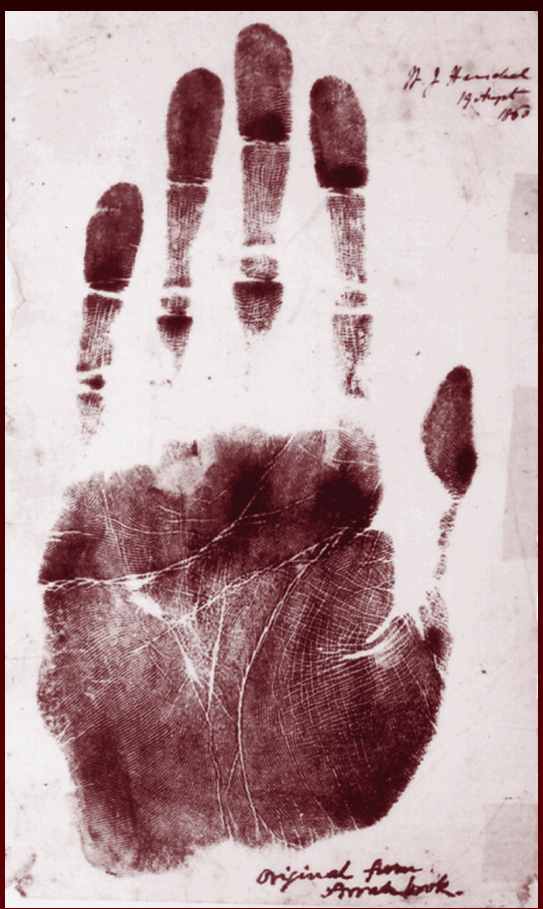
QUANTITATIVE-QUALITATIVE FRICTION RIDGE ANALYSIS

An Introduction to Basic and Advanced Ridgeology



David R. Ashbaugh

Quantitative-Qualitative Friction Ridge Analysis: An Introduction to Basic and Advanced Ridgeology

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CRC Press
Boca Raton New York

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6000 Broken Sound Parkway NW, Suite 300
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Version Date: 20150828

International Standard Book Number-13: 978-1-4200-4881-0 (eBook - PDF)

This book is dedicated
to my wife
Linda Anne

About the Author

David R. Ashbaugh, a Staff Sergeant in the Royal Canadian Mounted Police, is the Detachment Commander in Hope, British Columbia, Canada. He is also the Director of Ridgeology Consulting Services, a company that specializes in friction ridge identification training for accredited police organizations, and sits on the Fellowship Board of the Canadian Identification Society, the Editorial Board of the Journal of Forensic Identification, and the Forensic Identification Standards Committee for the International Association for Identification.

Staff Sergeant Ashbaugh has been a sworn police officer for 32 years and has served the last 24 years as a Certified Forensic Identification Specialist. He is a Life Member of the Michigan-Ontario Identification Association, a Life Member of the Canadian Identification Society, a Distinguished Member of the International Association for Identification, a Fellow of the Fingerprint Society of the United Kingdom, a member of the Forensic Science Society of the United Kingdom, and a member of the Pacific Northwest Division of the International Association for Identification. He has presented expert evidence at various levels of court in the provinces of Ontario, Manitoba, and British Columbia in Canada, and in the U.S.

During the last 21 years, Staff Sergeant Ashbaugh has carried out extensive research into the scientific basis and methodology of the friction ridge identification discipline. In 1982 he coined the term "Ridgeology" to describe a modern evaluative friction ridge identification process based in science. He has published several papers on the subject, and has lectured extensively in North America, South America, and the U.K. His Ridgeology philosophy and methodology are taught at the Canadian Police College, the Ontario Police College, and other training facilities around the world. He is frequently called upon as a lecturer and as a consultant on friction ridge identification cases or training needs in both the national and international arenas.

Staff Sergeant Ashbaugh played a key role in bringing about changes to the Canadian Identification of Criminals Act. He has contributed to the Scientific Working Group on Friction Ridge Analysis, Study, and Technology chaired by the Federal Bureau of Investigation in the U.S.; the Province of British Columbia Criminal Justice Branch Database on Ridgeology; and the Training Branch of the Province of Alberta Attorney General's Office. He is a consultant to the Royal Canadian Mounted Police on Ridgeology, and is an ad hoc national and international consultant for friction ridge identification training and for operational cases. In 1999 Staff Sergeant Ashbaugh was a key witness for the U.S. Government during a Daubert Hearing when the friction ridge identification science was challenged in U.S. Federal Court in Philadelphia, Pennsylvania. He also played an active role in the Training the Trainers Program for the Association of Chiefs of Police Officers of the United Kingdom at New Scotland Yard in London, and the National Training Center for Scientific Support to Crime Investigation in Durham.

Acknowledgments

During the last 20 years there have been so many forensic identification specialists who have shared the vision of friction ridge identification evolving into a modern forensic science that I cannot list them all here. Those who have worked with me on the bench, forwarded problem prints, or have given a few words of encouragement will know inside who they are, that I often think of them, and that I am grateful for their assistance. Many are referenced in this book.

There are key people who have gone beyond the call of duty to assist and at times tolerate. My wife Linda is at the top of the list followed by my daughters Lisa and Rebecca. Without their support I would have given up on ridgeology years ago. David and Rhoda Grieve of Illinois have edited my scratchings for the *Journal of Forensic Identification* and have become dear friends. David, a world-ranking expert in his own right, has unselfishly given moral and technical support as needed during occasional dark periods over the years. Pat Wertheim of Forensic Identification Training Seminars in Oregon, a colleague, expert, friend, and dedicated instructor, has frequently shared his perspective on the science and is diligently working to pass on to others what he has learned.

Several organizations have contributed to the contents of this book directly or indirectly: Tulane Medical Center, Department of Anatomy, Tulane University, New Orleans, Louisiana; The Canadian Identification Society; The International Association for Identification; The Fingerprint Society; The Forensic Science Society; The Federal Bureau of Investigation; and especially the Royal Canadian Mounted Police, an organization I have served for the last 24 years of my 32-year police career. To all of these people and organizations, "Thank you."

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Preface

The unique patterns of friction ridges may have been used as a method of personal identification for hundreds or even thousands of years. The true origin of friction ridge identification is shrouded in the history of the Orient and we may never learn exactly when the science began. In the West the science is now over 100 years old. It is therefore rather surprising to note that as an identification science it has matured more during the last 25 years than at any other time since its inception.

In 1973 the gradual evolution of the science surged dramatically into the future. That year, the identification community in North America embraced a new standard for friction ridge identification. The out-of-date static threshold identification ideology was unanimously rejected and replaced with a floating threshold philosophy where the worth of friction ridge formations is evaluated by an expert.

During the first few years this new philosophy caused some confusion. The relevance of the change in doctrine was not fully understood. Few could describe how the process was actually used during friction ridge comparison, other than the fact that there was no longer a specific minimum number of ridge characteristics required for individualization. As a result of this obvious lack of insight, the evaluative philosophy was likely adopted and readily accepted as a solution to an old and ambiguous question — How many points are enough? — rather than modernizing the friction ridge identification science in preparation for the future.

That position is supported by the literature of the day. Friction ridge identification journals do not contain sufficient investigation or scientific discussion on the topic to have justified such a major doctrine change. Had the discipline evolved naturally to the point where an identification could be based on a quantitative-qualitative analysis of friction ridge formations, the various identification and scientific journals would have reflected this. There would have been supporting articles and discussion papers published for several years prior to the evaluative process being accepted and used. Notwithstanding the absence of a practical protocol, from that time forward friction ridge identification was based on a quantitative-qualitative analysis of friction ridge formations. While the change in doctrine was in the

best interests of the friction ridge identification science, it placed a great deal of responsibility on the shoulders of those who practice within the science.

For example, the responsibility of ensuring that one has adequate knowledge of friction skin formation and is aware of how that relates to the premises of friction ridge identification was left to the individual expert. Also left to the individual were developing an understanding of how the friction skin leaves latent or visible prints on substrates and the various distortions which may take place during that deposition, gaining an awareness of the current philosophy and methodology used to individualize friction ridge prints, and being cognizant of the morals and obligations demanded of those who pursue forensic science as a career.

Those issues are addressed in this book. My hope is that this information will assist you with fulfilling those responsibilities, and that it will play a role in your ability to pursue a career in the friction ridge identification science, a career based on knowledge, understanding, and integrity where you can master your craft with confidence and self-assurance.

Introduction

I

The First Step toward Quantitative-Qualitative Analysis

Everyone the world over carries out the identification process mentally in exactly the same way. The ability to identify is a natural process inherent to the human brain. This process corresponds to the way in which we see and identify objects every day of our lives. Any identification process must mirror as closely as possible the brain's natural approach to this task. Such a process would be truthful and would accurately reflect what actually takes place during comparison and individualization. Philosophies that stray from this natural identification process will continually develop procedural flaws. The farther the doctrine is away from the natural process, the more difficult it will be to explain and defend, and the greater the opportunity to develop procedural flaws.

While the ability to identify is inherent, an understanding of the process and the ability to describe it is not. This has resulted in a hodgepodge of doctrine that is far removed from the truth. Generally, these doctrines require a certain leap of faith and many of the rules have no supporting rationale. Over the years, as flaws developed, new arbitrary doctrines were enacted to patch the defects. Eventually, hyperbole without substance exists and one must either modernize or put one's head in the sand. A few years ago a giant step was taken toward modernization of the friction ridge identification science.

During 1973, this major change in friction ridge identification doctrine took place in North America. After a three-year study by a committee formed by the International Association for Identification, referred to as the "Standardization Committee," the following statement was officially endorsed and readily adopted by all North American friction ridge identification specialists:

> The International Association for Identification assembled in its 58th annual conference in Jackson, Wyoming, this first day of August, 1973, based upon a three-year study by its Standardization Committee, hereby states that no valid basis exists at this time for requiring that a predetermined minimum

> of friction ridge characteristics must be present in two impressions in order to establish positive identification. The foregoing reference to friction ridge characteristics applies equally to fingerprints, palmprints, toeprints, and soleprints of the human body.

This new philosophy immediately replaced the old static threshold process, or number of points philosophy. The number of points philosophy had been in use since the inception of the science just over 100 years ago. With this new doctrine, an opinion of identification could now be based on a varying number of points. A point or ridge characteristic is a location on a friction ridge path where something dramatic takes place. The ridge path may bifurcate, stop, start, or two ridge characteristics may combine to create another distinct formation. At the time, the change in doctrine appeared to be only a minor adjustment in identification philosophy but the consequences were far-reaching. In the beginning this new doctrine was not fully understood, leading to uncertainty and greater confusion as opposed to a solution.

Adding to the confusion, the original number of points philosophy was also not fully understood. Prior to the Standardization Committee an identification was based on a specific minimum number of ridge characteristics. In North America this threshold was set somewhere around the 10 or 12 characteristic marks. Originally, this number was arrived at through what can best be described as an educated conjecture, based on past observations, as to when there was thought to be enough detail in agreement to feel safe that an error could not be made.

While the threshold philosophy was thought to have been simplistic, that was not the case. There was more taking place during the comparison and counting of ridge characteristics than realized. For example, during a comparison based on a specific threshold, each ridge characteristic is compared as to its type and spatial location. These attributes were knowingly compared and counted by the examiner in an effort to meet the predetermined threshold. At the same time, however, the brain was observing and comparing the smaller intrinsic shapes found within the ridge characteristic configuration. The identification specialist was usually unaware of that aspect of the comparison. Further, as the surrounding ridge configuration was assessed as to its spatial interrelationship to the recognized ridge characteristics present, the brain also assessed the intrinsic shapes found on those neighboring ridges.

In past years this involuntary comparison of smaller ridge configuration was not recognized as part of the identification process. Most identification specialists believed that friction ridge identification was based on an agreement of ridge characteristic type and location only. There was little, if any, understanding of the value and interrelationship between intrinsic friction ridge details and ridge characteristics during comparison, but it is these small

intrinsic shapes that permit us to differentiate between similar ridge characteristics of the same type, an issue that must be understood before evaluative friction ridge identification can be adopted.

Another factor added to the uncertainty. During most discussions of the identification process, many early authors referred to ridge characteristics as *points* or *points of comparison*. The use of the word *point* tended to remove the fact that there was a configuration or shape to the ridge characteristic being discussed. A ridge characteristic may at times be a single point of comparison, such as a bifurcation in a very poor quality print. There are also instances when one ridge characteristic has several points of comparison within its configuration. Such a case may arise when a ridge characteristic is in a very clear print and is found to have an unusual configuration. As the clarity of a print increases, the opportunity for the smaller details on the ridges to be visible also increases. These small details add complexity to the ridge characteristic configuration and are additional points of comparison the brain considers. Therefore, the clarity of the friction ridge print usually dictates the complexity of ridge formations available for comparison and their value or weight toward individualization.

Comprehending the interrelationship between clarity and the presence of small friction ridge details is another key aspect of quantitative-qualitative friction ridge analysis. Without a basic understanding of the clarity factor, a large void would be created in one's ability to understand and explain this new philosophy. This lack of understanding was reflected in the identification literature and pedagogy of the day. Most efforts to describe or defend the evaluative identification process were more an exercise in reciting rhetoric and dogma as opposed to describing a scientific process. Specific facts and logical interpretation were conspicuous by their absence.

On occasion, the failure to understand the relationship between clarity and intrinsic friction ridge details presented a dilemma that most experienced identification specialists will recognize. This dilemma can best be described with the phrase, "I know it is an identification, but I don't have enough points to take it to court." In hindsight it is not difficult to understand how this situation frequently arose. Considering our current understanding of clarity and the brain's role during comparison, the phrase should read, "My brain tells me it is an identification, but I do not have sufficient knowledge of how friction skin forms or an in-depth understanding of the identification process, therefore I cannot defend that opinion." In the years leading up to the Standardization Committee, many forensic identification specialists struggled with friction ridge comparisons involving prints of this nature. They knew in their own minds they were identifications, but the unknown print had so few ridge characteristics they were uncomfortable with taking the identification to court. Possibly the continual reoccurrence of this situation

was another mitigating factor that smoothed the transition to the new identification philosophy without serious debate.

A fundamental circumstance that helped the new identification process gain acceptance was the fact that few identification specialists were challenged in court. Legal counsel shied away from dwelling on a science that was considered exact and infallible, a belief that was difficult to dispel without adequate and structured literature being available. Most challenges were haphazard at best, usually ill-prepared, and often confusing. The majority were doomed to fail. Each failure further entrenched the infallibility of the science.

It is difficult to comprehend that a complete scientific review of friction ridge identification has not taken place at some time during the last 100 years. A situation seems to have developed where this science grew by default. This is especially alarming in light of the magnitude of change contained in the new identification philosophy put forward in 1973. Had challenges periodically surfaced, not only of the new process but the whole basis of friction ridge identification, they would have benefited all. Challenges should be welcomed within a science as an opportunity to present the founding premises and demonstrate the strength of current methodologies. Challenges lead to open debate, published articles, and a platform of discussion from which all can learn.

In the past the friction ridge identification science has been akin to a divine following. Challenges were considered heresy and challengers frequently were accused of chipping at the foundation of the science unnecessarily. This cultish demeanor was fostered by a general deficiency of scientific knowledge, understanding, and self-confidence within the ranks of identification specialists. A pervading fear developed in which any negative aspect voiced that did not support the concept of an exact and infallible science could lead to its destruction and the destruction of the credibility of those supporting it.

The failure of the identification community to challenge or hold meaningful debate can also be partly attributed to the fact that the friction ridge identification science has been basically under the control of the police community rather than the scientific community. In the eyes of many police administrators, friction ridge identification is a tool for solving crime, a technical function, as opposed to a forensic science.

Friction ridge identification had become commonplace within the police universe. It was a weapon to be used as needed, similar to other gadgets attached to an officer's Sam Browne belt, used as required and then stored away awaiting the next call. While this approach was appropriate when addressing the role of a scenes of crime officer, it was not acceptable for governing the behavior of those engaged in a scientific role. Friction ridge identification is a forensic science. As such, those who carry out comparisons

are in need of adequate training, continual maintenance, and structured practice.

Many police agencies completely overlook the fact that there are actually two separate roles with separate training needs involved in the duties of most identification specialists. One role is the scenes of crime officer fulfilling the police function of collecting evidence. The second is that of a forensic scientist comparing the evidence. The expert in the forensic scientist role must also have an in-depth knowledge of scenes of crime procedures and development methodology to carry out accurate analysis on friction ridge prints. The failure to recognize this need can produce a general passive attitude within the police community toward meeting the needs required to fulfill the scientific mandate. The most blatant example is the movement of personnel into identification services for very short tours of duty as fingerprint *experts*. As with other sciences, it takes considerable training and years of practice to become an expert.

This attitude has been reinforced by the friction ridge identification science itself. The role of the scenes of crime officer is continually emphasized in literature. Over the last few years most advancements that have taken place within the science are related to how friction ridge prints are developed, stored, or searched by computers. As a result, most available funding is allotted to furthering those developments. Little, if anything, has been reported on the importance and need for scientific knowledge, understanding the evaluative identification process, or the training necessary to be able to analyze, compare, and evaluate friction ridge prints. Apparently, it is assumed that anyone has the ability to compare friction ridge prints and form an unbiased opinion of individualization.

The duality of the identification specialist role can put experts in a rather awkward position. They are, in effect, serving two masters with, at times, differing agendas. The scenes of crime officer performs technical duties that are consistent with the police environment. Once a physical task is mastered it can be efficiently repeated. Basic training may last a few weeks. However, the identification specialist fulfills a role consistent with other forensic sciences. There is a need to remain abreast of current knowledge by reading various identification journals, and possibly by playing an active role in an identification association. While an identification technician may possibly be trained in months, training a friction ridge identification expert may take years.

Few police organizations have developed an infrastructure or have implemented the processes necessary to ensure their experts receive adequate scientific training. There is also a need for some form of national certification process as well as periodic quality review. Such a review should include

performance testing, blind case testing, and a vehicle to disperse pertinent research material. Employers should be mandated to encourage active participation in identification and scientific associations and support that position with some manner of funding. Most of these considerations are a prerequisite in other forensic disciplines. Friction ridge identification is the most positive method of personal identification. It is also the most cost effective of the police forensic sciences. Unfortunately, it has been basically ignored or overshadowed by the scenes of crime function.

It is only during the last few years that some training institutions have begun to consider how to incorporate the basic rudiments of friction ridge quantitative-qualitative analysis into their courses of study. It has been more than 20 years since the Standardization Committee published its report. It is becoming more apparent as time passes that the friction ridge identification science is more vulnerable now than at any time in its history. It may be said that an old science is finally maturing, but while the movement is forward, the effort appears rudderless.

Due to current social trends and the financial challenges faced by all areas of law enforcement, it is important to be effective and focused with any changes made in the training and management of personnel. However, today citizens are demanding rightful process or they seek civil redress. It is becoming incumbent on the administrators of justice to ensure all those who purport to be forensic experts are truly experts. It is unfortunate that these issues are surfacing at a time when budget restraint is the norm in our society. One can only speculate that future costs, for continued non-action may far outweigh current savings.

The friction ridge identification science was recently challenged in the United Kingdom. During 1980 the Home Office commissioned a study of the then current 16-point fingerprint identification standard. Dr. Ray Williams, a forensic scientist, and Ian Evett, a statistician, were tasked to conduct the review. A working group was formed and various forensic identification specialists from several countries were interviewed and requested to carry out a few comparisons and report on their findings. An unflattering report entitled, "A Review of the Sixteen Points Fingerprint Standard in England and Wales," was presented to the Chief Constables Council in 1989 but was not accepted. The authors of the report recognized there was a need to modernize the identification process in the United Kingdom by developing a clear and structured identification doctrine, as well as ensuring that adequate training was made available and that there was some form of quality review.

In 1994 the 16-point standard was again reviewed by Deputy Chief Constable Reynolds of the Thames Valley Police. The recommendation from that review was similar to the first, that the police forces in England and Wales drop the static threshold identification philosophy and adopt a process

based on quantitative-qualitative friction ridge analysis. The Chief Constables Council endorsed that recommendation and set a target date of April 3, 2000 for the change.

Challenges to the friction ridge identification science in North America have been informal, infrequent, and usually very subtle. The absence of a jurisdictional mandate within the science has permitted either easy deflection or dismissal of any concern as the musings of overly cautious lawyers or scientists. The challenges in the U.K. were officially sanctioned by the Home Office and cannot be dismissed. The challenge in the U.K. was the greatest provocation to the science since its inception at the turn of the century. Another court challenge, the Daubert hearing in the U.S. federal court in Philadelphia, PA, will continue to unfold over the next few years. The future will harbor many similar challenges.

While the review of the 16-point identification standard report was originally completed in 1989, it was not released until June, 1995 during a meeting in Israel. As a result of its release and the subsequent dialogue, the original International Association for Identification Standardization Committee resolution was reaffirmed with a slight variation.

The friction ridge identification specialists attending the international symposium on fingerprint detection and identification in Ne'urim, Israel held from June 26 through June 30, 1995, agreed upon the following resolution: "No scientific basis exists for requiring that a predetermined minimum number of friction ridge features must be present in two impressions in order to establish positive identification."

This resolution was unanimously approved and later signed by 28 identification specialists from Australia, Canada, France, Hungary, Israel, the Netherlands, New Zealand, Sweden, Switzerland, United Kingdom, and the United States. Unfortunately, the views expressed in many cases were the opinions of the scientists and forensic specialists present and were not binding or intended to represent their individual agencies or governments.

There is little doubt that there is a need for the forensic scientific community to become more involved with scrutinizing the scientific rationale behind friction ridge identification protocol and training. The release of the Home Office report at the Ne'urim symposium may be that first important step toward global agreement on friction ridge identification philosophy, methodology, professional standards, training, and quality control.

The Ridgeology Revolution

The years following the Standardization Committee report were somewhat confusing to those working within the friction ridge identification science.

Independently there were several individuals in North America carrying out research in an effort to identify the scientific basis of the new evaluative identification process and to understand its protocol. For some the research was for no reason other than to clarify the process in their own minds. Some researchers published their findings in forensic and identification journals while others did not. A few authors who presented their material at various identification conferences were at times met with some degree of suspicion from their peers.

During this time the friction ridge identification science continued to evolve slowly in other countries. The debate taking place in the U. K. is an example of healthy evolution. In North America, however, the sudden change in identification philosophy was like jumping out of an airplane to solve a weight problem; shortly after solving the weight problem a second problem surfaced involving a safe landing. The act of suddenly removing the static number of points required to form the opinion of identification, without thought of what process was to take its place, meant that immediate research, ideologies, philosophies, and methodologies had to be developed in a very short time to meet the growing need. This rapid progression is more akin to a revolution than normal evolution.

The term *ridgeology* was coined by the author in an article published in 1983. The rationale was that a new word would draw rapid attention to new ideas, new ideas that involved a more scientific approach required to meet the needs of the floating threshold protocol laid out by the Standardization Committee. While most *-ology* words tend to drop the *e*, here the *e* was intentionally left in place to attract more attention and initiate debate. While the word *ridgeology* was originally an attention-getting device it was also intended to focus on the fact that this information was based on empirical study and related scientific research. It was also meant to underscore that this new evaluative identification process was not business as usual. Over the years ridgeology has gained acceptance as a word describing a friction ridge identification process based on a quantitative-qualitative analysis as opposed to the old static threshed method.

Ridgeology can be defined as "The study of the uniqueness of friction ridge structures and their use for personal identification." Today, evaluative friction ridge identification or ridgeology has a strong scientific basis. The scientific knowledge supporting ridgeology has been extracted from various related sciences such as embryology, genetics, and anatomy. A clear identification process has also been developed consisting of a philosophy and methodology of identification.

The first part of this book reviews the history of friction ridge identification. The balance addresses the scientific basis and the various steps of the

identification process. While discussing the scientific basis, the formation of friction skin is covered in some detail. That knowledge is required to understand the premises of friction ridge identification and how various ridge formations are applied and evaluated during the identification process.

The identification of manufactured and biological media is also discussed and related to friction ridge formations. A clear philosophy of friction ridge identification is established and the issue of probability identifications is briefly discussed. The methodology of friction ridge identification is broken down into segments and each segment is addressed. That is followed by the historical and practical aspects of *poroscopy* and *edgeoscopy*. A chapter is devoted to a new branch of forensic science, *Palmar Flexion Crease Identification*. The original paper on the subject was published in 1990 by the author. Since that time several important cases have been solved using palmar flexion crease identification. A method of preparing a written report of a friction ridge analysis, comparison, and evaluation is presented, and an example is included.

The level of knowledge required to function as a forensic identification specialist today is far greater than only a few years ago. This book will lay out the basic information one must understand and the various processes one must use. It cannot, however, supply the balance of the formula required to be an expert — *experience*, which can only be gained through years of practice. The number of years of practice required to make an expert depends on one's ability. It should be remembered that practice only counts as experience when it is carried out from a position of knowledge, and gaining knowledge is the purpose of this book.