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The Evolution of Questioned Document Examination in the Last 50 Years

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ABSTRACT: The last 50 years have seen significant changes and growth in questioned document problems. New writing instruments have come into use affecting handwriting identification and the detection of forgery. Electronic typewriters and word-processing systems have been developed, increasing the difficulty in establishing the source of "typewritten" material. Various new office machines, especially copiers, produce documents very different from those of the 1930s. With all of these problems, there has been an evolution and development of new methods for examining documents and new equipment to assist the examiner. Also throughout this period, certain office machines created challenging problems for several years but subsequently have been replaced for the most part by contemporary equipment. They too are considered since the problems of the 1930s as well as those of the intervening years can still be encountered occasionally.

KEYWORDS: questioned documents, historical background, handwriting, typewriters, photocopiers

Questioned document examination has undergone significant changes in the last 50 years. In a number of respects, it is a more complicated science than it was in the mid 1930s; however, one should not think the work then was easier than today. It has never been an easy task to identify handwriting or typewriting, to detect forgeries or alterations in documents, or to answer many of the problems submitted to the examiner. The manner in which documents are prepared today, however, may provide a greater variety of problems than in the past. From the viewpoint of North American examiners, this paper considers the factors that have brought about the numerous changes that have confronted the profession during these years.

The differences in case work in the 1930s and today did not occur in one or two definite steps, but have developed with a series of changes in the materials and methods of producing documents. It has been a gradual but challenging evolution. In fact, some problems that at one time were vexing gradually ceased to be commonplace because of further developments in document production. Today they may be encountered only on rare occasions when documents of former years are involved. Probably the greatest change in examinations in the last 50 years is that the examiner today must have some knowledge of the problems of the 1920s and 1930s as well as those of the intervening years. Document examination, like all sciences, involves an ever-increasing accumulation of information and techniques. We cannot completely dismiss the past.

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Questioned Documents in the 1930s

Questioned document examination was not much different in 1936 and 1937 than it had been in 1929 when A. S. Osborn published the second edition of *Questioned Documents* [*1*]. In fact, problems were much the same as they had been when he first wrote this text in 1910 [*2*], although there was greater acceptance of the work in the 1930s than in the early years of the century. He and others had honed techniques for greater precision. In the early 1930s, infrared photography had been first applied to document examination [*3*], as had ultraviolet radiation [*4*]. The fountain pen was gradually replacing the dip pen, and a few other type pens enjoyed very occasional use. Typewriters were all manual typebar machines, except for the Hammond with its print wheel and interchangeable type and the new Electromatic typewriter, now IBM, the first electric typewriter to remain in continuous production [*5*].[2] Virtually all machines in the United States were of domestic manufacture, each with distinctive type design. European typewriters, whose manufacturers might have purchased identical type from a typeface factory, were rarely imported [*6*].

Writing inks were all water based, with blue-black, iron-based inks the most common. Various color dye inks were available but less popular. It was 1936 when O'Neill proposed the use of sulphocyanic acid fumes to restore erased iron-based ink, a significant improvement over hydrogen sulfide [*7*]. Paper was manufactured without brighteners, and documents were copied by Photostat, a photographic process that produced readable negative, paper-based copies.

The Changing Problems

New Writing Instruments and Inks Affect Handwriting

In a large measure this situation continued until late 1945, when on 30 October the Reynolds ballpoint pen was first sold at Gimbels, New York City. The new pen took the country by storm. Protests by bankers and document examiners were unheeded [*8*]. Despite the pen's poor writing quality, Reynolds pens and the numerous copies that followed sold by the thousands. The price dropped rapidly from $16.00 to less than a dollar within a year or so. With it the document examiner found the first of challenges that were to continue to occur for the next 40 years. It became necessary to differentiate between faults of forgery and defects of the typical ballpoint pen [*9*].[3]

Within ten years, ball pens were by far the most common writing instruments [*10*]. With improved ink and manufacturing techniques, they had become a reliable writing instrument [*11*]. Fountain pens were disappearing, and sometime in the 1950s the U.S. Post Office replaced its infamous steel nib pens with ball pens. Even banks installed ball pens on customer desks. A series of smaller balls were developed to produce finer strokes, and in 1979 PaperMate introduced the first erasable ball pen. Its ink when fresh could be easily erased [*12*], resulting in a new concern for the document examiner.

Early in the 1960s the Japanese imported the first of the fiber tip pens, a soft-tip, fluid-ink instrument [*13*]. Originally, there were broad-line writing instruments, but gradually they were modified to produce fine-tip writers, most with porous plastic points. These latter pens constitute a subclass of pens with some different writing qualities. In 1975 the roller pen was introduced, a ballpoint pen with fluid, water-based ink. As early as 1952 or 1953, attempts had been made to produce such a pen, but in the 1970s, ink formulation finally permitted

[2]The Electromatic Company was organized to market an electric typewriter in 1929 and merged with IBM in 1933. IBM has successfully marketed this type machine since that date [5]. Beeching [5] details the earlier attempts to produce electric typewriters. Only Mercedes (1922), Woodstock (1924), and Remington (1927) produced and sold earlier machines, but later discontinued them.

[3]A more extensive analysis of the writing faults of these pens appears in Ref *10*.

the ball to write without clogging. These, plus the revived use of the fountain pen, are the present-day choices [*14*]. All of the post-ball pen developments were gradually accepted, but it took time for some examiners to recognize that these pens created problems not even anticipated 50 years ago.

Changes in Typewriters

The immediate post-World War II years brought about changes in typewritten documents. As the typewriting companies returned to typewriter manufacturing, each introduced electric models,[4] and typefonts in addition to pica and elite were featured. Foreign companies began selling more machines in the United States. Early in the 1950s, IBM launched a significant sales campaign for its Executive model, proportional spacing, typewriter. IBM had developed the machine as early as 1939, but few had been sold before the effective 1950s sales campaign. Three escapements were available based on units of 1/32, 1/36, and 1/45 in. (0.79, 0.71, and 0.56 mm) [*15*]. The first two were the principal sizes. Unlike machines equipped with new fonts by IBM and its competitors, this machine required new tools and techniques to answer identification problems [*16*]. Remington and Olivetti developed similar machines, but IBM dominated the market.

31 July 1961 stands as a key date in typewriting examination. On that date the IBM Selectric was formally introduced, although some few had been field-tested earlier. The Selectric was the first modern, single-element, typeball machine. Entirely new concepts were introduced into the identification formula [*17*]. Typeballs were interchangeable between machines and could be replaced with type of a different design in the course of writing a page of text. There is a definite correlation between groups of defects, and the great majority of defects are not very prominent. With IBM's highly efficient sales apparatus, the Selectric quickly became the standard office typewriter. In due course other companies introduced their own typeball machines, but they sold few in comparison to the Selectric [*18*]. With these competing machines, type styles were closely copied, making it difficult to determine from the document the probable make of typewriter that had been used. In September 1971, an improved Selectric II was released with dual escapement, that is, the ability to type in units of 1/10th and 1/12th in. (2.54 and 2.12 mm) without removing the copy [*19*]. Fifty years ago, pica and elite typing on a single page, not to mention a change of font of either size, would have been instant evidence that two typewriters had been used. It is not necessarily so today. On 1 April 1973, IBM added to the Selectric II the Correcting Selectric with its lift-off ribbon, leading to cleaner corrections and alterations in documents [*20*]. These machines, and their ultimate copy by other companies, are the most advanced electrically powered typewriters. Only with the development of memory chips and electronic typewriters and word processors have further advancements been possible.

In 1972, Diablo developed the first print-wheel typing unit which was used as a printer for computer systems and word processors. Xerox purchased the company and released its models 800 and 850 word processors in 1974 with the print-wheel printer for hard copies. In 1979, Qyz Exxon applied the print-wheel concept to the first memory typewriter, capable of serving both as a typewriter and a low-volume word processor. Since then, a number of manufacturers has replaced the typeball and typebar typewriter with the print-wheel concept [*21*]. Both the typeball and the print-wheel single-element writer produce typed copy that has only very inconspicuous defects. With the great volume of typing being produced by typewriters, computers, and word processors using the print wheel, the document examiner has again been challenged to develop adequate identification techniques. Typewriting identification has become much more exacting since 1937.

The widespread use of computers in business and for personal use are creating a series of

[4]Beeching [5] gives dates of introduction of various makes (p. 181).

new problems to challenge the skills of the document examiner. Personal computers use daisy wheel, dot matrix, and laser printers. The first are consistent with the print-wheel typewriter problems, but dot matrix and laser printers add to the new problems confronting workers today. Main-frame computers may require high-speed printers of either the chain or drum type, involving different techniques for identification. With computer crimes becoming more frequent, familiarity with these types of problems will become important [*22*].

The developments in typewriter design have also seen changes and improvements in typewriter ribbons. In the 1930s and for a number of years thereafter, most typewriter ribbons were cloth impregnated with an oil-based ink. The 1950s saw the introduction of the carbon ribbon, a paper ribbon with a carbon wax coating. By the 1960s, improvements in these ribbons included the introduction of a plastic base to replace the paper and changes in the composition of the carbon coating; these ribbons were a single-strike variety. IBM improved on these single-strike ribbon with a multiple-strike plastic ribbon for some models of the Selectric typewriter. A more significant change came with the correctable ribbon, that is, a plastic base coated with an ink that could be lifted from the paper for some time after the original typing. It was this development that occurred simultaneously with the introduction of the Correcting Selectric in the 1970s. Today this class of ribbon is available for use on all electronic typewriters as well as the late Selectric models and printwheel machines of other companies and now has widespread use.

The dot-matrix machine required the development of special inks to be sprayed on the paper, and thermal printing machines have required the development of heat-sensitive ribbons to print their characters. Each new ribbon has modified the work of the typewriter in some way and with some changes created modification in the way that typewriting is examined.

Evolution of the Modern Copier

While writing instruments and typewriters were changing, so were the means of copying documents. Business found the need (or perhaps manufacturers of office copiers developed it) for quick, convenient means of copying documents. The document examiner's principal problem with the work of several of these copiers was how to make a meaningful examination from their poor quality copies.

First, Diazo printing was developed to replace blueprinting in industry, but these units were not well suited for copying commercial and personal documents. Two methods were developed that involved reflex copying, that is, passing light through the document as it rests on the sensitized copy paper. The diffusion transfer method was the first introduced in the United States in 1952. A wet development produced a negative that was pressed against the positive sheet to transfer the images. The two sheets were then peeled apart while still damp.[5] The Eastman Verifax process, known as a gelatin transfer, produced a similar direct positive copy. Because of the diffusion of light as it passed through the original document, there was a loss of finer details with both methods even under the best of circumstances. If the solution was nearly exhausted, very poor quality results could be expected and were not uncommon. These photocopies seriously restricted the work of the document examiner.

The first dry, direct positive copying process was the Thermo-Fax, developed by 3M in 1950. It is a thermographic method using infrared or heat to develop the copy image. Two serious defects were that nonmetallic dye inks would not copy and the copies themselves deteriorated slowly or more rapidly under hot storage conditions. Occasionally, document examiners would encounter copies of signatures that appeared to be traced or freehand for-

[5]This method and several other methods for office photocopying are discussed in some detail in *Chemical and Engineering News*, 20 July 1964. The issue is devoted to a special report on office copy machines.

geries only to find, when the original document was examined, that the signature had been traced over with pencil to record in the Thermo-Fax copy. In the 1960s, 3M improved on this method with its dual-spectrum process that overcame both the poor lasting quality and the failure to copy some inks. The dual-spectrum system required special copying paper and could not compete successfully with Xerox's plain-paper copiers.

Introduced in the late 1950s, the transfer electrostatic process used by plain-paper copiers produces a good black-and-white reproduction on ordinary paper. The Xerox machine is a photographic type camera with a lens system that transfers the image onto an electrostatically charged drum, which in turn picks up toner. The drum rolls across the paper to transfer the toner to the sheet, and the image is fused to it, forming a permanent copy of the original. The mechanism involved is complex, and early machines were large, expensive units. In the course of time smaller, compact units were designed for small offices and very complex units were developed for high-volume rapid copying and collating of multipage documents.

In 1961, several companies marketed another type of office copier suitable for moderate-size offices. It was a direct electrostatic unit that produced the copy on zinc-oxide-coated paper. The finished copy was much like plain-paper type copy except for the paper base. When the transfer electrostatic method (Xerox) became available to other manufacturers and the unit was made more compact, the transfer electrostatic copier became in time the almost universally used copier. The document examiner has learned to work from these copies, at least for preliminary study as long as they are good grade reproductions.

In examining photocopies of this class today it is sometimes possible to show that two or more copies came from the same copier by mean of trash marks that are found on the copies. Methods have been developed to distinguish between work from different makes of copiers [*23*]. With the easy access to these copiers, the problem of fraudulent photocopies is encountered on occasion [*24*]. The problem is not new, since even with the old Photostats an occasional problem of fraudulent manipulation was encountered 50 or 60 years ago, but the present-day machines have simplified the problem a good deal for the forger.

Within the last 15 years, color photocopies have been available. Development work continues on these machines to improve the quality of their copies. As the newer machines become more commonplace, document examiners may be faced with other new problems.

Writing Papers

In the 1950s, changes in writing paper were introduced, which created occasional and relatively minor problems for the examiner. The use of brighteners in paper produced whiter sheets. Brighteners reflect ultraviolet (UV) radiation and reduce the usefulness of some UV examinations. The second change was the development of erasable typewriter paper. With standard typewriter inks on such paper it is much easier to erase fresh typing. The presence of such erasures and alterations may require more careful study than similar changes on other types of papers. In fact, some might even pass unchallenged by the layman.

New Examination Techniques and Equipment

Document photography today requires skills that were not required of the document examiners of the thirties. The development of color films and the 35-mm camera provides the modern examiner with useful techniques that did not exist 50 years ago. Still, the traditional black and white photography continues to be a valuable tool.

During the last 30 years especially, document examiners have developed or adapted several new examination techniques. These have arisen out of the problem of answering questions created by changes in writing instruments and office equipment that prepared or copied the documents.

Changes in inks have lead to significant use of thin-layer chromatography [*25,26*] and spectrography. Also, nondestructive tests with dichroic filters [*27*] and infrared luminescence [*28,29*] combined with the older ultraviolet and infrared studies are valuable in differentiating between apparently similar inks. Infrared studies have been simplified by the adaptation of electronic infrared viewing equipment. Even infrared luminescence tests can be shortened with electronic equipment, eliminating the need for photography by displaying the test results on a cathode ray tube.

Modern inks and pens have created questions concerning the sequence of strokes that could not be solved by the same criteria that had been developed for nib pens and fluid ink. The Krome-Kote lifting technique proved to be an answer to certain classes of ink intersections [*30*]. With other problems, study and modification of traditional tests established the order of writing. In a few laboratories, sequence problems have been examined experimentally with the electron microscope, with some success [*31*].

A very significant addition to equipment for document examination occurred in the 1970s: the electrostatic detection apparatus (ESDA) is the most sensitive means of revealing pressure patterns on documents, even impressed writing traces that cannot be recognized by visual study and photography under carefully controlled lighting conditions [*31*].

A number of techniques and modification of equipment have been of importance in solving problems when more traditional methods were inadequate. In 1939 Tyrrell [*33*] improved decipherment of charred documents by pretreating them with UV radiation before using Davis's method of placing the charred paper in tight contact with photographic plates [*34*]. When confronted with a large volume of charred documents, Black in 1947 found that chloral hydrate solution lead to good, rapid results [*35*]. Black also investigated burr striations in ball pen strokes and showed that under proper conditions they could lead to identification of a suspected pen [*36*].

To reveal malalignment of proportional spacing typewriting, the Osborn alignment grid was redesigned for both 1/32- and 1/36-in. (0.79- and 0.71-mm) escapement [*16*]. The methods of identifying typewriting was broadened by recognition that variable defects, those that only occurred in some but not all impressions of a character, could be considered as part of typewriting identification and dating [*37*]. However, the most important change in typewriting identification occurred in 1961 with the IBM Selectric's typeball and its influence on typewriting identification [*17*].

In sequence determination, the bright specular reflection found at an intersection was proven to establish that a certain ink line actually was written after an existing typewritten line [*38*].

In the 1930s, location of an erasure was detected by physical changes in the paper surface, and these methods are still quite effective today. However, in 1979, Kind and Dabbs reported a sensitive test using Lycode powders to disclose the erasure sites that might otherwise have been overlooked [*39*].

Professional Societies and Journals

It is fortunate that during the last 50 years, several professional organizations have been established. Before 1936/1937, Dr. A. S. Osborn invited a small group of document examiners to meet annually to discuss questioned document problems. All were private consultants; at that time there were few examiners in government service. The FBI laboratory was organized in the early 1930s. Scattered around the country were a few other examiners working for a federal, state, or municipal law enforcement agency. In 1942, E. W. Stein and Clark Sellers suggested that the Osborn group organize into the American Society of Questioned Document Examiners. For over 10 years it remained exclusively an organization of consulting document examiners.

In 1948, there was a meeting of forensic scientists in St. Louis that led to the formation of

the American Academy of Forensic Sciences. From that beginning, the policy was to develop a broad-based forensic science academy. In 1952, this writer was urged by Ralph Turner, Secretary-Treasurer, to develop a questioned document section. The following year at the Chicago meeting, a small group of document examiners, both private consultants and government examiners, participated in the first document section meeting. Annual meetings have continued with steady growth in membership. Through meetings and publications, document examiners in these two groups have made it possible to keep abreast of changes in this work.

The first international meeting in question documents was part of the 1963 International Forensic Science meeting in London. Dr. Camps, president of the meeting, in response to this writer's inquiries, invited document examiners to organize a program and join the meeting. After extensive premeeting correspondence among examiners in many countries who would be interested in attending, and with Peter Baxter's assistance in London, the first triennial meeting occurred, and more extensive international exchanges resulted.

Besides meetings, publication of new methods and procedures influenced the evolutionary process. The *American Journal of Police Science* began publication in 1930 and was soon to be incorporated with the *Journal of Criminal Law and Criminology*. It was the original forensic science forum. In 1956, the American Academy of Forensic Sciences launched the *Journal of Forensic Sciences*, which has become a leading publication, covering all disciplines in the field. The Canadian Society of Forensic Science was organized in 1963 and began publishing its *Journal* in 1969. In 1961, the *Journal of the Forensic Science Society* began publication in England and has made further contributions to the progress of questioned documents. *Forensic Science International* (1973) is a further source of new information. Through these and other English and foreign-language journals, the body of knowledge in questioned documents continues to grow.

Professional qualifications of document examiners has been the concern of the leading examiners throughout the century. Professional societies and publications have endeavored to enhance the qualifications of members and readers. It was the sole purpose of A. S. Osborn's group from as early as 1913. In 1977, after several years of consultation, a group of examiners organized the American Board of Forensic Document Examiners to provide a program of professional certification for U.S. and Canadian examiners only. Its requirements mandate a framework of general and professional education, ethical practice, and the need to demonstrate fundamental abilities in solving technical problems. In 1985, the Forensic Science Society in England inaugurated a comparable program leading to a Diploma in Document Examination, but admits non-U.K. citizens and nonmembers of the Society. These are first steps in providing a measure of the competency of those claiming qualifications in this branch of the forensic sciences.

As one looks at the field of questioned document examination today, it appears to be a much more complex discipline than it was 50 years ago. Of course, the basic problems of handwriting and signatures still occupy an examiner's principal concern, but knowledge of many other document problems is also necessary. Important documents are produced in many different ways, and the examiner must be able to verify or disprove their authenticity. Document-producing equipment changes and new devices are being developed each year, and the question of what kind of documents will be produced by them is among the problems ahead. Questioned document examination is an ever-changing profession. Examiners must continue to search for solutions to new problems.

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