Second Edition

Huber and Headrick's

HANDWRITING IDENTIFICATION

Facts and Fundamentals

Heidi H. Harralson • Larry S. Miller

CRC Press
Taylor & Francis Group

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To a notable researcher, forensic pioneer,
esteemed colleague, and friend …

Dr. Bryan Found
1962–2016

Contents

Preface

In 1999, Tom Headrick wrote in his Foreword to *Handwriting Identification: Facts and Fundamentals* "may I be so presumptuous as to describe this contribution as the Foreword to the First Edition of a progeny that will be followed by many succeeding and constantly improving revisions." This is probably the wish of any author of an academic textbook who knows that their scientific field is constantly shifting and evolving. Unfortunately, Roy Huber and Tom Headrick did not revise their seminal work—a work that has been extensively relied upon by the scientific document examination community for nearly 20 years. No other book has surpassed Huber and Headrick's text with its thorough and investigative assessment of handwriting identification. This book was published during a transitional time period in the scientific development of handwriting identification, which saw a critical review and assessment of the field and resulted in court rulings that placed limits on the "science" of handwriting identification. Even as working professional document examiners, Huber and Headrick were nonetheless courageous in their efforts to investigate and question the science behind handwriting identification principles.

Some of the changes in this new edition include some practical revisions. As we incorporated new material and revised Huber and Headrick's text, we realized that we could not maintain their first person stance as it would inevitably cause the reader to wonder who the "we" referred to and would be potentially misleading as to original authorship.

We have maintained a substantial portion of the original text written by Huber and Headrick and were especially cautious in ensuring that many of their original references were maintained. Although many of the references are dated and more recent research has since been published in peer-reviewed journals, we thought it was important to maintain the older references even from meetings and other less formal sources as it provides source material on which handwriting principles are based and, probably more importantly, Huber and Headrick gathered into one source, rare and difficult to find sources that are not readily available in other books. While many of the references refer to proceedings and lectures, they still provide important background showing the development of handwriting identification science through the years. We have supplemented these sources, where relevant, with recent published studies in the handwriting sciences. We have focused on materials that are published in widely known, peer-reviewed publications such as the *Journal of Forensic Sciences*, *Forensic Science International*, and *Science and Justice*. To a lesser extent, we have also referenced materials from the journals or publications from professional organizations such as the *American Society of Questioned Document Examiners*, *Association of Forensic Document Examiners*, *National Association of Document Examiners*, and the proceedings from both the *International Graphonomics Society* and the *American Academy of Forensic Sciences*. Where relevant, especially with respect to electronic processes and computerized technology, we have also relied on other technical publications. We have stressed the use of references from peer-reviewed journals with high rankings so as to establish the scientific credibility of handwriting identification to the fullest extent possible.

To the over 600 references maintained from the first edition, we have incorporated nearly 200 additional references. The new references primarily serve to update the extensive research

carried out and the revised methods developed in the field of handwriting examination since the book's first edition in 1999.

One of the primary contributions to this new edition includes the addition of illustrations. College students using this book as a text for class work frequently comment that it would be helpful in their learning to see more illustrations. Handwriting examination is, indeed, a highly visual process, so we have supplemented the text with over 100 illustrations.

Huber and Headrick voiced their concern about the scientific limitations in handwriting identification in their original work. Many of their questions and concerns have been addressed placing handwriting identification as a viable science in forensics. This is the reason why we decided to revise their section headings from questions into descriptive titles. Many of the questions have been answered, and it is now easier to teach the discipline to new students in the field.

We have maintained as much of the original language written by Huber and Headrick as possible for several reasons. Even though some of their approach may seem dated, it provides a basic framework and historical background for handwriting identification. Their description of the 21 elements of handwriting has been relied upon in groundbreaking studies in the field. It is not to say that other measurements or elements are not relied upon, but to the extent possible we retained the 21 elements, which we consider the heart of the book, in the original state with minor revision.

We consider this revision a work in progress. Handwriting examination methodology is in transition, and the time for revising and updating Huber and Headrick's 21 elements and other components of this book is the task of the next edition. We, along with Tom Headrick, hope that this second edition marks the beginning of several successive and constantly improving revisions.

Heidi H. Harralson, MA
East Tennessee State University

Larry S. Miller, PhD
East Tennessee State University

Acknowledgments

We wish to extend our appreciation to several colleagues who have assisted us with this second edition.

The conversion of the citations and references to APA would not have been possible without the considerable assistance from the librarians at the Sherrod Library at ETSU (East Tennessee State University). We want to thank Patricia Russell Van Zandt, Celia Szarejko, Joanna Anderson, Kathy Campbell, Alison Lampley, Katy Libby, and Jennifer Young for the many hours spent converting hundreds of citations. We also want to extend appreciation to students at ETSU for providing suggestions for text revisions.

We thank Dr. Hans-Leo Teulings at NeuroScript, Professor Martin Jarvis at Charles Darwin University, Cina Wong, Kaleigh Brown, and Johndennis Govert for their assistance in specific areas of the text.

We appreciate Dr. Bryan Found (Victoria Police Forensic Services Department) and Dr. Carolyne Bird (Forensic Science South Australia) for recently publishing a revised version of the *Forensic Handwriting Method* (2016) and making it available to all handwriting examiners. The method was cited multiple times in this second edition. We acknowledge the large volume of research carried out by Dr. Found, Dr. Rogers, and their students and colleagues over the years. Their research (and indeed the research work of many others) was cited extensively and helped make a second edition of this text meaningful as their work was a significant contribution toward the scientific advancement of forensic handwriting examination.

Finally, we wish to thank Tricia Clapp at Mostly Books for her ideas about revising this text and helping to make this second edition possible.

Authors of the First Edition

Roy A. Huber was trained in the examination of questioned documents in the Crime Detection Laboratories of the RCMP (Royal Canadian Mounted Police) from 1949 to 1951. He testified as an expert witness in six provinces of Canada, and in the United States. He authored, or coauthored with Mr. Headrick, 16 published articles and 11 unpublished articles on the subject of questioned document examination, expert evidence, and on science as applied to document examination. He conducted a private practice in the examination of questioned documents from 1976 to 1996, most of which was shared with Mr. Headrick.

He graduated from Carleton University in 1959 with a bachelor of science degree, majoring in chemistry, statistics, and psychology, 10 years after he entered the field of questioned documents. He served for 35 years (1940–1975) as a uniformed member of the RCMP, the last 26 years of which were spent in the Crime Detection Laboratories. He retired from the RCMP in 1975, with the rank of assistant commissioner, as director of the Laboratory and Identification Services.

In 1958, Mr. Huber established and organized the Central Bureau for Counterfeits under the RCMP. In 1961, he was appointed as the RCMP representative on the Bank of Canada special committee to redesign Canadian currency. Mr. Huber served as special advisor on security in printing to the Canadian Bank Note Company, printers of currency, stocks, bonds, passports, licenses, and negotiable instruments, from 1975 to 1986.

In 1960, at the invitation of the Canada Council, Mr. Huber lectured at the Stratford Festival Theatre on Shakespeare's handwriting, at the first Shakespeare seminar held under the auspices of the universities of Canada.

Mr. Huber was editor of the *Canadian Society of Forensic Science Journal* from 1976 to 1981. He was president of the Canadian Society of Forensic Science (1967–1968), a fellow of the American Academy of Forensic Sciences, a diplomate of the American Board of Forensic Document Examiners, and a former board director (1978–1983). He was president of the American Society of Questioned Document Examiners (1996–1998).

Alfred M. Headrick attended primary and secondary schools in Brooks, Alberta, receiving the Governor General's Medal for academic achievement. He received a BSc (cum laude) with a major in physics from Mount Allison University in Sackville, New Brunswick.

Prior to entering private practice as an examiner of questioned documents in 1985, he served 35 years in the RCMP, 32 years of which were spent in the field of document examination and in the administration of the Crime Detection Laboratories. In 1984, he retired from the position of director of laboratories, holding the rank of assistant commissioner. During his time as a document examiner, 1954–1967, he testified as an expert witness in courts in all provinces east of Manitoba and in the state of New York.

Mr. Headrick held the positions of auditor, editor, and president of the Canadian Society of Forensic Science. He held the position of vice-chairman of the Operations Research Committee of the Canadian Association of Chiefs of Police and was a life member of that association. He was a member of the American Society of Questioned Document Examiners.

Authors of the Second Edition

Heidi H. Harralson has practiced forensic document examination professionally since 1997. She has been court-qualified in the United States and in Mexico and has worked on cases throughout the United States and internationally. She has testified in state and federal courts and is the managing partner of Spectrum Forensic International, LLC, a full-time handwriting and document examination practice. She is a court-qualified and board-certified forensic document examiner.

She has authored two books: *Developments in Handwriting and Signature Identification in the Digital Age* (2013) and *Forensic Handwriting Examination of Motor Disorders and Forgery: Research and Applications* (2008). She is the coauthor of a chapter on evidential documents in *Crime Scene Investigation* (2013). She has lectured extensively to professional organizations and universities on the handwriting sciences internationally and published original research in peer-reviewed journals on forensic handwriting and document examination topics. Her research work has focused on electronic signatures, handwriting and neuromotor disorders, handwriting on works of art, development of training courses, and other topics in the handwriting sciences.

Ms. Harralson has been consulted by attorneys, and public and private clients internationally. She is a board-certified diplomate through the Board of Forensic Document Examiners and the NADE (National Association of Document Examiners). She was president of NADE (2013–2017) and has served NADE in other capacities as vice president and certification chair.

She holds a bachelor of science in the behavioral sciences, a master of arts in handwriting science and forensic document examination, and a forensic crime scene technician certificate. In 1999, she assisted Dr. Larry Miller in developing courses for a graduate certificate degree in Forensic Document Examination at ETSU. Currently, she is an affiliate professor at ETSU where she teaches graduate courses in forensic document examination.

Larry S. Miller is a court-qualified, board-certified forensic document examiner. He is a distinguished professor and chair of the Department of Criminal Justice and Criminology at ETSU. He received his bachelor of science from ETSU in 1974, a master of science from Eastern Kentucky University in 1977, and his PhD in health and safety with collaterals in forensic anthropology and criminology from the University of Tennessee in 1981.

He began his career as a crime scene investigator and photographer with the Sullivan County (TN) Sheriff's Department. He worked as a patrolman with the Kentucky State Police and became chief administrative deputy with the Washington County (TN) Sheriff's Office. After receiving his MS degree, he was employed as an assistant professor and director of the Tennessee Regional Crime Laboratory at Walters State Community College in Morristown (TN). It was during his tenure at the crime laboratory that he was trained as a forensic document examiner. In 1984, he became employed with ETSU in Johnson City.

Dr. Miller has been with ETSU since 1984 and normally teaches courses in the areas of law enforcement, forensic science, and forensic document examination. He developed the graduate

program in Forensic Document Examination and created a laboratory at ETSU to examine questioned documents submitted by state and local law enforcement agencies in Tennessee.

Dr. Miller's primary research interests are in police studies and forensic science, and he has served as a member of the board of the National Forensic Academy. He has also held offices with several organizations including the NADE (National Association of Document Examiners), the AFDE (Association of Forensic Document Examiners), and the BFDE (Board of Forensic Document Examiners). He served as a member of the group on Human Factors in Handwriting Identification with the National Institute of Science and Technology (US Department of Commerce) helping to develop standards for forensic document examinations. He has authored or coauthored 15 textbooks and numerous articles in criminal justice publications.

Introduction: The World of Documents

Documents are evidence of our compliance with society's requirements, and of the terms and conditions of our interaction with our clients, customers, and neighbors. They are the record of past actions and future intentions, the message bearers of our civilization, and as personifying as a fingerprint or as anonymous as a grain of sand.

As our dependence upon documents grows, so does our reliance on their integrity. As documents acquire new values and serve new purposes, it is understandable that they are frequently the instruments of fraudulent manipulation, the targets of counterfeiting, or the means of concealing incriminating truths. Changes in the world of documents has its ramifications upon the field of forensic document examination, placing new demands upon skill and new taxes on knowledge.

Time has had its effects upon handwriting as well, its status in the school curriculum, and its role in business and social intercourse. Electronic technology has usurped much of the function of handwriting in the business world. Penmanship is no longer assiduously taught nor extolled as a principal goal for the aspiring student. The old triumvirate has become "reading, recording, and texting." Handwriting is taught with less aesthetic and more functional consideration. Consequently, it receives greater latitude in method and yields wider variation in the end product. Accordingly, the approach to handwriting identification must be modified.

With this text, a course is charted for the discipline that begins with a scientific perspective. Forensic document examination deals with physical evidence and physical evidence cannot lie. Only its interpretation can err, and only the failure to find it or the disinclination to hear its testimony can deprive it of its value.

Chapter 1

History of Forensic Document Examination

1.1 HANDWRITING IDENTIFICATION AND THE JUDICIAL PROCESS

The examination of disputed handwriting may well be the progenitor of forensic science. Certainly it is one of those rare disciplines to have been born as a forensic necessity, rather than as a discipline established first in its own right for other reasons, and later harnessed for forensic tasks. Historical references indicate that the practice of forgery and related frauds involving documents evolved almost as early as the development of writing. In the days of the Roman Empire, the law provided for the acceptance of expert testimony based on documents. It was not until centuries later that such testimony was admitted in English-speaking courts.

1.1.1 Documents and the Rules of Evidence

The relevancy of documents in civil and criminal litigation is largely dependent on their authorship or origin. Numerous ways have evolved to attest to the truthfulness of a writing. Before the origin of the signature, the application of a wax seal served to authenticate the document. The wax seal bonded the ends of a ribbon of fabric which fed through a slit in the paper and was embossed with a personal motif. Later, signatures served the purpose, but additionally, the legal process has tended to also require the signatures of witnesses to the signing.

There have always been situations where unsigned or anonymous writings on documents were potentially important, for example, personal notebooks in which relevant or incriminating information was recorded. The provision of proof regarding the authorship of such documents has long been an issue.

Historically, circumstantial evidence was the vehicle by which authorship was established for many cases. This was used in the absence of witnesses to the act of writing. For many years, courts debated as to what evidence was acceptable. Certainly, the inclination was to seek proof that was independent of the document's circumstances. As early as the nineteenth century, Wigmore (1896) commented that the idea of handwriting expertise was novel.

In the course of developing an acceptable standard of proof, many related issues surfaced. Should triers of fact (judge or jury) be permitted to compare writings for themselves? If so, what writings could be used as standards? The answer to the first question became affirmative, provided some kind of corroborative evidence was supplied. Corroboration was then sought through the testimony of a *recognition witness*—someone acquainted with the alleged writer's handwriting. Recognition witnesses then became the means by which writing standards were authenticated and tendered as evidence. The extent of the acquaintance with a person's writing and the manner in which it was acquired were without precise boundaries and the evidence offered proved to be unreliable.

Any person having observed another person write, even once or years before, was permitted to testify regarding the authenticity of a writing. Despite the inherent weaknesses in this evidence,

shreds of the policy continue to prevail regarding the proof of writing standards. Requirements were then placed upon the standards. They must have some relevance to the matter in dispute and could not simply represent a given person's writing practices.

The case of *Goodtitle d. Revett v. Braham* (1792) is said to be the first in English-speaking courts in which specially qualified witnesses were proffered. These witnesses would testify solely from direct comparison between standards and disputed writing rather than from recognition. Their special qualifications were acquired from experience as inspectors of franks. They checked the authenticity of the signatures of MPs and others on mail that was dispatched pursuant to the franking privilege. On that occasion, Lord Kenyon admitted the testimony of two inspectors, on the authority of *Folkes v. Chadd* (1782) in which Lord Mansfield admitted the expert testimony of an engineer.

The next year the same evidence was refused by the same judge, Lord Kenyon. Not until Massachusetts admitted testimony regarding the comparison of disputed documents with writing standards in 1835 (*Moody v. Rowell*), and England passed the *Common Law Procedure Act* in 1854, did the practice become more consistent.

1.1.2 Prior to 1900

By the year 1672, Europeans such as Jacques Raveneau had written on the subject of handwriting identification (Buquet 1981). In the 1800s, the La Ronciere case, the Dreyfuss letters, and the La Boussiniere will, all testified to the endeavor to resolve major issues on the strength of writing examination in that part of the world.

In the North America, Albert S. Osborn (1929) is credited with launching handwriting identification as a distinct discipline at the turn of the twentieth century. Furthermore, he broadened its scope to include typewriting, ink, and paper examinations under the wider umbrella of document examination. Others of his era, such as Hagan (1894), Frazer (1901), Ames (1900), and Lee and Abbey (1922) made their contributions in published form. Osborn's works (1922, 1929, 1946), however, are still deemed to be the accepted texts of the specialty, although they were not written expressly for that purpose.

While Osborn's success in gaining acceptance for handwriting identification was achieved largely through his writings, lectures, and testimony, there is no doubt that he derived much assistance from his friendship and association with John H. Wigmore, the eminent authority on American evidence law. Wigmore et al. (1940) held a great personal interest in forensic science and recognized its potential in the court's search for truth. The claim for document examination as a forensic science can be traced to the oracles of Wigmore (1896), some of which were expressed or quoted in the writings of Osborn just after the turn of the twentieth century.

In Canada, provision was made for handwriting examination evidence in the *Common Law Procedure Act* of 1854 of England and that those authorities were broadened under the *British Criminal Procedure Act* of 1865. Remarkably, the Act applied only to civil proceedings. Some courts expressed a preference for expert testimony over lay witness identification of handwriting as early as the 1860s (*Reid v. Warner*, 1867). The *Common Law Procedure Act* and the *Criminal Procedure Act* were superseded by the *Canada Evidence Act* of 1868 that, with some modification, has continued to provide for the admission of expert testimony respecting handwriting—but respecting handwriting only—for the last 150 years. Authority for the presentation of evidence by the document examiner in areas of his and/or her work, other than handwriting, must be sought in case and common law.

The reason for giving handwriting evidence special attention in the *Canada Evidence Act* of 1868 illustrates that handwriting experts were probably the first of the forensic experts to make their contribution to the judicial system. In the absence of precedents, special provision had to

be made for their admission. Certainly, the *Canada Evidence Act* of 1868, one of the many early statutes passed after confederation in 1867 when Canada became independent of British rule, merely adopted the provisions of a similar statute on the law books of England from 1856. That being the case, the real reason why handwriting evidence is segregated under the law from other forms of forensic expertise must lie in the history of British law.

1.1.3 The Twentieth Century: The First 40 Years

Notwithstanding the legislation governing its admission into the courts and into a growing volume of judicial decisions, not all members of the legal profession readily accepted the testimony of the expert witness at the turn of the twentieth century. The disparaging manner in which older law literature has referred to their contributions suggests that the vanguard of the profession of forensic scientists left something to be desired in qualification, motivation, or attitude. Wellman (1913) remarked that "expert witnesses become so warped in their judgment … that, even when conscientiously disposed, they are incapable of expressing a candid opinion" (p. 73). Wellman found that experts were shrewd and cunning. Occasionally, the pages of law books dripped with sarcasm from such statements as, "He swears scientifically does the expert" (Wrottesley 1910). Harris (1911) made a classic statement: "You will be amazed at the elaboration of the system for finding out nothing, which has been invented by science" (p. 140).

For writing identification, such skepticism, indeed hostility, is alleged to have stemmed from the often disputed rationale that underlay the admissibility of handwriting expert testimony. Undoubtedly, admission was granted simply on the grounds that experts could not be worse than recognition witnesses (*Moody v. Rowell* 1835).

While legislation resolved the question of admissibility, opponents continued to argue against handwriting identification on the grounds of weight. Per *Mutual Benefit Life Ins. Co. v. Brown* (1878): "All doubts respecting the competency of the opinion of experts in handwriting based upon mere comparison, as evidence, have been removed by statute, but it still must be esteemed proof of low degree."

A reasonably complete account of the legal history of handwriting identification, as developed and recorded in case law in the United States, may be found in an article by Risinger et al. (1989). Although the article has been criticized for its language, its objective, and for a number of errors and omissions, it presents the beginning of a serious critique of forensic handwriting examination. This in turn led to a reaction of the criticism aimed at the field through published research and standards.

For the most part, the early examiners in North America were sincere, well-intentioned individuals. Despite little training, they had one thing in common: a small collection of the books of Osborn (1929, 1946) and his contemporaries Hagan (1894), Quirke (1930), Ames (1900), and Frazer (1901).

Examiners came from diverse disciplines: bankers, lithographers, engravers, court clerks, and police officers. The greatest number of them was teachers of penmanship and business college instructors. Obviously, it was felt that those who taught penmanship and the preparation of written records were better qualified to discriminate between the writing of different persons. This was because, at a time of strict adherence to copybook styles, there was great similarity in the writing of many people. Furthermore, teachers were able to appreciate the capabilities of the average individual in altering or modifying writing habits.

A second and smaller group included bankers, court clerks, and police officials that developed an interest in document examination, probably as a result of their exposure or involvement in criminal cases. The need for the talents of the document examiner was evident and the availability of such experts was limited.

Initially, document examiners were self-trained. Historically, they did not have educational backgrounds in science and few were called upon in forensic cases more than a few times a year. Certainly, document examination offered few opportunities for full-time employment in North America until the opening of the federal, state, and provincial police laboratories in 1937 and later.

If and when the successful solution of a civil or criminal case demanded it, more than one document examiner would be engaged to examine the evidence. Often, the second examiner would be Albert S. Osborn. Such were the circumstances in the trial of Bruno Richard Hauptmann for the kidnapping and murder of the son of Charles Lindberg, the famous aviator, in 1934. Osborn and seven other examiners testified based on the handwriting of a number of ransom notes, and in so doing, established the legitimacy of writing identification in the eyes of the public. On such occasions, examiners would share experiences, learn from one another, and develop their competence. Osborn was a teacher, a stimulus, and an encouragement to those who were less practiced. Out of these unstructured beginnings, the profession of the document examiner slowly emerged.

Undoubtedly, the growth and development of the profession was not too different in Canada from that of the United States. In North America, police or government forensic laboratories established standards for the work, formalized their own training curriculum, and pursued limited programs of research to assemble much-needed knowledge. However, these institutions were few in number and all had very modest resources.

1.1.4 1940 to 1975

The development of the manual typewriter, the advent of the ball point pen, the introduction of the electric typewriter, and the evolution of the electronic age significantly affected document examination. They profoundly changed the means by which society communicated and recorded its information. The profession of teachers of handwriting diminished. Penmanship was at one time tenaciously taught and diligently practiced. It is, however, no longer extolled as an important student achievement. Writing enjoys greater latitude in learning methods and wider variation in the end product. Whereas the objective in years past was to ensure legibility for the benefit of others, the goal now seems to be to provide a convenient process for note taking, with readability chiefly for the writer. Communications and records are matters for machines; therefore, the approach to writing identification has had to be modified significantly.

The forensic science services that have developed since 1940 have established document examination laboratories in most of the major cities across the land. All are administered by the government authorities responsible, directly or indirectly, for law enforcement in the area. For the most part, the services have been available free of charge to law enforcement agencies at all levels.

1.1.5 1975 till Present

Since the 1980s, the widespread use of computer and digital technology has changed the field of document and handwriting examination in two fundamental ways: (1) the analysis of computerized or electronic documents, and (2) the computerized or digital equipment that document examiners use in analysis. Cases involving the analysis of typewritten documents are now rare and older document examination textbooks and training that focus on typewriting seem outdated. However, it is a reality in casework that older documents come into question and the knowledge of how older documents were produced is an important area of study that can lead to specialization. The George W. Bush letters regarding his service in the Air National Guard (purportedly typewritten in the early 1970s) serve as a popular example as to why document examiners need training in both old and modern writing machines.

The typewriter has been gradually replaced in both offices and the home by computers, printers, and scanners. In the forensic examination of handwriting, the shift to digital technology has required the implementation of software and techniques to analyze handwriting on digital or digitized documents. Document examiners also use digital techniques to photograph evidence and create demonstrative exhibits. The trend to maintain only digital records has resulted in fewer available original documents for examination and a widespread increase in the analysis of digital files. This requires the training and knowledge of document examiners who have an understanding as to how digitization affects handwriting and how documents can be manipulated by splicing handwriting images (i.e., a signature) from a source document onto a manufactured document. Manipulated documents can be created so skillfully with simple office equipment that it sometimes requires scientific instrumentation to detect whether a signature is produced with a real ink pen or is the product of a color printer. In order to maintain current knowledge with rapidly changing technology, professional document examination organizations that provide certification to their members require periodic continuing education.

Regarding trends in training and education, historically there was no university program of study offering courses or training available in North America to those wishing to enter the discipline. In the government sector, an apprenticeship-style training has been promulgated. Per ASTM (American Society for Testing and Materials) Standard E2388, Standard Guide for Minimum Training Requirements for Forensic Document Examiners, the recommended training is 2 years full-time. In a broad sense, the ASTM training standard was used as a guideline to determine the training qualification of an expert document examiner. In the private sector, various schools and courses in document examination have been established, but there has been a lack of standardization of training requirements.

With the increasing popularity of forensic crime shows, a demand for forensic coursework in universities helped to establish three university programs in North America. Oklahoma State University developed a graduate-level forensic program which allows a specialization in forensic document examination. In 2009, East Tennessee State University initiated a graduate certificate program in document examination. In keeping with the ASTM requirements, both university programs require a minimum undergraduate degree as a prerequisite for acceptance into the program. Other universities and colleges sponsor document examination courses within forensic and criminal justice programs at undergraduate and graduate levels, but they are typically one course or one semester in length and constitute an introduction to document examination. One exception is a certificate in forensic document analysis offered by the University of Baltimore, which promotes a four-course undergraduate program.

Standardization in training, certification, and methodology has been a theme in both the public and private sectors of document examination. In 2000, the FSAB (Forensic Specialties Accreditation Board) established accreditation for the forensic science disciplines with support from the National Institute of Justice and the American Academy of Forensic Sciences. FSAB accredits boards in forensic disciplines including forensic document examination. Currently, the National Institute of Standards and Technology (NIST) is developing a formal recommendation that certifying bodies should be accredited to ISO/IEC 17024. ISO is the International Organization for Standardization and it publishes a standard regarding general requirements for bodies operating certifications of persons (2012).

With continued interest and awareness of the scientific underpinnings of forensic disciplines, there has been increased intervention on the part of government-sponsored agencies to create greater oversight and accountability in the forensic sciences. In 2009, the NAS (National Academy of Sciences) published its report on *Strengthening Forensic Science in the United States: A Path Forward*.

In its assessment of questioned document examination, the committee stated: "The scientific basis for handwriting comparisons needs to be strengthened … although there has been only limited research to quantify the reliability and replicability of the practices used by trained document examiners, the committee agrees that there may be some value in handwriting analysis" (pp. 5–30). Almost as an answer to the criticism aimed at forensic handwriting examination, a 2012 court ruling originating in the District of Columbia Court of Appeals challenged forensic handwriting examination using criticisms taken from the NAS report. In *Pettus v. US*, the appellant's argument was based upon the NAS report's criticism that forensic pattern-based disciplines are not scientific and do not meet the requirements for scientific admissibility. The appellate court agreed with the original trial court's decision that handwriting identification did indeed meet the *Frye* test for admissibility. The court further reasoned that appellant's presentation of the criticism from the NAS report "exaggerates the measured conclusions and recommendations of the Report to read them as a rejection of the scientific basis for all pattern-matching analysis, including handwriting identification" (p. 27). Rather, the court found that the NAS report does not recommend a rejection of handwriting identification, but instead cautions courts to insist on reliability of forensic methods. Overall, the appellate court found that the NAS report did not specify a reason for rejecting handwriting identification noting that the NAS report's review of handwriting identification was brief. The court concluded that the methodology behind handwriting identification is well-established and accepted in the forensic community.

The NIST (National Institute of Standards and Technology 2015) has sponsored conferences involving error analysis and mitigation, which also included handwriting identification. In 2013, NIST sponsored a conference dedicated to the forensic challenges associated with handwriting identification, specifically measurement and quantitative analysis. NIST continues to take an active role in developing standards for the forensic sciences and there are presently several committees developing standards for the forensic sciences within NIST. In 2013, the ASTM document and handwriting examination standards were replaced by the SWGDOC (Scientific Working Group for Document Examiners) standards. The standards are virtually the same, but the revision process of the standards will be carried out via SWGDOC instead of ASTM in the future until NIST formally publishes new standards.

1.2 DEFINING DOCUMENT EXAMINATION

Document examination is the discipline that seeks to determine the history of a document by technical or scientific processes. From the viewpoint of its application to civil and criminal litigation—its forensic function—forensic document examination is the study of physical evidence, and physical evidence cannot lie. Only its interpretation can err. Only the failure to find it, or to hear its true testimony can deprive it of its value.

Forensic document examination may entail the study of a complete instrument of communication, or of some element of it: the writing, lettering, or printing; the ink, the graphite, the paper, or its surface contour. It may also entail the study of the dimensions of any of its attributes. Document examination may seek information about the origin of the document or evidence of the chronology of the events that subsequently occurred. Notwithstanding the many elements of the document that testify to its history, the handwriting it bears is the element most frequently in dispute.

Questioned handwriting and hand lettering, however, may be inscribed on walls, woodwork, or on any other physical object of any size, perhaps using paint instead of ink, and broad

markers, brushes, or spray cans instead of the customary writing instruments. The message may be threatening, offensive, obscene, libelous, annoying, or incriminating, and the identity of the author may be essential to establishing liability or culpability. Understandably, the document examiner will be called upon to apply his or her skills to identify the author of the inscription, although the medium (e.g., a lavatory wall or a concrete bridge) does not fall within the common definition of a document. While these occasions are infrequent, document examination and, in particular, handwriting identification, should be thought of in this broader context.

Both ASTM and SWGDOC provide a standard description of the scope of the work related to forensic document examination. This scope tends to deal with a document in the more limited sense. The standard description also makes reference to the qualifications of practitioners, although few specifics are provided except by inference. It does, however, clearly separate forensic handwriting examination from calligraphy, engrossing, and graphology.

1.2.1 The Purpose of Document Examination

The examination of a document is conducted to determine:

- Origin—where did the document come from?
- Production source—what person or machine produced it?
- Production process—how was it made?
- Inscription—what has faded or been obliterated?
- Chastity—what changes, if any, have been made to it?
- Integrity—is it genuine or false?
- Legitimacy—is it an original or a reproduction, and if so, what generation?

The reason for seeking this information through a technical process is to shed light on events in the history of the document that have occurred prior to its arrival in court. This will enable the court to confirm assumptions that may otherwise be made. It will also allow the court to review the correspondence between the technical testimony of the document and the oral testimony of witnesses.

Notwithstanding the breadth of scope of questioned document examination, in practice, most examiners find that a large percentage of their work involves the study of handwriting or handwritten signatures. If some areas of criminal work tend to provide a somewhat different variety of tasks, certainly the private examiner finds that he or she is more constantly engrossed with handwriting. For these reasons, handwriting is deserving of the examiner's most comprehensive attention.

Chapter 2

The Development of Handwriting

2.1 THE MECHANICS OF HANDWRITING

Handwriting is an acquired skill and clearly one that is a complex perceptual-motor task, sometimes referred to as a neuromuscular task. Skilled writing movements are so commonplace that one is inclined to overlook their complexity. Without exaggeration, however, writing is one of the most advanced achievements of the human hand.

The hand is an extremely complex and delicate mechanism, containing some 27 bones controlled by more than 40 muscles. Most of the muscles are situated in the lower arm and connect to the fingers by an intricate set of tendons. Their ability in manipulating a writing instrument is precisely coordinated by a timing system under a neural control of movements of the arm, the hand, and the fingers. The precise ordering and timing of the movements determines the structure of the pattern that is recorded by the pen or pencil.

Writing is a continuous or flowing task, not one of discrete or separated actions. There are apparent interruptions at word boundaries, but in many cases the pen movement may be continuous and uninterrupted, although not recorded as an inked line. A feature of skilled performance, and certainly of handwriting, is that it involves the smooth execution of a structured sequence of coordinated movements in which each movement occurs at its proper time and place in the sequence (Thomassen and Teulings 1983). The particular pattern of these movements constitutes the habitual aspects of writing that are peculiar to each individual. The fact that, with practice and skill, the execution of writing habits becomes more automatic, renders the writing process less subject to conscious control.

2.2 HANDWRITING RESEARCH

Much has been studied and written about handwriting and many studies pursued the correlation of writing features with various medical and mental conditions. Considerable research work has involved the pedagogy of handwriting and remedial approaches to improve its quality in the writing of children.

Historically, many surveys or studies have involved the correlation of handwriting with psychology or behavior. Allport et al. (1933) reviewed and worked with experimental studies on expressive movement in handwriting. McNeil and Blum (1952) examined methodology in handwriting correlated with psychology. Fluckiger et al. (1961) reviewed the experimental research in handwriting and behavior from 1933 to 1960. Herrick (1960b) produced the most comprehensive bibliography on handwriting studies (from 1890 to 1960) that listed

1,754 papers, books, and articles. Unfortunately, up to that point, few of the studies were rigorous and experimental and most were described as suggesting hypotheses rather than testing them.

With respect to handwriting and pedagogy, Herrick and Okada (1963) suggested the various directions that research, respecting the teaching of handwriting, might pursue in the 1960s. Later Askov et al. (1970) reviewed the research of that decade to assess the progress made along the lines suggested. They expressed some disappointment, commenting that handwriting instruction tended to follow accepted practices rather than basing its practices on research findings. A decade later, Peck et al. (1980) reviewed progress and reported finding some encouraging signs. They mentioned the promising trend in experimentation on the handwriting of learning-disabled children. Their comments are of particular interest to handwriting examiners today as they mentioned that in an age of technical communication, handwriting is still relevant as a mode of personal expression.

Huber (1983) endeavored to stimulate interest in the published literature on handwriting among document examiners and added 200 titles dated between the years 1958 and 1983 to Herrick's survey of 1960. Baier et al. (1987) surveyed the material produced relating to document examination from 1873 and cataloged 5,871 monographs, articles, books, and papers, a substantial portion of which deal with handwriting.

A trend toward more rigorous experimental investigation became apparent in the 1960s and 1970s (Herrick 1963). The *International Workshop on the Motor Aspects of Handwriting* in 1982 brought together research scientists from the disciplines of experimental psychology, bioengineering, neurology, and education, and gave birth to a new discipline of graphonomics.

With the advent of graphonomics and its scientific rigor, research is endeavoring to study and understand the development of handwriting as a perceptual-motor skill. Graphonomics has and continues to seek the structures and processes operating at different stages of handwriting, and the factors involved in their modification or change. Thomassen et al. (1983) reported that handwriting is a complex type of motor behavior. The greatest difficulty in writing letters is not in the execution of their particular strokes but in the execution of complex combinations of strokes in ever-changing contexts. The practiced writer does not simply follow a given trace to produce the required movements. Research has shown that the writer retrieves the necessary information from abstract motor memory. Handwriting involves a continuously proceeding output process that intrinsically intertwines the retrieval process, a buffer storage, and a monitoring action. Thus, the brain works much like a computer (Teulings 1996).

The representation of motor acts in memory appears to be nonmuscle specific. Hence, writing follows similar patterns whether executed with an instrument in the hand, held by the foot, or in the mouth. The integrated sequence of movements is a hierarchical process. A combination of letters or a word may be executed as a unit. Thus, the execution of movement sequences appears to be far more independent of the monitoring of a feedback system than was once believed.

As Thomassen and Teulings (1983) have elucidated in some detail, there are at least three different theories of how a skilled performance such as handwriting is achieved, and the role that feedback plays in it. The open-loop theory was described by Keele (1968); the closed-loop theory was developed by Adams (1976). A form of central motor program theory was proposed by Schmidt (1975, 1976) under the name of schema theory. Plamondon and Maarse (1989) evaluated research on biomechanical motor models of handwriting and found that velocity-controlled models best represented natural handwriting.

Caligiuri and Mohammed (2012) summarized decades of motor control research, reviewing the models most relevant to handwriting which included (1) hierarchical models,

(2) cost minimization models, and (3) the equilibrium point model. While all three models accurately describe motor control with respect to handwriting, cost minimization models seem to model the factors associated with simulation in handwriting most effectively. Cost minimization models describe the motor program in terms of movement, and research associated with these models has been based on velocity profiles. Within cost minimization models, other models such as minimum jerk, the isochrony principle, and the two-thirds power law have been developed to explain movement in handwriting. Applying the motor control theory of the isochrony principle, Caligiuri et al. (2012) examined online handwriting features to determine whether simulated signatures adhere to isochrony kinematics. Results demonstrated that simulated signatures do not adhere to the isochrony principle which showed how motor control theories are useful in supporting the scientific basis of forensic handwriting examination.

To write satisfactorily requires the ability to distinguish visually between graphic forms of letters and other characters and to judge their correctness. Learning to write requires the ability to distinguish between the feedback provided by the senses associated with correct and incorrect movements. Modifying or controlling the movement of the writing instrument is also required.

Writing is described as a tool-using skill. Connolly and Elliott (1972) have distinguished seven types of grip for tools, five of which they classify as power grips (as in holding an ice pick or screwdriver), and two that they classify as precision grips (as in grasping a pencil or a pen). The grip employed with a writing instrument may facilitate or inhibit certain types of strokes. The course of development in writing is a gradual improvement in control, especially of the more precise finger movements. This is reflected by a reduction in the size of writing and by a reduction in the number and extent of superfluous movements.

In the development of writing there are both qualitative and quantitative changes. Of the variables that can be more precisely measured, speed is probably the simplest overall measure of proficiency one can use. An increase in speed of writing as a function of increasing age has been described by Cormeau et al. (1970). The rate at which the speed of writing increases is greatest between the ages of 7 and 9 years. It tapers off to 13 years, when there is little further increase.

As mentioned previously, writing is a culture-bound activity, not only insofar as language and its orthography, but also in many motor aspects that are greatly influenced by culture and education. This is sometimes overlooked. Writing is spelling, as well as a perceptual-motor task; two quite different educational problems occurring coincidentally, that beg to be tackled at the same time. Teaching the motor preliminaries of writing involves the introduction of cultural standards such as regularity and neatness, the introduction of cultural biases such as slant, counterclockwise rotations, and left to right transport. It also involves the introduction of various constraints such as posture, grasp, and handedness. In different cultures these standards, biases, and constraints may differ, producing different effects in the writing of their subjects.

In the development of writing or drawing, certain biases or rules have evolved for large numbers of the population. There are directional preferences of which writers are not always conscious. These preferences prompt the writer, almost invariably, to execute vertical lines from the top down and horizontal lines from the left to the right. When these rules are broken, the handwriting examiner looks for reasons to explain them, such as the IHP (inverted hand position) in left-handed writers. It may also explain why there are many writers that tend to omit the upstroke in letters such as the “i,” “t,” “h,” or “l,” and commence the structure with simply a vertical stroke—from the top down (Rhodes 1978).

With growth in age and development in handwriting, there is increased conformity to the rules, but the strength of one rule may decline while another increases, as Goodnow and Levine (1973) observed.

2.3 ORIGINS OF THE ALPHABET

The fabulous faculty of writing has prompted many to impute its origin to the gods. Assyrian, Chinese, Egyptian, Indian, and Scandinavian deities have all been credited with bestowing on mankind the knowledge of writing (Figure 2.1). In 1750, Champion opined that the invention of letters was derived from Adam.

Whether of divine origin or not, writing is nevertheless considered one of mankind's most important inventions. Coulmas (1989) claims that writing is the most important system invented on the planet and while civilization is not necessarily the product of writing, it is a

Figure 2.1 Thoth, Egyptian god of writing, holding a reed pen (Luxor Temple, Egypt).

tool shaping civilization. Daniels and Bright (1990) purports that "humankind is defined by language; but civilization is defined by writing" (p. 1).

The development of writing is complex because it is, in part, culture-dependent, and cultures differ with locales and undergo constant change. The evidence of this dependence is manifest in class, system, or national characteristics which are of particular interest in the forensic examination of handwriting. In order to identify individualizing features in writing, an examiner must take into consideration the class characteristics of the writing system. A review of the historical development of writing is a broad introduction to understanding class characteristics culturally.

Neolithic man began written communication as long as 20,000 years ago, when he graphically represented objects and ideas in drawings on cave walls that are now referred to as iconographs (Diringer 1968; Diringer and Freeman 1953). After these came the first pictographs or picture stories when action was added to the drawings of animals (Figures 2.2 and 2.3). To these were added figures of man, and the complexity of the depicted events gradually increased to become what were called ideographs or picture symbols.

Ideographs were simpler drawings, such as stick figures, yet more difficult to interpret. Then, iconographic symbols were combined with ideographs to provide more information. Particular combinations expressed ideas. For example, the moon symbol and slashes might represent the lunar month (Diringer 1968; Ogg 1959). The origin of the first systematic method for written communication is uncertain, but the evidence found in artifacts suggests that such a system began sometime after 3500 BC.

In the initial development of writing in any culture, the symbols used represent objects rather than the spoken words. The linguistic elements followed. The phonetic use of symbols to

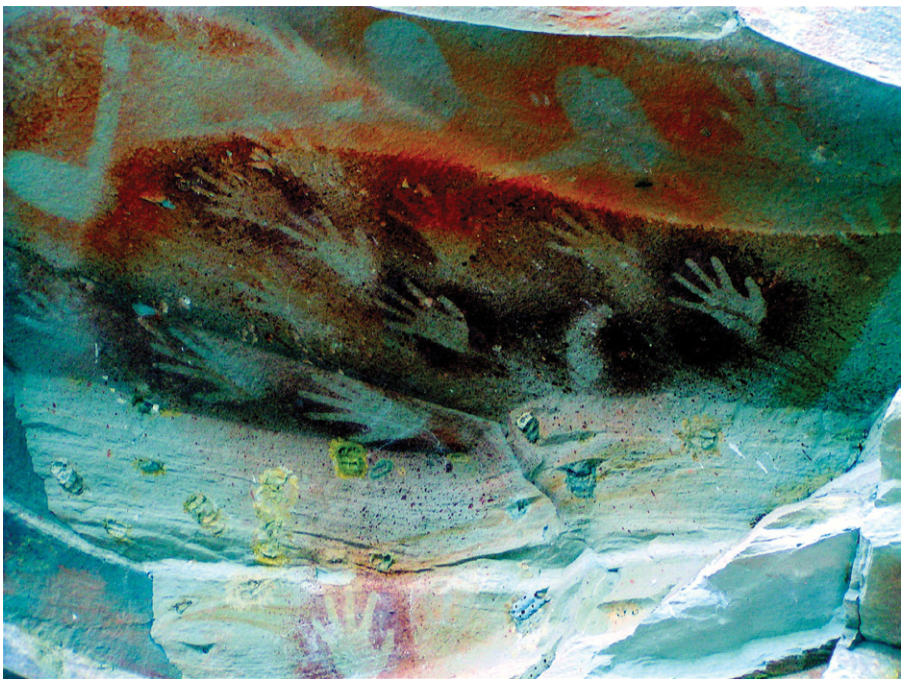

Figure 2.2 Aboriginal cave painting.

Figure 2.3 Petroglyphs carved in stone (Signal Hill, AZ).

represent syllables of words probably commenced with the endeavors to write foreign names, which conveyed no meaning other than identification. From this, syllabic usage spread into everyday words.

The earliest known forms of Egyptian hieroglyphics exhibited elements of a syllabic system. In fact, they exhibited elements of the final step from syllabic writing to true alphabetic writing in which symbols represented speech sounds and not just syllables (Humphreys 1855).

Early writings took on several forms. The Sumerians produced a cuneiform system that dates back to 3200 BC and is perhaps the oldest writing system. Not to underestimate the importance of cuneiform or its use in recording information, Coulmas (1989) stated that "microchips are merely a technical improvement over clay tablets" (p. 9). Later cuneiform underwent transition to ideographic and syllabic form (Diringer 1968). With the introduction of clay as a writing substrate, symbols were simplified and straight-line wedge shapes, made with a broad-tipped stylus, replacing round lines. Hence, the name *cuneiform* was coined to mean wedge-shaped. In today's digital age, it is interesting to note the return of writing with a stylus on a tablet albeit a digital tablet instead of a clay tablet (Figure 2.4).

Cuneiform was adopted by many Semitic tribes and evolved in different versions under the Acadians, Assyrians, Babylonians, Elamites, Hittites, and Kassites. The combination of ideographs and phonetic forms produced polyphones (symbols with more than one syllabic value), homophones (different symbols with the same phonetic value), and developed a need for determinatives to identify a word as being ideographic or phonetic, and/or its phonetic form. Phonetic symbols also served to sort ideograms with multiple meanings.

Various kinds of cuneiform writing survived throughout Egypt, Asia Minor, and Greece for over 2,000 years. The Persians adapted a mode of it for their use about 600 BC and then simplified

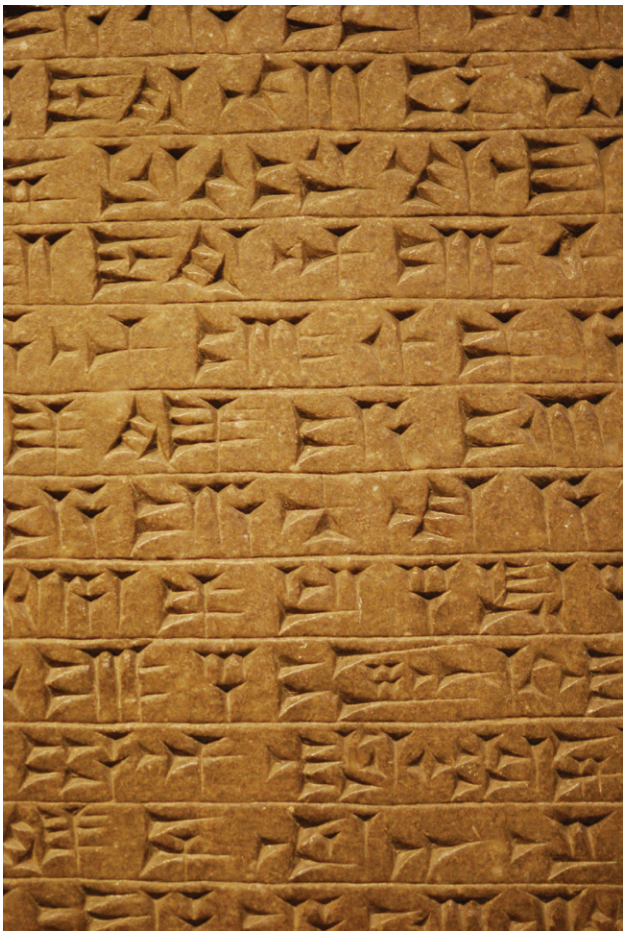

Figure 2.4 Cuneiform clay tablet in the British Museum. (By Matt Neale from the United Kingdom [CC BY 2.0 (http://creativecommons.org/licenses/by/2.0)]. Courtesy of Wikimedia Commons.)

it to about 40 signs, which may have been the beginning of a true alphabet. Cuneiform began its demise around 500 BC. Although priests and astronomers continued to use it at the beginning of the Christian era, there is no record of it beyond 75 AD.

Egyptian writing developed three different styles of symbol systems—hieroglyphic, hieratic, and demotic, each using the same combination of characters but in a different written form. Egyptian scripts were essentially national, living and dying only in Egypt. Egypt's hieroglyphics achieved early advancement over other systems, combining ideographs, syllabic forms, and even single letter symbols as well as determinatives. Despite its early growth and advance in development, it did not turn into an alphabetic form. Hieroglyphics, which prevailed until after 500 AD, were preferred for royal and religious inscriptions (Humphreys 1855).

The introduction of the reed pen and papyrus around 2000 BC encouraged the development of hieratic writing that employed simpler forms to depict the same figures. As a result of its speed of execution, arising from the simplicity of some forms, hieratic became the choice for business and private documents.

A highly cursive form of hieratic, called demotic, developed about 700 BC, but since it used the same system as hieroglyphics (ideograms, phonograms, and determinatives), it did not turn into a true alphabetic system. Demotic symbols, however, were so cursive, and execution so much simpler, that it replaced hieratic and hieroglyphic styles, leaving them to religious and traditional transcriptions. The demotic system spread into general use in Egyptian writing, achieving the level of importance of hieroglyphics or Greek. Indeed, the Sumerian and this Egyptian system were probably the most influential on subsequent developments. Champollion's translation of the Rosetta Stone, discovered in 1799, provided the clue to deciphering Egyptian hieroglyphs as three written languages appeared on the stone: Egyptian hieroglyphic, demotic, and ancient Greek (Figure 2.5).

The Cretan civilization, the Elamitic civilization, the Indus Valley civilization, and the Hittite civilization each developed their particular version of Babylonian cuneiform. This was later replaced by more cursive or pictographic systems.

The Chinese writing system has been in continuous, uninterrupted use for over 3,000 years making it unique among writing systems due to its longevity (Coulmas 1989). The Chinese system is markedly different from the Western alphabet and although it has been classically referred to as ideographic or logographic, Coulmas argues that Chinese is more accurately described as a morpheme-syllable writing system. The earliest Chinese pictographic forms were found on oracle bones dating around 1200 BC. However, Ronan and Needham (1978) suggest that writing may have occurred on other more perishable items such as bamboo that have not survived. Over thousands of years, Chinese characters or logograms have increased to number over 50,000, but only 2,000–3,000 hanzi (Chinese characters) are in regular use. In learning to write Chinese characters, the order of the strokes are standardized and precise, and the number of strokes in a character is used to determine its placement in a Chinese dictionary. Traditionally, Chinese is written in columns and is read from right to left. Writing on bamboo as a medium explains why the traditional Chinese writing is written vertically.

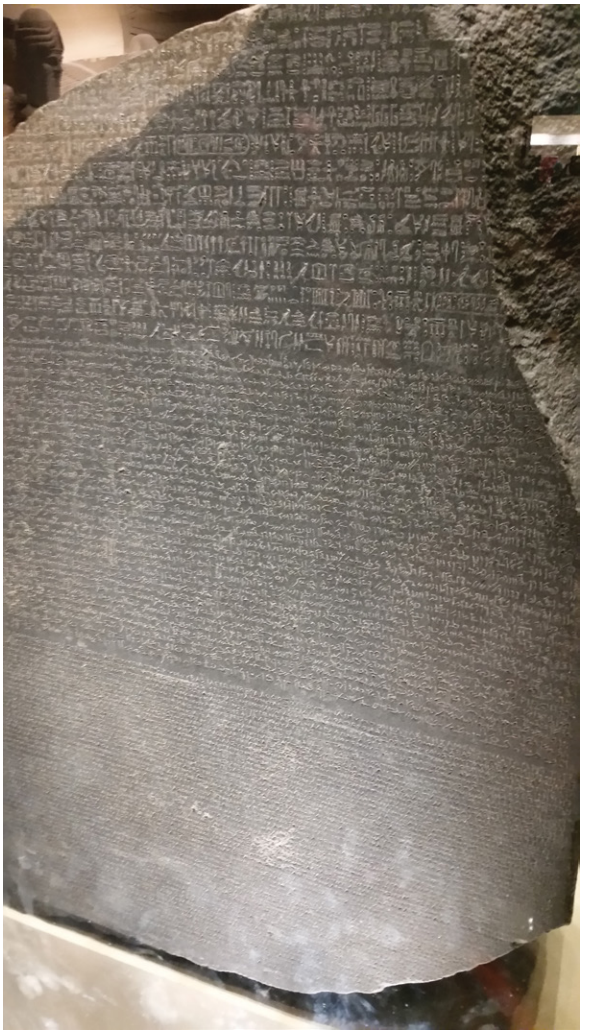

Figure 2.5 The Rosetta Stone depicting three different written languages: hieroglyphic, demotic, and Greek.

For Japanese writing, Coulmas (1989) stated that it is regarded as the

"most intricate and complicated system ever used by a sizeable population" (p. 122). Although initially derived from Chinese, Japanese writing evolved into a far more complex system. Similar to Chinese, it also consists of over 50,000 kanji (Japanese characters) with a few thousand in standard use. Japanese utilizes syllabic kana which is divided into two syllabaries referred to as hiragana (informal) and katakana (formal) (Robinson 1995). In modern times, there have been controversial proposals to reform and simplify the Japanese system due to the increased use of technology.

Brush calligraphy originated in China and is a stylized, artistic approach to letter forms that focuses on dynamic, continuous movement rather than rigid forms. The letters or images are formed with a brush onto the medium. Brush calligraphy is considered both a practice and an art (Figure 2.6).

2.3.1 The First Alphabet

The Phoenicians, the merchants of the Mediterranean from 1200 to 900 BC, are credited with the spread of the first alphabetic system through their travels from Palestine to Gibraltar (Ogg 1959). Diringer (1968) reported that the first true alphabet surfaced between Egypt and Mesopotamia in the years 1730 to 1580 BC, perhaps in the Sinai Peninsula (1600 BC) where Hebrew-Egyptian script was used to write a Hebrew-Semitic language. The language needed only the development of basic linguistic sounds rather than syllables (Mercer 1959). Diringer contended that Canaanites (i.e., Phoenicians) combined Egyptian and Semitic systems, eliminating everything but the fundamental sounds.As Palestine's culture was highly developed, and an active international trading center situated between the two great cultures of Egypt and Mesopotamia, it is a likely location for the origin of the alphabet.

Figure 2.6 Chinese brush calligraphy. (Joe Mabel [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)]. Courtesy of Wikimedia Commons.)

The first alphabet was largely a northern Semitic development. The north Semitic true alphabet can be traced to Byblos, Phoenicia about 1100 BC, but may have begun in Gebal, Phoenicia, 200 years before (Irwin 1967; Mercer 1959). While the sounds of the alphabet remained stable, its physical appearances changed significantly. There were three styles of the early script:

1. Phoenician script proper, with Cyprian, Sardinian, and Carthaginian varieties
2. Libyan and Iberian scripts that evolved from the Carthaginian
3. Aramaic script that developed as an offshoot about 1000 BC

Because of the Aramaeans' control of the Damascus area and the retention of the system to the time of the birth of Christ, the Aramaic style acquired some importance for Western civilizations. Another system of note derived from the Aramaean was Arabic. The spread of Islamic with the Arabic alphabet eventually displaced the Aramaic language. A South Semitic alphabet also developed independently with many derivatives.

The Greeks derived and developed their own alphabet from the Phoenician system, introducing vowels to accommodate the Greek language. Other consonants not used in Greek were dropped, resulting in the formation of the Greek alphabet. Evidence of this derivation can be found in the letter names (Fairbank 1955). The names of the letters of the Phoenician alphabet were representative of tangible objects or animals, for example, *aleph* (ox), *beth* (house), *gimel* (camel), *daleth* (door), but the names of Greek letters have no other significance than as names of letters, for example, *alpha, beta, gamma, delta*. In the tenth to fifth centuries BC, there were changes in the methods of writing, particularly in its direction. Those methods went through stages: first right to left, then alternating with each line (sometimes called plowing style or boustrophedon), and finally left to right. By 350 BC, the writing in all Greek states was standardized and Athens had adopted a fixed form for Greek letters (Diringer 1968).

To facilitate the freehand execution of forms, the Ionic Greek alphabet was modified by the scribes. The writing of capitals with ink on papyrus and vellum provided a slight rounding effect that became known as the Greek uncials.

Two classes of writing evolved—calligraphy, which used book-hand forms, and tachygraphy, which used document-hand forms. The former sought clarity, precision, regularity, and beauty and was used to transcribe literature of importance. The latter sought speed and efficiency, and was the style for work documents. Calligraphy maintained a fairly stable design of uncials that became known as book-hand cursive. Tachygraphy allowed changing cursive forms to alter the appearance of the letters. After 250 BC, rounder forms permitted ligatures to link letters and gave writing more speed. The trend continued until the seventh or eighth century AD when a new design of handwritten Greek emerged called minuscule. Some previous uncial forms combined with it and a formal minuscule evolved between 1000 and 1400 AD. The forms of letters in this system do not differ significantly from modern Greek printing.

A derivation of the Greek alphabet was that of the Etruscans in northern Italy, who, around 800 BC, combined Semitic and Greek letters to create their own alphabet. Its final form remained in use from 400 BC until displaced by the Latin alphabet of the Roman Empire in the first century AD. Another derivation of the Greek was the Messapian alphabet, which is thought to date from 800 BC when its people lived in Italy.

The last link between ancient and modern alphabets is the Roman alphabet. Before the Roman Empire peaked, Italy was dominated by the Etruscans in the north and the Messapii in the south, both of whom used alphabets garnered from the Greeks. Consequently, in about 70 to 0 BC, when a script was selected for adaptation to the Latin language, the Romans understandably chose a Greek derived design. The first Latin alphabet consisted of 21 Greek letters from the Etruscan alphabet (Humphreys 1855).

After 600 years of changes and additions to accommodate differences in pronunciation, the Roman alphabet was established. When the Romans conquered Greece in the first century BC, two more Greek symbols ("Y" and "Z") were added. The medieval addition of three more modifications of existing Latin letters ("U," "W," and "J") brought the total to the current 26 letters.

The Romans also developed new forms for the letters, the first of which was called lapidary capitals. The Romans introduced graceful, rounded curves, and tapered stroke endings.

A finishing line, called a serif, across the end of some strokes became popular in stone inscriptions during the first century.

As the use of pen and parchment increased, square capitals, or book capitals that were slightly rounded forms of the lapidary styles evolved. These more freehand formations provided a written rather than a drawn characteristic. At the same time, a second design emerged that sacrificed small details in favor of speed. Serifs became a last turn of the pen rather than a separate stroke. Pen lifts were avoided when possible. The resulting, somewhat casual design, became known as rustic capitals.

The execution of these styles with a broad, flat-tipped pen held at an acute angle to the line of writing, gave the strokes of the letters varying thicknesses. For the square capitals, vertical strokes tended to be broader than the horizontal strokes, but for the rustic capitals, the converse was the case. Both forms were majuscule, that is, the entirety of the letters could be contained between two parallel, horizontal lines. This is roughly equivalent to the meaning of the words *capital letter* today. Rustic capitals, popular for literary works until 600 AD, appeared thereafter only in titles until their demise in the twelfth century.

The everyday Roman writing, used for business during the first century AD, was called cursive capitals. Made with a sharp pointed instrument and fewer pen lifts, the writing line was more uniform in width and connected. Some letters of the style became "minuscule," that is, containing strokes that extended above or below the main body of the letter (e.g., "h" or "g"). This is not precisely the meaning that the word currently carries.

Tannenbaum (1930) reported that Julius Caesar wrote in old Roman cursive, of which there are very few specimens in existence. It is of great historical importance and helps to explain the origin of modern scripts. Several of minuscular letters are traceable to the forms of Roman cursive script found on wax tablets (libelli), discovered at the site of Pompeii in 1875. When this script was formalized, it became the ordinary diplomatic hand of Italy and France until about the ninth century.

The development of writing styles is somewhat obscure in the second, third, and fourth centuries AD, although it became evident that in this interim two new book hands and a new business hand came into use. The older book hand, the Roman uncial, used the broad-tipped pen, but after 500 AD, the pen tip was turned to an angle more parallel to the line of writing. Most of the forms were majuscule, but a few were minuscule. The newer of the book hands, called semiuncials, was written with a parallel pen tip. It was almost entirely of cursive origin and minuscule form (Thompson 1893).

The uncial system fared well until the seventh century AD. After 800 AD it was restricted to titles and disappeared in the twelfth century. The semiuncial system had a more limited use in common literature and died about 1000 AD.

The fourth century saw the introduction of the new business hand called cursive minuscules. It employed a pointed pen like the cursive capitals but utilized minuscule forms like the semiuncials, with a high frequency of connecting ligatures. Their importance in later developments should not be underestimated. They were the basis for the eighth century Carolingian minuscules that dominated Europe for 700 years. The Gothic cursives of the thirteenth to fifteenth centuries that also evolved, yielded to a revival of the pure Carolingian minuscules.

Development in writing systems was encouraged by development in writing materials, all geared to produce speed and efficiency. The domination of Rome produced vellum and the quill pen, but after Rome's decline and the loss of a centralized influence, a new influence surfaced—nationality. From then until today, national characteristics became the major factor in writing styles (Diringer and Freeman 1953; Humphreys 1855; Ogg 1959).

Cursive minuscules were the basis for many national business hands. Uncials and semiuncials were perpetuated in religious texts. An Italian semicursive minuscule of the seventh to ninth centuries was one of the first predominant national styles. From it sprang other national styles such as Lombardic minuscule (tenth to eleventh centuries), Beneventan (eighth to thirteenth centuries) and a pre-Carolingian book hand of northern Italy.

There were numerous other national styles: Merovingian script (sixth to eighth century, France), Visigothic script (seventh to ninth century, Spain), and Germanic pre-Carolingian (eighth to ninth century, central Western Europe). The most important of the new developments were the Insular or Anglo-Irish hands developed by the church, as were most writing systems of the Middle Ages. Of these there were two groups, the Irish hands and the Anglo-Saxon semiuncial. The former is generally attributed to St. Patrick and Irish missionaries, who, using Latin hands, spent countless hours copying Biblical texts. In the struggle for beauty and clarity, new forms of these letter styles surfaced.

The seventh to eighth century Anglo-Saxon hands, a more orderly derivation of the earlier Irish, were employed for Latin until about 940 AD and continued in use for Anglo-Saxon literature. During their time, three new letters were introduced for the sounds of "w," "th," and "dh," but only the "w" survived (Diringer 1968).

Around 800 AD, Charlemagne of France and his Holy Roman Empire became the major centralized influence in Western Europe after the fall of Rome. He learned that many errors had been made in the Biblical texts copied over the previous decades and proposed to correct them. In 781 AD, he persuaded Alcuin of York, a foremost Biblical scholar, to undertake the revision and rewriting of all the church literature. At a school set up in Tours, at the Abbey of St. Martin, Alcuin provided special training for scribes. He introduced a minuscule letter style designed from a combination and modification of the Anglo-Saxon script, Irish semiuncial script, and other early Germanic Carolingian scripts. The emphasis was on simplicity and clarity. Letters were joined for speed in writing, but not at the expense of clarity. The use of some punctuation and of capitals for titles was standardized.

By about 850 AD, the Carolingian developed by Alcuin replaced most of the national hands of Europe, and for 300 years was virtually the only book hand of Western Europe. By the tenth century, however, the Carolingian style had experienced various national modifications. German Carolingian became conservative, the Italian version became a round book hand and eventually the Italian Gothic. English Carolingian and that of northern France was beautiful and regular, and served as the base for German Gothic (Gard 1937; Ogg 1959). The business hands of Western Europe of the ninth to the twelfth centuries were almost exclusively Carolingian. There were national and personal variations, but all became increasingly connected.

During the twelfth and thirteenth centuries a number of factors influenced the development of writing styles. There was an increase in the level of literacy. The use and development of alphabetic systems had become established. Literacy was no longer exclusive to the Church. Changes in alphabets dealt less with basic concepts and more with the design of forms. Styles for artistic purposes were born. The shortage of writing materials could not meet the demand for written works and, consequently, writing was compressed into less space which necessitated some style alterations. Perhaps the greatest factor influencing changes in letter designs was the advancement of printing and the invention of moveable type.

As a result of these factors, German Gothic rose to prominence during the thirteenth and fourteenth centuries. Its narrow angular letters allowed for words to be compacted. As a book

hand, it was popular with the scribes who had taken over much of the copying task from the churches. The business of this era also approached this sharp, angular style in the form of Gothic cursive minuscule, but it took longer to exhibit the broad lines of book hand Gothic. Gothic became the first widely used printing design to be spread by the emerging printing industry (Gard 1937; Ogg 1959).

Gothic letter styles, like the Carolingian, experienced national variations and had replaced most of the previous national Carolingian styles by 1300 AD. Gothic, in one form or another, became the major hand of Europe (Diringer 1968; Ogg 1959). Italy was an exception. Though much of Italy used a Gothic cursive, by about 1350 AD that style's illegibility and lack of aesthetic appeal prompted the development of new styles.

The new styles were an attempt by some to revive a simple form of the Carolingian minuscule (Tannenbaum 1930). The first of these, a new book hand, was the product of Poggio Bracciolini who introduced a new humanistic round hand in Florence. This began to replace Gothic as the standard type for books by 1500 AD.

A comparable humanistic cursive was originated by Niccolo Niccoli, an official scribe of the Vatican, which helped to popularize the style. This cursive style, thinner in line and greater in ligature connections than Bracciolini's, was adapted to typeface by Aldus Manatius in Venice in 1501. Originally called Aldinian, it soon became known as italics and, as a running hand, became the standard for writing in most of Europe (Humphreys 1855; Ogg 1959). Cancellaresca, an important variety of italics, became the style of the manual of handwriting *La Operina*, printed in 1522 by Lodovico Arrighi.

From this point on, the progress of printing and the development of paper manufacture forced scribes and their book hands to yield to printers and their typeface designs. From the German Gothic and Italian fonts, numerous national styles emerged: some transient, some enduring, some ornate, and some extremely simple (Thompson 1893).

At the same time, the role of business and personal handwriting also experienced change. The art began growing beyond its restraints. Writing masters, whose primary employment was teaching writing, began to develop individual systems and styles in an effort to compete with each other. The upper class, who wrote at their leisure, developed their own personal styles according to whim or fashion. Although, generally variations of the Gothic and/or Italian hands, the disregard for calligraphic rules often produced designs that defied classification.

One of the more significant variations of the Gothic cursive minuscule to emerge was called the secretarie hand in England, around 1550 AD (Dawson and Kennedy-Skipton 1966; Tannenbaum 1930). Derivations of this design were used by many other countries as well. In France and Spain, the varieties of Ronde that surfaced were based on the secretarie hand, with some influence from the humanistic cursive. Kurrentschrift, a variety of Gothic cursive that was the everyday hand in Germany until after World War II, was based on the secretarie hand and the Gothic cursive hand of Holland (Tannenbaum 1930).

A lighter, more cursive style of the aforementioned cancellaresca became the basis for a manual printed by C.A. Hercolani in 1574. His use of copper plates for printing, instead of wood blocks, allowed more delicate lines for the ascenders and descenders of the letter forms. Between 1680 and 1700, Colonel John Ayres of London worked on merging the cancellaresca hand and the secretarie hand. He introduced a slant to the right and gave delicate loops to the ascenders and descenders. The new vogue formed the basis for many of today's styles. Ayers' variation of what had previously been called testaggiata became known as copperplate, of which there were two designs: round hand—a bold business hand—and Italian, a delicate ladies' hand. By the beginning of the nineteenth century, the English hand was in general use in England, France, Spain,

and Italy. In 1809, Joseph Carstairs introduced a system in England that required the movement of the whole forearm, not just the fingers. Many of the current systems are modeled after the Carstairs system (Dougherty 1917).

2.3.2 Recent Writing Systems

In North America, the early colonists used designs that generally relied on the same hybrids of the italic and secretarie hands, as in Britain. Later, derivatives of the German kurrent hand appeared as the style of the Pennsylvania Dutch. In 1791 in Boston, John Jenkins published one of the first American copybooks, which was based on a contemporary English round hand (Nash 1959). After about 1830, a variation of the Carstairs system developed called Spencerian. This was the first major system native to the United States and was later imitated in Britain. Several current United States styles (Zaner-Bloser, Palmer, and others) used the wide swinging style of Spencerian as their basis, but replaced the contrasting thick and thin strokes with lines of more uniform thickness.

In 1913, largely due to a mistake at a London teachers' conference, printing or manuscript writing, called printscript, was introduced (Fairbank 1970). This style found use in the United States as an introductory form for children learning to write. It became a final system of its own in some schools.

In North America today, there are a number of commercial handwriting styles that have been advocated by major companies and school districts. The emphasis for most writing systems is to teach speed and legibility. The student is exposed to one of these copybook designs, but the emphasis on clear and efficient execution soon acquiesces to the idiosyncrasies or individuality of the pupil's own needs, as long as they do not interfere with legibility. The need that causes these minor deviations from the copybook examples is generally the same need that brought the alphabet to its present form—the need to simplify the physical motion required to execute the letter designs.

2.4 HISTORY OF HANDWRITING INSTRUCTION

Probably the earliest culture that possessed formal schools of writing was that of ancient Egypt. Private schools and private tutors taught primarily children of the nobility, as the ability to read and write was a necessary complement to their social status. Working class children who showed some signs of intelligence were sent to district schools where they were taught to read and write by older pedagogues. Trade schools were available to teach job skills to the young (Gilbert 1966). Those who were educated in district schools might become apprentices in scribe offices; after years of training they could enter the profession of a scribe, a highly regarded position. Scribes escaped the physical torment that the working class normally received. They could become notaries, writing letters and contracts for the illiterate, or even achieve a position in administration, or in the house of a wealthy person.

Students memorized the names of designs of the written symbols and were given samples to copy. The copies were corrected and returned to the students who continued to practice until they mastered the art (Bowen 1972). These methods were used for the teaching of the hieratic or demotic forms of Egyptian writing. Hieroglyphic inscriptions, that were matters of drawing and carving rather than writing, were also taught, but their use was generally restricted to the priestly or royal classes for official works (Figure 2.7).