J Forensic Sci, Oct. 1979, Vol. 24, No. 4

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Criminalistics—A Look Back at the 1970s, a Look Ahead to the 1980s

It would be an overt act of omission to permit this decade to expire without reflection on its impact on criminalistics in the United States. Its influences were profound. No prior comparable period matched the growth and maturation of our profession during this decade. In the short span of ten years criminalistics, at first a stepchild of the analytical sciences, grew to achieve full acceptance as a legitimate discipline of applied science. In retrospect, this progress was long overdue considering that criminalistics entered the 1970s not as a new phenomenon but as one that had been in existence for nearly 60 years. Given the political and economic climate of the 1970s, anything less than the unprecedented growth experienced would have warranted a severe condemnation of its professional community.

With growth came the entry of hundreds of chemists and biologists into our ranks. In 1969, the American Academy of Forensic Sciences had a total membership of 804, with 156 members affiliated with its criminalistics section. By 1978, Academy membership had expanded to 1932, with 465 joining in the activities of the criminalistics section. However, Academy membership represents just the tip of the iceberg, and perhaps it is best to look at membership in regional associations to gauge the population of our field.

The emergence of strong regional associations dedicated to fostering local professional conduct and interaction among criminalists was a positive phenomenon of the 1970s. Joining the long-standing California Association of Criminalists were the Southern, Midwestern, Mid-Atlantic, Northwestern, and Northeastern Associations of Forensic Scientists, representing nearly 1600 criminalists. Given the fact that these organizations do not account for the entire criminalistics community, I would conservatively estimate that today there are more than 3000 practicing criminalists in the United States.

The increase in the number of government-operated crime laboratories is likewise impressive. In 1966, 110 crime laboratories were identified [*1*]. A recently conducted proficiency testing program cited 240 active criminalistics facilities [*2*].

Searching for reasons to account for this growth is not difficult. Social and political concerns of the 1960s focused on crime and led to the creation of the Law Enforcement Assistance Administration (LEAA) in 1968. Through this agency the federal government distributed vast sums of money for rehabilitating our country's criminal justice systems. One obvious benefactor of this monetary infusion was the crime laboratory. As crime laboratories were created or expanded, workloads also continued to grow. Drug abuse, a problem that primarily affected the lower socioeconomic levels of society during the first half of the century, slowly grew during the 1950s and early 1960s. With the inception of the Vietnam War drug abuse accelerated to uncontrollable levels. The start of the new decade saw crime

The opinions or assertions contained herein are the private views of the author and are not to be construed as necessarily reflecting the views of the American Academy of Forensic Sciences or the New Jersey State Police. Presented at the 31st Annual Meeting of the American Academy of Forensic Sciences, Atlanta, Ga., 15 Feb. 1979. Received for publication 7 March 1979; revised manuscript received 8 May 1979; accepted for publication 10 May 1979.

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laboratories inundated with drug specimens and facing the problem of inordinately large work backlogs. Ironically, drugs, a type of evidence assigned low priority and scorned as a nuisance by some early criminalists, suddenly engulfed and consumed the time and energies of crime laboratories. With the drug abuse boom and the entrance of the LEAA monies into budgetary pipelines, 1970 marked a turning point in the evolution of criminalistics. Expansion of crime laboratories now became necessary to restore them to their proper role in the criminal justice system.

Physical plants are in themselves relics if they are not properly equipped and supplied. Denied adequate funding since their inception, many crime laboratories began the 1970s ill-equipped to deal with the problems imposed on them. It now seems difficult to comprehend that back in 1967 only 32 crime laboratories were identified as having facilities for thin-layer chromatography; 50 laboratories reported having infrared spectrophotometers and 56 had ultraviolet spectrophotometers; 46 were equipped with gas chromatographs; 22 had X-ray diffraction capabilities; and only 17 had access to electrophoresis [*1*]. For the most part, major analytical developments that took place in the 1950s and 1960s were not available to most crime laboratories. Two, and in some cases three, generations of an analytical instrument were on the market before the first one found its way into crime laboratories during the 1970s.

When monies finally became available the floodgates opened. Every forensic science facility became fair game for equipment manufacturers. For a time it seemed that all major equipment manufacturers had brochures and advertisements expounding on the use of their products for solving forensic science problems. Reams of notes on applications to the forensic sciences were published. Instrument manufacturers discovered criminalistics and competed for their share of what proved to be a very lucrative market. Their successful penetration of this market more than any other event in the 1970s indelibly changed the criminalistics scene.

Historically, fictional characters have elicited public acceptance of our work. The exploits of Sherlock Holmes caught the imagination of the reading public and made science an integral part of criminal investigation. In large measure, Sherlock Holmes was responsible for creating an atmosphere conducive to the public support of crime laboratories in the early years of the 20th century. The American public's fascination for police adventures continued into the 1970s, and, more than any other medium, television exerted its influence by reaching into millions of homes. The skills of Chei Fong, *Hawaii Five O's* criminalist par excellence, dwarf the realities of forensic science. Take a pathologist, give him the attributes of a criminalist and police investigator, provide him with good Hollywood scriptwriters, and you have *Quincy*, one of television's most popular programs. *Quincy* on occasion may stretch credibility, but, on the whole, the character has strived not to stray too far from reality. However, let us not belittle the impact these characters have had on our profession. Because of them, the meaning and utility of forensic science have become known to millions of Americans. While our work may be excessively glamorized, the public image of our profession is extremely positive. This observation is especially relevant because, unlike most branches of science, our work is not consistently subject to peer review but is weighed by a jury of laypersons.

The popularization of criminalistics can only serve to create an atmosphere that is more conducive to the acceptance of our data in the courtroom. However, there is a distinct danger of abuse and misplaced confidence with such a situation. The U.S. Court of Appeals has already cautioned that scientific expert testimony carries with it danger of undue prejudice because of its aura of special reliability and trustworthiness [*3*]. The Court has spelled out strict guidelines for assessing irrelevant and prejudicial testimony by scientific experts. This danger of misplaced trust has not escaped members of the American Academy of Forensic Sciences. Recently, a strict code of ethics was incorporated into its bylaws to discourage any misrepresentation of qualifications or data.

Perhaps the task of assessing the present-day capabilities of criminalists will be easier if we consider their analytical chores from two distinctly different points of view: identification and comparison. Simply stated, the identification process seeks to describe a substance in either chemical or physical terms. It encompasses the chemical identification of drugs, explosives, and hydrocarbon mixtures and the species determination of wood, hair, or blood. Comparative analysis attempts to assess the origin of objects. In criminalistics, the ultimate objective of a comparison is to link physical evidence to a single person or source. Comparisons of hairs, paint chips, bullets, or fingerprints are common examples of this endeavor.

Given the extensive preoccupation of crime laboratories with drug analyses, it is not surprising that chemical identifications were afforded much attention during the past ten years. However, identifying a drug or an explosive presents no more formidable an analytical problem than the identification of most other organic substances. Therefore, it is no surprise that the criminalistics community became a major benefactor of the advances made by analytical technology in the 1950s and 1960s. Like most other analytical chemists, we have come to rely on gas and thin-layer chromatography and ultraviolet, infrared, and mass spectrometry for our results and are beginning to explore the applications of high pressure liquid chromatography.

None of the techniques just cited were developed during this decade; nevertheless, important, innovative improvements and refinements of each did occur. For example, newly designed nitrogen-phosphorus detectors incorporating electrically heated alkali glass became available in 1975. These and subsequent modifications extended the ability of gas chromatography specifically to detect nitrogenous drugs at orders of magnitude that are nearly two-fold higher than those of previous efforts.

As we entered the 1970s, the combination of gas chromatography and mass spectrometry (GC/MS) was a new commercial reality. As we enter the 1980s, GC/MS has become an analytical necessity. Criminalistics is a science that requires the ultimate in specificity, and GC/MS is a technique that satisfies this demand. We perhaps more than any other branch of applied science can appreciate the rigorous criteria that must be attached to a "positive" identification. The question of how many tests are needed to insure that an identification attains reasonable scientific certainty has been and still is gnawing for criminalists. The GC/MS achieves the highest levels of confidence for organic identifications and will, for the foreseeable future, serve as the benchmark against which all past, present, and future schemes of analysis will be measured for accuracy and validity.

Perhaps the most important contribution to analytical instrumentation in the 1970s was the introduction of the microprocessor. Twenty years ago it took a computer weighing three tons and containing 7000 vacuum tubes to do the work of today's hand-held programmable calculators. The marriage of microcircuitry to analytical instrumentation has made automation possible along with the technology for rapid data collection and dissemination. Thus, as we enter the 1980s, we know that a new and powerful dimension has been added to analytical instrumentation, yet the full implications for forensic science technology remain unclear. What is certain is that fundamental changes in the design and capabilities of instruments will be a hallmark of the 1980s.

Focusing on analytical technology satisfies only one aspect of the identification process. Access to comprehensive standards and reference files is also an essential prerequisite for a successful identification. In criminalistics the accumulation of reference data is complicated by the wide diversity of natural and manufactured products presented for analysis. This effort is further hampered by the fragmented nature of our crime laboratory system. Few organizations are in a position to mount a concerted national effort to collect meaningful reference materials and then follow up with the equally important task of keeping them current. Hence, the commitment of the National Bureau of Standards (NBS) to provide crime laboratories with relevant reference materials represents an important step forward.

The NBS has assembled an automobile paint collection, starting with 1974 models, to aid in the identification of automobile makes and models from paint fragments recovered at crime scenes. Comprehensive collections of animal hairs and synthetic fibers are now being planned by NBS.

The Crime Laboratory Information System (CLIS) represents a more sophisticated approach in reference data collection and dissemination. This system provides for telecommunication between crime labs and a computer maintained by the FBI. Such an arrangement allows for the convenient storage and retrieval of selected reference material. In 1978, a prototype of the CLIS system began operation with a General Rifling Characteristics File. Its purpose is to access stored computerized information so that crime laboratories can determine the possible make and model of a firearm from a fired bullet or cartridge case. Nearly 40 laboratories are presently using or planning to use this file.

Although the identification process is important to the criminalistics enterprise, it is from our comparative efforts that our profession derives its character and uniqueness. Spurred on by successes in fingerprint and bullet individualization during the formative years of criminalistics, we hoped that these accomplishments could be quickly achieved with other types of physical evidence. Who would deny the implications of being able to link a hair or bloodstain to a single person? Think of the consequences if a scientist could determine that a paint chip is unique to one surface or a fiber unique to one fabric. As of now, these dreams have not become realities, and criminalists enter the 1980s, for the most part, little better prepared than they were in 1970 to assess the consequences of most comparisons. This is not to deny the important corroborative value of class evidence. The annals of crime investigation are glutted with examples of individuals unjustly accused or convicted in the absence of corroborating physical evidence as well as with court cases lost because of insufficient physical evidence.

The 1970s will be remembered as a decade that witnessed dramatic improvements in the quantity and quality of the hardware at the disposal of crime laboratories. The major disappointment is that the task of assessing the discriminating power of these instruments for distinguishing similar types of physical evidence barely began. There were some bright spots, however, and consequent hopes for future successes.

I find it rather easy to designate the most significant advancement in forensic science comparative analysis during the 1970s. In fact, it was in 1970 that the renowned British forensic serologist Bryan Culliford came to this country to demonstrate newly developed electrophoretic procedures for detecting protein and enzyme polymorphs in bloodstains. These procedures dramatically improved the discriminating power of bloodstains and enhanced their value as comparative evidence. At that time, Culliford held a workshop at John Jay College in New York City to train 21 American serologists. Culliford then went on to publish state-of-the-art procedures for bloodstain discrimination under the title *The Examination and Typing of Bloodstains in the Crime Laboratory* [4], a publication that in my estimation is the single most important contribution to the forensic science literature in the 1970s.

Continued progress toward incorporating these and subsequently developed procedures into the routine of most crime laboratories proved disappointingly slow. By 1975, a nationwide voluntary proficiency testing program of crime laboratories revealed only 33 facilities capable of reporting one or more blood polymorphs [2]. Concerned with this lack of progress LEAA in 1977-1978 supported research efforts by Brian Wraxall and Mark Stolorow that culminated in the development of methods suitable for the multisystem analysis of three groups of protein and enzyme polymorphs in bloodstains [5]. The project also included funding to assure transfer of this technology to at least 100 crime laboratories. This training is presently in progress. The decade thus ends on a very optimistic note concerning the future status of serology on the American forensic science scene.

The problems of forensic science comparisons are as varied as the evidence crime laboratories encounter. One area that offers tremendous potential for improving our capabilities for discriminating items of physical evidence is trace elemental analysis. The wide variation of elements in natural and man-made products has not yet been fully taken advantage of to accomplish forensic science comparisons. Perhaps a major impediment to progress has been the absence of an instrumental technique that fully addresses itself to the needs of the criminalist. For instance, neutron activation analysis is an excellent technique for simultaneous multielement determinations at low levels, yet it suffers from the disadvantages of high cost and the requirement for a fission reactor. Most crime laboratories are in no position to overcome these limitations. The emission spectrograph has long been used in crime laboratories. However, while it can provide for simultaneous multielement analysis, it offers only semiquantitative information. Furthermore, obtaining reproducible data is highly dependent on operator skills in sample preparation. X-ray spectroscopy has received a considerable amount of attention during the 1970s, particularly when it is coupled with the scanning electron microscope. Under these circumstances, sample size presents no problem, but multielement analysis yields only semiquantitative data. Additionally, the technique is relatively insensitive for detecting trace elements in a solid matrix. On the other hand, atomic absorption (AA) spectrometry has extremely high sensitivity and produces quantitative data. Yet present instruments are not suitable for performing simultaneous multielement determinations.

There now appears to be a solution to this quandary: atomic emission spectrometry [*6*]. Sensitivities approaching AA are achieved by exciting atoms in an inductively coupled plasma source. The light emitted from excited atoms is resolved with a scanning monochromator. This provides for the simultaneous and quantitative detection of up to 48 elements. This instrument seems to overcome many of the deficiencies inherent in other analytical techniques with respect to forensic science applications. The technique deserves a good deal of investigation in the 1980s.

The impressive advances of criminalistics in the 1970s should perhaps be cause for optimism in the 1980s. However, there are clearly ominous signs on the horizon. It would be foolhardy to discount our profession's intimate ties with government. Most criminalists are employed by federal, state, or local governments. As we entered the 1970s rising crime rates were a burning political issue. During the 1970s LEAA's budget increased ten-fold, reaching nearly one billion dollars in annual expenditures. A portion of this money filtered down into many crime laboratories to finance new and expanded services. However, rampant inflation and growing fiscal conservatism have already adversely deflated this support. Fiscal retrenchment has reduced the appetite of the federal government even for law enforcement support. As we enter the 1980s federal dollars for crime laboratory services are increasingly harder to come by. I am not forecasting a massive shutdown of crime laboratories for I am confident that we will continue to receive sufficient funding to support our existence. But to exist is not to flourish. When priorities must be set in the light of limited resources we as scientists have come to expect that research and development become expendable. If this comes to pass the prospect for meaningful growth during the next decade is limited.

Up until now many of our advancements were made by capitalizing on developments in other branches of science. Selecting an analytical instrument for a crime laboratory proved to be a rather easy chore. Various analytical sciences quite convincingly demonstrated the applicability of gas and thin-layer chromatography and ultraviolet, infrared, and mass spectrometry to our needs. However, now that the more obvious choices have been made a more perceptive evaluation of emerging analytical methods will be required. We can no longer count on extrapolating data developed by other branches of analytical science, who are in pursuit of their own particular endeavors, to gauge the applicability of a particular instrument or technique to criminalistics. Criminalistics is a scientific endeavor encountering unique problems requiring innovative solutions. Without research and development we will have no choice but to confront 1980 problems with 1970 solutions.

The fact is that 1970 solutions leave much to be desired, particularly in the area of comparative analysis. We have been given potent tools with which to conduct our work but as yet have failed to define in statistical terms the meaning and significance of the data they generate. When we agree on the desirablity of evaluating a particular physical or chemical property, the diversity of techniques and procedures used by crime laboratories often prevents the acquisition of standardized data amenable to producing valid frequency of occurrence information. Like a vicious cycle, without this interpretive information how certain can we be that the properties selected in the first place were best suited to meet our objectives? Certainly, we cannot expect, nor should we expect, other scientific disciplines to address themselves to these questions.

I do not pretend to know what breakthroughs 1980 technology will bring, but I do know that it is possible only through the efforts of our own profession to consolidate gains made in the 1970s. For this reason, I am optimistic that the FBI's announced plans to establish a forensic science research center will be a major milestone in the history of criminalistics. At last the United States will have a national research and development laboratory in criminalistics to attack our shortcomings. Furthermore, with the creation of 15 forensic science degree programs during the 1970s, increased participation by the academic community in criminalistics research is to be expected [7].

In the light of present economic restraints, priority is being placed on funding research that attacks our economic and social ills. Under these circumstances continued support of the criminalistics effort is more than justified. Our profession must launch a coordinated effort to enlighten the government and the general public of this fact. Much has been accomplished, but even more now remains to be done.

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