRINT_EXAMINER\).pdf](http://www.mtacd.org/attachments/CPE/Nelson/CROSSEXAMINATION_(FINGERPRINT_EXAMINER).pdf) (accessed on 09-01-2018).

Fuentes GA “Toward a More Critical Application of *Daubert* in Criminal Cases: Fingerprint Opinion Testimony after the National Academy of Sciences Report” 2012 *Bloomberg BNA Expert Evidence Report* <https://jenner.com/system/assets/publications/11214/original/Fuentes112.pdf> (accessed 28-10-2017).

Graham F “Fingerprints and Expert Identification Evidence: Markers of Unreliability” 2014 <http://docplayer.net/56711302-Fingerprints-and-expert-identification-evidence.html> (accessed 03-12-2017).

Griesel A “Fingerprint Analysis in Forensic Investigations: An Interesting History” 2014 <http://www.csinvestigate.co.za/fingerprint-analysis-in-forensic-investigation-an-interesting-history/> (accessed 23-08-2016).

Hunt JW “Admissibility of Expert Testimony in State Courts” 2010 <http://www.fitzhunt.com/sites/default/files/news/Admissibility%20of%20Expert%20Testimony%20in%20State%20Courts-Hunt.pdf> (accessed on 04-05-2016).

Hutchin LA “Systems of Friction Ridge Classification” in National Institute of Justice: *The Fingerprint Sourcebook* (2011) <http://www.nij.gov/pubs-sum/225320.htm> (accessed on 23-08-2016).

International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM 3ed) JCGM (2012) https://www.bipm.org/utls/common/documents/jcgm/JCGM_200_2012.pdf ((accessed 25-10-2017).

Jain AK, Jianjiang F and Karthik N “Fingerprint Matching” 2010 http://biometrics.cse.msu.edu/Publications/Fingerprint/JainFpMatching_IEEEComp10.pdf (accessed 28-08-2016).

Jones J “Forensic Tools” <http://www.pbs.org/wgbh/frontline/article/forensic-tools-whats-reliable-and-what’s-not-so-scientific/> (accessed on 04-05-2016).

Jones J “Friction Ridges Make a Lasting Impression” 2006 <http://www.forensicmag.com/article/2006/10/friction-ridges-make-lasting-impression> (accessed 28-08-2016).

Jones J “The ACE-V Methodology-Reliable or Accurate” 2014 http://auburnhillscriminallawyer.com/wp-content/uploads/2014/05/Fingerprints.Forensic.Paper_.pdf (accessed 23-06-2016).

Koehler J “Forensics or *Fauxrensics*? Ascertaining Accuracy in the Forensic Sciences” 2016 http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2773255 (accessed 25-04-2017).

Lennard C “The Detection and Enhancement of Latent Fingerprints” 2001 <http://latent-prints.com/images/specialpresentation.pdf> (accessed 28-08-2016).

Live Science Staff “The Real Crime: 1,000 Errors in Fingerprint Matching Every Year” 2005 <http://www.livescience.com › Strange News> (accessed 27-11-2017).

Lord Thomas of Cwmgiedd (Lord Chief Justice of England and Wales) “Expert Evidence: The Future of Forensic Science in Criminal Trials”; The 2014 Criminal Bar Association Lecture (14 October 2014) <https://www.judiciary.gov.uk/wp-content/uploads/2014/10/kalisher-lecture-expert-evidence-oct-14.pdf> (accessed 23-03-2016) 1-14.

Maceo AV “Anatomy and Physiology of Adult Friction Ridge Skin” 2002 <http://www.nij.gov/pubs-sum/225320.htm> (accessed 28-08-2016).

Magruder J “NAS Report to be Force of Change in Forensic Field” ASU News 9 February 2009 <http://www.asunews> (accessed 24-11-2016).

McNaughton JS “What is Good Science?” 1999 <http://www.jstor.org/stable/40923911> (accessed 28-03-2016).

McShane JJ “The Problems with the Modern Practice of Forensic Firearm and Tool Mark Analysis” 2014 <http://www.thetruthaboutforensicscience.com/problems-modern-practice-forensic-firearm-toolmark-analysis/> (accessed 12-04-2017).

Mnookin LJ “Fingerprints: Not a Good Standard” 2003 *Issues in Science and Technology* issues.org/20-1/mnookin/ (accessed 24-08-2016).

National Institute of Justice “Forensic Friction Ridge (Fingerprint) Examination Validation Studies” 2000 <http://www.ncjrs.org/txtfiles1/nij/sl000386.txt> (accessed 17-09-2017).

National Physical Laboratory “A Beginner’s Guide to Measurement.” 2010 <http://npl.co.uk/upload/pdf/NPL-Beginners-Guide-to-Measurement.pdf> (accessed 07-05-2017).

Organization of Scientific Area Committees “Study to Assess the Accuracy and Reliability of Firearm and Tool mark” 2015 http://www.nist.gov/forensics/osac/upload/FATM-Research-Needs-Assessment_Blackbox.pdf (accessed 11-07-2017).

Pacheco I, Cerchiai B and S Stoiloff S “Miami-Dade Research Study for the Reliability of the ACE-V Process: Accuracy & Precision in Latent Fingerprint Examinations” 2014 www.ncjrs.gov/pdffiles1/nij/grants/248534.pdf (accessed 17-09-2017).

Peterson PE, Dreyfus CB, Gische MR, Hollars M, Roberts MA, Soltis GL, Webster HM and Ruth RM “Latent prints: A perspective on the state of science” 2009 *Forensic Science Community* <https://archives.fbi.gov/archives/about-us/lab/forensic-science-communications/fsc/oct2009/review> (accessed on 28-08-2016).

Puddington A and Roylance T “Freedom in the World 2017” https://freedomhouse.org/sites/default/files/FH_FIW_2017_Report_Final.pdf (accessed on 23-05-17).

Rea S “Fingerprints Lack Scientific Basis for Legal Certainty” 2017 <https://phys.org/news/2017-10-fingerprints-lack-scientific-basis-legal.html#nRlv> (accessed 28-10-2017).

Red-Leaf <http://red-leaf.co.za/facilitators/bierman-ja-mr/> (accessed 01-11-2017).

Richmond S “Do Fingerprint Ridges and Characteristics within Ridges Change with Pressure?” 2004 <http://www.latent-prints.com/images/changes%20with%20pressure.pdf> (accessed 27-08-2016).

Roman J, Walsh K, Lachman P and Yahner J “Post-Conviction DNA Testing and Wrongful Conviction” 2012 Justice Police Center <http://www.urban.org/sites/default/files/alfresco/publication-pdfs/412589-Post-Conviction-DNA-Testing-and-Wrongful-Conviction.PDF> (accessed 25-05-2016).

Rouse M “*Minutae*” <http://searchsecurity.techtarget.com/definition/minutiae> (accessed on 26-06-2016).

Rudin N and Inman KEP “Fingerprints in Prints, the Sequel” CAC News 2005 www.cacnews.org (accessed on 23 -10-2016).

Rule 702 of the Federal Rules of Evidence available at <http://www.uscourts.gov/sites/default/files/Rules%20of%20Evidence> (accessed on 20-10-2017).
Saks JM and Koehler JJ “The Coming Paradigm Shift in Forensic Identification Science” 2005 <http://ssrn.com/abstract=962968> (accessed 23-07-2016).

Scientific Working Group Friction Ridge Analysis Science and Technology “Fingerprint Examination Methodology for Latent Fingerprint Examination” 2002 www.swgfast.org (accessed 23-08-2016).

Scientific Working Group Friction Ridge Analysis Science and Technology “Guidelines for Latent Print Proficiency Testing Program in Forensic Identification” 2004 www.swgfast.org (accessed 23-08-2016).

Scientific Working Group Friction Ridge Analysis Science and Technology “Standards for Conclusion: Quality Assurance Guidelines for Latent Print Examiners” 2006 www.swgfast.org (accessed 23-08-2016).

Simplified Guide to Fingerprint Analysis <http://www.forensicsciencesimplified.org/prints/Fingerprints.pdf> (accessed 27-03-2016).

Socka P and Wright A “Prints on Trial: Wrongful Convictions and the ‘Science’ of Fingerprints” 2014 <https://www.aidwyc.org/blogfingerprints/> (accessed 27-11-2017).

South African History Online: Towards the People's History 2011 <http://www.sahistory.org.za/organisations/south-african-police-sap> (accessed 24-08-2016).
Stephanie W “History of fingerprinting: How fingerprint works” <http://science.howstuffworks.com/fingerprinting3.htm> (accessed 23-03-2016).

Strutin K “Report – President’s Council of Advisors on Science and Technology Casts Doubt on Criminal Forensics” 2017 http://llrx.com/2017/03/report-presidents-council-of-advisors-on-science-and-technology-casts-doubt-on-criminal-forensics/#_ftn3 (accessed 15-04-2017).

The Fingerprint Enquiry: Submissions on behalf of Shirley Mckie, Iain Mckie and David Asbury 2009 www.shirley.com/documents/FINALREVISEDVERSION (accessed on 27-03-2016).

The Forensic Outreach Team “From Egypt to Babylon and beyond: uncovering Ancient Fingerprints” <http://forensicoutreach.com/library/from-egypt-to-babylon-and-beyond-uncovering-ancient-fingerprints/> (Accessed 20-08-2016).

The Law Commission “Expert Evidence in Criminal Proceedings in England and Wales” 2011 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/229043/0829.pdf (accessed 26-06-2016).

Triplett M “The Invincible Fingerprint: Understanding The Basics, Defeating The Myths” NYSBA Criminal Justice Section Fall Meeting. 25 October 2013 <http://www.fprints.nwlean.net/2013%20THE%20INVINCIBLE%20FINGERPRINT,%20UNDERSTANDING%20THE%20BASICS,%20DEFEATING%20THE%20MYTHS.pdf> (accessed 28-10-2017).

Ulery BT, Buscaglia J, Hicklin RA and Roberts MA “Accuracy and Reliability of Forensic Latent Fingerprint Decisions” 2011 *Proceedings of the National Academy of Sciences* 7733-7738 www.pnas.org/cgi/doi/10.1073/pnas.1018707108 (accessed 02-09-2016).

Vanderkolk JR “Examination Process” in Holder et al *The Fingerprint Sourcebook* (2011) <https://www.ncjrs.gov/pdffiles1/nij/225320.pdf> (accessed 24-08-2016).

Verburg Attorneys “Seven-point Standard followed by South African Courts regarding Fingerprint Evidence” 2015 <http://verburg.co.za/seven-point-standard-followed-by-south-african-courts-regarding-fingerprint-evidence/> (accessed 27-06-2016).

Wertheim K “Embryology and Morphology of Friction Ridge Skin” in Holder et al *Fingerprint Sourcebook* (2011) <https://www.ncjrs.gov/pdffiles1/nij/225320.pdf> (accessed 24-08-2016).

White M “Cross-Examination of Friction Ridge Experts” Gideon Fellow 2014-2015
<https://www.maricopa.gov/DocumentCenter/View/2455> (accessed on 29-11-2017).

William L “What are the Effects of the *Daubert* Decision on Fingerprint Identification?” 2005
<http://www.fingerprintidentification.net/sitebuildercontent/sitebuilderfiles/researchpaperondaubert1.pdf> (accessed 27-06-2016).

Theses

Dumani M *Aspects of Expert Evidence in the Criminal Justice System* (Magister Legum Thesis Nelson Mandela Metropolitan University May 2005).

Faurie A *Admissibility and Evaluation of Scientific Evidence in Court* (LLM-Thesis, University of South Africa, 2000).

Krishnamoorthy RP *Fingerprint Recognition for Forensic Applications* (LLD Thesis Universidad Autonoma de Madrid May 2015).

Matlala MM *The Use of Automated Fingerprint Identification System to Improve the Quality of Service rendered by South African Police Service on the East Rand* (Magister Technologiae University of South Africa November 2012).

Senbeta HB *An Evaluation of the Techniques used to Collect Latent Prints from Documents: A Case Study of Addis Ababa* (Magister Technologiae University of South Africa October 2010).

Stevens PG *The Role of Forensic Expert Evidence in Support of the Defence of Criminal Incapacity* (Doctor Legum Thesis University of Pretoria February 2011).

