ARTICLES

THE EVOLUTION OF FORENSIC SCIENCE: PROGRESS AMID THE PITFALLS*

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I. INTRODUCTION

There have been several significant social, legal, and scientific changes in the criminal justice system and the forensic sciences since the 1970s that have dramatically altered the contours of the law-science interface. While this Article highlights several scientific and technical breakthroughs that have fundamentally enhanced the types of assistance that forensic science provides to the criminal justice system, its primary emphasis will be on the key legal, cultural, professional, and organizational changes that have shaped how science is used in today's criminal justice system. DNA typing is, without question, the single greatest forensic scientific breakthrough in the past century,[1] but there have been

* This Article originated as a presentation that introduced a session at the National Conference on Science, Technology and the Law held September 12–14, 2005, at Stetson University College of Law. This particular session was devoted to the impact of new technologies on the criminal justice system and included presentations on the use of DNA technology in solving burglaries and lesser offenses, the ability of cameras and related technology to monitor high-crime urban streets, and various quality assurance factors affecting the reliability of forensic evidence entering the criminal justice system. This Article expands on many of the points and trends identified in the presentation at the conference.

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1. There are many sources of information in scientific, legal, and popular literature on the effects of DNA typing on criminal justice. *See e.g.* President's DNA Initiative, *Ad-*

several other key changes, such as the following: landmark Supreme Court decisions have modified how our courts evaluate and admit scientific evidence;[2] professional initiatives have addressed the credentials of forensic examiners, the quality of laboratory operations, and the accuracy of scientific evidence testing;[3] and legal and popular culture has created an unprecedented awareness of, and appetite for, forensic science.[4]

Still, we cannot disregard factors that seriously limit the full usage of the forensic sciences by our justice system. We pour resources into DNA typing but fail to devote the necessary funds to the collection and analysis of other types of evidence in crime laboratories. Backlogs of evidence awaiting analysis in crime laboratories slow the judicial process. We also have recurring reports of poorly trained and equipped forensic scientists who make errors in their examinations of evidence and indications of other examiners who shape their results to satisfy the desires of parties to a case.[5] We have created standards that, if followed, can lift up the quality of forensic science, but our legal institutions have failed to mandate that the standards be satisfied by examiners who submit their reports and give testimony in our courts. In fact, it is only logical that high scientific standards should be invoked *before* scientific evidence is allowed in court, but judges and lawyers have not insisted that those criteria be met in every case.[6]

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vancing Justice through DNA Technology, http://www.whitehouse.gov/infocus/justice/dna_initiative_policy_book.pdf (accessed Sept. 24, 2006) (discussing scientific articles and case studies, and providing detailed information for investigators, officers of the court, and policy-makers regarding the advancement of DNA technology).

2. *See generally Kumho Tire Co. v. Carmichael*, 526 U.S. 137 (1999) (holding that *Daubert* applies to all types of expert testimony); *Gen. Electric Co. v. Joiner*, 522 U.S. 136 (1997) (holding that the trial court did not abuse its discretion by refusing to admit evidence that did not meet the *Daubert* standard); *Daubert v. Merrell Dow Pharms., Inc.*, 509 U.S. 579 (1993) (rejecting the *Frye* standard for admitting scientific evidence and suggesting a series of factors for admitting relevant and reliable scientific evidence).

3. Jan S. Bashinski & Joseph L. Peterson, *Forensic Sciences*, in *Local Government Police Management* 559 (William Geller & Darrel Stephens eds., 4th ed., Intl. City/Co. Mgt. Assn. 2003).

4. Max M. Houck, *CSI: Reality*, 295 Sci. Am. 84 (July 2006).

5. Paul C. Giannelli, *Scientific Evidence*, 18 Crim. Just. Mag. (Spring 2003) (available at http://www.abanet.org/crimjust/spring2003/scientific_evidence.html); Paul C. Giannelli, *"Junk Science": The Criminal Cases*, 84 J. Crim. L. & Criminology 105, 113–117 (1993) [hereinafter Giannelli, *Junk Science*].

6. Peter D. Barnett, *The Role of Standards in Forensic Science*, 23 ASTM Standardization News 24 (Apr. 1995); John J. Lentini, *Standardization in the Criminalistics Laboratory*, 23 ASTM Standardization News 34 (Apr. 1995); Michael J. Saks, *The Legal and Sci-*

It has been recognized for decades that scientists and lawyers do not think and reason alike and that they employ different value systems in their treatment and interpretation of evidence.[7] The adversarial legal process, with its high premium on winning cases, allows advocates to employ and promote dubious science if it serves their clients' needs and helps them prevail in the courtroom.[8] This Article will address a number of major forces that have influenced this dynamic field over the past thirty years, and it will offer suggestions as to where we need to concentrate our efforts to ensure that scientific truth reaches the factfinder on a regular basis.

II. THE 1970s: AN INCREASE IN CRIME AND GROWTH IN CRIME LABORATORIES

In terms of the criminal justice system's use of forensic science, several factors emerged in the 1970s that influenced the direction of forensic science. The nation experienced a dramatic increase in crime in the late 1960s and early 1970s, with all crimes increasing eighty-three percent from 1966 to 1971, and violent crimes alone rising ninety percent during this same period.[9] Americans were alarmed and insisted that their political representatives take action. The report of the President's Commission on Law Enforcement and Administration of Justice, published in 1967,[10] detailed the underlying social conditions driving crime upward, and the United States Congress passed the Omnibus Crime Control and Safe Streets Act[11] in 1968 to provide massive funding to state and local law enforcement to attack the problem. Scientific crime laboratories and crime-scene technicians were acknowledged as necessary to investigate and solve violent

entific Evaluation of Forensic Science (Especially Fingerprint Expert Testimony), 33 Seton Hall L. Rev. 1167 (2003).

7. Thomas A. Cowan, *Decision Theory in Law, Science, and Technology*, 140 Sci. 1065 (1963).

8. John I. Thornton, *Uses and Abuses of Forensic Science*, 69 ABA J. 289, 292 (Mar. 1983); John I. Thornton, *Criminalistics—Past, Present, and Future*, 11 Lex et Scientia 1 (1975).

9. L. Patrick Gray, III, *Uniform Crime Reports for the United States—1971*, at 61 (U.S. Govt. Printing Off. 1972).

10. Pres. Commn. on L. Enforcement & Administration of Just., *The Challenge of Crime in a Free Society* (U.S. Govt. Printing Off. 1967).

11. Pub. L. No. 90-351, 82 Stat. 197 (1968).

crimes. As the President's Commission predicted, "More and more, the solution of major crimes will hinge upon the discovery at crime scenes and subsequent scientific laboratory analysis of latent fingerprints, weapons, footprints, hairs, fibers, blood, and similar traces."[12]

Drug abuse became a huge societal problem, and crime laboratories were needed to identify any suspected controlled substance to allow for a successful prosecution.[13] Soon, drugs became the predominant type of evidence examined in laboratories, a condition that continues to the present day.[14] In a number of significant cases decided in the 1960s, the United States Supreme Court curbed certain police practices, such as the interrogation of suspects without first informing them that they had the right to remain silent, the right to counsel, and the right to have a lawyer provided for them if they could not afford one.[15] But in return, the Court permitted the police to gather physical evidence from suspects without violating their Fifth Amendment rights.[16] Police were encouraged to rely more on scientific evidence and to avoid third-degree tactics when securing confessions from suspects:

> We have learned the lesson of history, ancient and modern, that a system of criminal law enforcement which comes to depend on the "confession" will, in the long run, be less reliable and more subject to abuses than a system which de-

12. Pres. Commn. on L. Enforcement & Administration of Just., *Task Force Report: The Police* 51 (U.S. Govt. Printing Off. 1967).

13. Brian Parker & Joseph L. Peterson, *Physical Evidence Utilization in the Administration of Criminal Justice* 34 (Natl. Inst. L. Enforcement & Crim. Just. 1972).

14. *Id.*

15. *See generally Miranda v. Ariz.*, 384 U.S. 436 (1966) (holding that a defendant's statements made during custodial police interrogation and without sufficient warning of constitutional rights were inadmissible because the statements violated the defendant's Fifth Amendment right against self-incrimination); *Escobedo v. Ill.*, 378 U.S. 478 (1964) (holding that when a suspect is taken into custody, interrogated, denied the opportunity to consult with an attorney, and not warned of his right to remain silent, he has been denied "[a]ssistance of [c]ounsel" in violation of the Sixth Amendment, and no incriminating statements may be used against him in a criminal trial).

16. *Schmerber v. Cal.*, 384 U.S. 757 (1966) (concluding that a blood sample taken from a defendant against his objection violated neither the Fifth Amendment privilege against self-incrimination nor the Fourth Amendment right to be free from unreasonable searches and seizures; therefore, the sample was admissible).

> pends on extrinsic evidence independently secured through skillful investigation.[17]

The United States Congress created the Law Enforcement Assistance Administration (LEAA) in 1968, which channeled billions of dollars in federal aid to law enforcement during the 1970s, and provided the funding for resources that police could use to recognize, collect, and analyze tangible evidence.[18] The number of forensic crime laboratories in the nation tripled (from about 100 to more than 300), and crime-scene units multiplied.[19] While the growth was necessary, it was unregulated and without clear guidance from, or adherence to, national standards. Thus, while crime-laboratory services expanded, some of the underlying problems of quality assurance and minimum scientific standards simply multiplied.

In addition to the "block grant" funding to the states, the research arm of the LEAA, the National Institute of Law Enforcement and Criminal Justice (NILECJ), began a modest forensic-science research program and supported several projects that will be described in subsequent sections of this Article.[20] LEAA stud-

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17. *Escobedo*, 378 U.S. at 488–489.

18. *See generally* Richard S. Allinson, *LEAA's Impact on Criminal Justice: A Review of the Literature*, 11 Crim. Just. Abstracts 608, 647 (1979) (questioning whether the billions of dollars pumped into the LEAA have produced "innovative" results); U. Research Corp., *Forensic Science Services and the Administration of Justice* (Natl. Inst. L. Enforcement & Crim. Just. 1978) (summarizing a national workshop held to describe the problems in the forensic science field and offer solutions); Arnold E. Levitt, *Crime Labs Expand as Business Flourishes*, Chem. & Engr. News 16 (Jan. 3, 1972) (explaining the relationship between the growth in crime and the need to expand forensic laboratories); Alexander Joseph, *Crime Laboratories—Three Study Reports*, (U.S. Dept. of Just. 1968) (discussing three studies that investigated the need for improved and more extensive laboratory resources, the status of laboratories in Massachusetts, and the pooling of laboratory resources).

19. *See* Joseph L. Peterson, Steven Mihajlovic & Joanne L. Bedrosian, *The Capabilities, Uses, and Effects of the Nation's Criminalistics Laboratories*, 30 J. Forensic Sci. 10 (1985) (reporting on the results of a survey sent to crime laboratories across the United States) [hereinafter Peterson et al., *Criminalistics Laboratories*]; *see generally* Brian Parker, *The Status of Forensic Science in the Administration of Criminal Justice*, 32 Rev. Juridica U. P.R. 405 (1963) (explaining that scientific investigation is used in a very low percentage of crimes); Joseph L. Peterson, *The Utilization of Criminalistics Services by the Police* (U.S. Govt. Printing Off. 1974) (discussing the role of criminalistics as used by police and criminal prosecutors in relation to the entire criminal justice system and explaining the need for improved education and training).

20. Charles R. Kingston, *A National Criminalistics Research Program*, in *Law Enforcement Science and Technology* vol. 3, 453–460 (S.I. Cohn & W.B. McMahon eds., IIT

ies demonstrated that police investigators used physical evidence to a greater extent if the laboratories were placed in closer proximity to law-enforcement officers. As a result of such studies and the availability of federal support, statewide systems of crime laboratories were created that brought analytical capabilities closer to local law-enforcement agencies and the crime problem.[21] Organizational and professional relationships among federal, state, and local crime laboratories improved, as did the quality and effectiveness of investigations. The operating crime laboratories drove the expansion and direction of this field with comparatively little consultation with or guidance from the legal and scientific academic communities. This trend continued for decades, and laboratories have only recently begun to address some of the fundamental problems of the field.

A handful of studies emerged that demonstrated the severe need for higher-education programs to prepare future forensic scientists for positions in government laboratories.[22] Early crime laboratories were staffed by chemists, biologists, and a combination of police professionals (firearms, toolmark, fingerprint, and questioned-document examiners), as well as a few individuals trained in criminalistics at the University of California at Berkeley, Michigan State University, and John Jay College of Criminal Justice in New York. Although there was a rapid growth of college- and university-based criminalistics degree programs nationwide, there was little standardization of coursework or recognition of the need for minimum faculty qualifications.[23] Even with this growth, there were few centralized training opportunities, and most examiners were Bachelor of Science graduates who were

Research Inst. 1970); Joseph L. Peterson, *LEAA's Forensic Science Research Program*, in *Forensic Science* (Geoffrey Davies ed., Am. Chem. Socy. 1975) [hereinafter Peterson, *LEAA's*].

21. C.J. Rehling & C.L. Rabren, *Alabama's Master Plan for a Crime Laboratory Delivery System* (U.S. Govt. Printing Off. 1973); Walter Benson et al., *Systems Analysis of Criminalistics Operations* (Midwest Research Inst. 1970); Pres. Commn. on L. Enforcement & Administration of Just., *Task Force Report: Science and Technology* (U.S. Govt. Printing Off. 1967).

22. *See generally* Kenneth S. Field et al., *Assessment of the Personnel of the Forensic Science Profession* vol. 2 (U.S. Dept. Just. 1977) (surveying the educational needs of the young and growing field of forensic science).

23. J.L. Peterson & P.R. De Forest, *Status of Forensic Science Degree Programs in the United States*, 22 J. Forensic Sci. 17, 25, 31 (1977).

trained on the job.[24] John Jay College in New York, with federal National Institute of Justice (NIJ) support, offered one of the first programs to offer practitioners advanced serological training in 1970.[25] Toward the end of the decade, the Forensic Sciences Foundation (FSF), again with federal NIJ support, coordinated much-needed training in microscopy and serology.[26]

Upon the death of J. Edgar Hoover in 1972, and the appointment of Clarence Kelley as the new Director of the Federal Bureau of Investigation (FBI) in 1973, the FBI entered a new era in which it actively cultivated professional and research relationships with state and local crime laboratories.[27] It was during this time period that the seeds were planted for a national accreditation program for crime laboratories.[28] Kelley's appointment also introduced more cooperation between the FBI and sister Department of Justice agencies like the LEAA, and the FBI began to offer more training and research opportunities at its Forensic Science Research and Training Center (FSRTC), which was established in 1981.[29]

The small research program at the NILECJ focused on refining and developing new techniques and instrumentation, assessing the staffing needs of laboratories, and examining the operations of forensic laboratories and their interface with other criminal justice agencies.[30] The FSF also received funding from the NILECJ in the late 1970s to establish certification boards in various forensic specialties like criminalistics, questioned documents,

24. *Id.* at 31.

25. *See generally* Bryan J. Culliford, *The Examination and Typing of Bloodstains in the Crime Laboratory* (U.S. Govt. Printing Off. 1971) (describing scientific techniques for examining blood in crime laboratories).

26. The Forensic Sciences Foundation, Inc. received research grants in the late 1970s to coordinate training in microscopy (Forensic Microscopy Workshops) through the McCrone Research Institute, and serology training in advanced bloodstain analysis techniques through the Serological Research Institute (SERI).

27. Am. Socy. of Crime Laboratory Dirs., Laboratory Accreditation Bd., *History*, http://www.ascld-lab.org/dual/aslabdualhistory.html (accessed Aug. 15, 2007).

28. *Id.*

29. *See generally* William Y. Doran, *The FBI Laboratory: Fifty Years*, 27 J. Forensic Sci. 743 (1982) (describing training and research opportunities at the FBI's Forensic Science Research and Training Center); Clarence M. Kelley, *FBI Assistance to the Law Enforcement Community*, 42 Police Chief 40 (1975) (describing the various services the FBI provides to local law enforcement agencies).

30. Peterson, *LEAA's*, *supra* n. 20.

toxicology, physical anthropology, odontology, and psychiatry.[31] The criminalistics profession, given its many subspecialties, was the last to agree on what education, training, and experiential standards were necessary for one to be certified as a working criminalist. It took a regional professional group (the California Association of Criminalists) to initiate its own certification program and the late Dr. Walter McCrone of the McCrone Research Institute to convene a meeting of national leaders in Chicago in the summer of 1988 to spur on criminalists to embrace national standards.[32] Even so, today most forensic practitioners do not complete the somewhat costly process of certification because the profession does not mandate it to practice, and crime laboratories, the police, and the courts do not require it to examine case evidence.

Another relatively modest research effort began quietly and set out to create a mechanism for determining the accuracy of the results coming out of crime laboratories. Research grants were issued to the FSF by the NILECJ from 1973 to 1977. While the focus of the grants was on developing the *process* whereby the proficiency of laboratories could be tested, the actual results of the completed testing revealed that laboratory performance was less than satisfactory and in some areas it was distinctly sub par.[33] The identification of controlled substances and bloodstain typing was generally done well, but the rate of false positives for a flammable liquid in the examination of fire debris and errors in the identification of animal hair were troubling.[34] Determining the common origin of bloodstains, glass, paint, and fibers was also problematic.[35] These proficiency testing results made headlines in newspapers around the country in 1977.[36] The FSF acknowledged

31. Joseph L. Peterson et al., *Forensic Sciences Certification Program: Periodic Report* (Forensic Sci. Found. 1978).

32. *See* Greg Matheson, *Report on Certification*, Cal. Assn. of Criminalists Newsltr. 11 (Apr. 1987) (describing standards for certification); Joseph L. Peterson, *Dr. Walter McCrone's Contributions to Microscopy Workshops and the Certification of Criminalists*, 49 J. Forensic Sci. 267, 268 (2004) (describing Dr. McCrone's role in the development of certification programs).

33. *See generally* Joseph L. Peterson et al., *Crime Laboratory Proficiency Testing Research Program* (Natl. Inst. L. Enforcement & Crim. Just. 1978) (summarizing the results of proficiency testing programs) [hereinafter Peterson et al., *Proficiency Testing*].

34. *Id*.

35. *Id*.

36. *E.g.* Ronald Ostrow, *Many Crime Labs Fail Tests: Evidence in Trials May Be Hurt*,

the errors by laboratories but also observed that the errors were not totally unexpected, given the fact that laboratory analysts lacked the requisite training, techniques, and resources to examine reliably the proficiency test samples submitted to them.[37] This research proved to be a milestone because it raised awareness, in both the scientific and legal communities, that the results from crime laboratories could not simply be assumed correct and that the quality of the results had to be reviewed much more carefully. This early study also stimulated the creation of many other quality assurance programs in the forensic sciences, and it led to many scientific and legal critiques of the reliability of crime laboratory testing that continue to the present day.

When grants to the FSF ended, Collaborative Testing Services, Inc. (CTS) began a fee-based proficiency testing program in 1978.[38] The program is still operational, and although not all crime laboratories have participated in this program over the years, proficiency testing has steadily become an expected practice in most laboratories. Participating in an external proficiency testing program, like CTS, is a requirement for accreditation under the American Society of Crime Laboratory Directors, Laboratory Accreditation Board (ASCLD-LAB).[39] The results of CTS proficiency testing have also been reported periodically in the scientific and scientific-evidence legal literature and will be addressed later in this Article.

The other theme that emerged in the 1970s was that, even though new laboratories were being built and the use of physical evidence was increasing, the government's financial support of forensic laboratories remained weak.[40] Co-author Peterson's research indicated that about eighty percent of crime laboratories were positioned within law-enforcement agencies.[41] The federal government's own National Advisory Commission on Criminal Justice Standards and Goals reported that funding for laborato-

L.A. Times A1 (Apr. 9, 1977).

37. Peterson et al., *Proficiency Testing*, *supra* n. 33.

38. *See generally* Charles Leete, *Crime Laboratory Proficiency Testing Program* (Collaborative Testing Servs. 2006) (describing the fee-based testing program).

39. Am. Socy. of Crime Laboratory Dirs., Laboratory Accreditation Bd., *About ASCLD/LAB*, http://www.ascld-lab.org/dual/aslabdualaboutascldlab.html (accessed Aug. 15, 2007).

40. Peterson et al., *Criminalistics Laboratories*, *supra* n. 19, at 10.

41. *Id.* at 11.

ries affiliated with law enforcement was woefully inadequate: "Too many police crime laboratories have been set up on budgets that preclude the recruitment of qualified, professional personnel."[42] Inadequate funding of forensic laboratories has been, and continues to be, a chronic problem that affects the quality, timeliness, and effectiveness of services rendered.

III. THE 1980s: THE FORENSIC SCIENCE PROFESSION RESPONDS

For forensic science, the 1980s was to be known for its major scientific breakthroughs (for example, DNA typing), the establishment of the first computerized databases of forensic evidence,[43] and the implementation of professional quality assurance programs like accreditation of crime laboratories by ASCLD-LAB.[44] The seminal 1985 publication of Sir Alec Jeffreys' discovery of the different repeating regions of DNA among individuals and the use of DNA evidence in the celebrated Colin Pitchfork case ushered in a new age in forensic science.[45] The first case in the United States was in Florida in 1986, and it resulted in the conviction of Tommie Lee Andrews.[46] Early efforts by the prosecution to admit DNA evidence met with little or no defense resistance. Soon after DNA evidence's initial introduction to courts in the mid-1980s, defense attorneys mounted more vigorous challenges to prosecution test results and achieved some success in excluding DNA test results when laboratories deviated from pre-

42. Natl. Advisory Commn. on Crim. Just. Stands. & Goals—Task Force on Police, *Standard 12.2, The Crime Laboratory* 299, 304 (U.S. Govt. Printing Off. 1973).

43. *See* David J. Klug, Joseph L. Peterson & David A. Stoney, *Automated Fingerprint Identification Systems: Their Acquisition, Management, Performance, and Organizational Impact, Final Report* (Natl. Inst. Just. 1992) (reviewing AFIS programs in the United States).

44. *See* FBI, *The Accreditation Decision*, 1 Forensic Sci. Communs. (Apr. 1999), http://www.fbi.gov/hq/lab/fsc/backissu/april1999/ascldbro.htm (providing information on the Laboratory Accreditation Board's objectives and requirements).

45. Peter Gill, Alec Jeffreys & David Werrett, *Forensic Applications of DNA Fingerprints*, 318 Nat. 577 (1985); Alec J. Jeffreys, *Genetic Fingerprinting*, 11 Nat. Med. 1035, 1036 (2005) (noting that DNA typing could be used to identify individuals positively instead of solely being used to exclude individuals from involvement in the subject case); Alec J. Jeffreys, Victoria Wilson & Swee Lay Thein, *Hypervariable "Minisatellite" Regions in Human DNA*, 314 Nat. 67 (1985); George Sensabaugh, *Forensic Biology—Is Recombinant DNA Technology in Its Future?* 31 J. Forensic Sci. 393, 395 (1986).

46. Stephen G. Michaud, *DNA Detectives*, N.Y. Times 70 (Nov. 6, 1988).

scribed protocols or when proficiency tests revealed that the laboratory committed errors.[47]

One of the early proficiency studies of DNA testing was conducted by the California Association of Crime Laboratory Directors from 1987 to 1988 and involved blind proficiency trials of three commercial laboratories.[48] Out of fifty samples, two firms declared one false match and a third reported no false matches.[49] In a second blind trial, one laboratory reported a single false match.[50] This study was significant for two reasons, as follows: it established the importance of conducting proficiency tests in DNA testing; it showed how clerical errors (e.g., switching of samples) could lead to improper conclusions; and it demonstrated how opposing experts or attorneys might employ proficiency results to discredit the laboratory or examiner performing the analysis.

While private laboratories were very active in paving the way for the use of DNA typing at the state and local level, the FBI laboratory was one of the early public laboratories that developed its own in-house capabilities and began accepting cases from local police agencies in 1988.[51] The laboratories involved in DNA testing embraced the adoption of DNA standards by forming the Technical Working Group on DNA Analysis Methods (TWGDAM) in 1988 and issuing guidelines in 1989, 1991, and 1995 in *Crime Laboratory Digest*.[52] These standards were not only significant for

47. *See e.g. State v. Schwartz*, 447 N.W.2d 422, 426–427 (Minn. 1989) (stating that DNA evidence should be inadmissible when the test laboratory does not follow reliable procedures to ensure accurate test results); *People v. Castro*, 545 N.Y.S.2d 985, 999 (N.Y. Sup. Ct. 1989) (excluding DNA evidence because the testing laboratory did not use generally accepted scientific techniques).

48. Margaret Kuo, *California Association of Crime Laboratory Directors: DNA Committee Report to the Board of Directors, Report #6, Orange County Sheriff-Coroner's Crime Laboratory* (Cal. Assn. of Crime Laboratory Dirs. 1988) (cited in U.S. Congress, Off. of Technology Assessment, *Genetic Witness: Forensic Uses of DNA Tests* 79–80, n. 60 (U.S. Govt. Printing Off. 1990)).

49. *Id.*

50. *Id.*

51. Jessie Jo Barr, *The Use of DNA Typing in Criminal Prosecutions: A Flawless Partnership of Law and Science?* 34 N.Y.L. Sch. L. Rev. 485, 528 (1989) (noting that all duly constituted local and state law-enforcement agencies can use the FBI laboratory to examine DNA evidence and supply expert testimony for court appearances).

52. Technical Working Group on DNA Analysis Methods, *Guidelines for a Quality Assurance Program for DNA Analysis*, 22 Crime Laboratory Dig. 21 (1995); Technical Working Group on DNA Analysis Methods, *Guidelines for a Quality Assurance Program for DNA Analysis*, 18 Crime Laboratory Dig. 44 (1991); Technical Working Group on DNA Analysis Methods, *Guidelines for a Quality Assurance Program for DNA Restriction*

the field of DNA typing but demonstrated to other forensic specialties that standard practices were desirable—both scientifically and legally. Also during 1988, the Banbury Center sponsored a major conference of DNA forensic scientists at Cold Spring Harbor Laboratory, New York, on DNA technology and forensic science.[53]

In 1989, the House and Senate held hearings on the new DNA technology and heard testimony on the scientific strengths of the technique, potential civil-liberties questions, the importance of quality assurance measures, and the contributions DNA typing could make to the criminal-investigation process.[54]

There were three other notable trends in the 1980s. First, the accreditation of crime laboratories, a voluntary, profession-based process for ensuring that institutions met defined standards, began with the first accreditation of a laboratory in 1982.[55] The American Society of Crime Laboratory Directors (ASCLD) created an accreditation group (ASCLD-LAB) that inspects, evaluates, and identifies laboratories that meet or exceed national ASCLD-LAB standards that ensure that evidence is examined properly and reported completely.[56] Areas reviewed and inspected under ASCLD-LAB include the operations, management, physical plant, safety, and security of crime laboratories.[57] A key element of the program involves the random selection of case files and all associ-

Length Polymorphism Analysis, 16 Crime Laboratory Dig. 40 (1989).

53. *See generally Banbury Report 32: DNA Technology and Forensic Science* (Jack Ballantyne et al. eds., Cold Spring Harbor Laboratory Press 1989) (addressing the application of DNA technology in the legal setting and concurrent policy concerns).

54. The House Committee on the Judiciary, Subcommittee on Civil and Constitutional Rights, and the Senate Committee on the Judiciary, Subcommittee on the Constitution, held hearings in March 1989. Co-author Peterson gave testimony before the Senate panel on March 14, 1989. *See* Sen. Jud. Comm., *Genetic Testing as a Means of Criminal Investigation*, 101st Cong. 41 (Mar. 15, 1989) (detailing co-author Peterson's testimony).

55. Ill. St. Police, *ISP Forensic Labs Re-Accredited*, http://www.isp.state.il.us/media/pressdetails.cfm?ID=117 (accessed Aug. 15, 2007) (stating that the Illinois State Police Division of Forensic Sciences was "the first to obtain accreditation in the United States by the ASCLD/LAB and the first to establish a Forensic Science Quality Assurance Program").

56. Jan S. Bashinski, *Laboratory Standards: Accreditation, Training, and Certification of Staff in the Forensic Context*, in *Banbury Report 32: DNA Technology and Forensic Science* 159, 167–169 (Jack Ballantyne et al. eds., Cold Spring Harbor Laboratory Press 1989); Bashinski & Peterson, *supra* n. 3, at 578.

57. Bashinski & Peterson, *supra* n. 3, at 578.

ated analyses, notes, and data gathered.[58] Interviews are also held with case examiners to verify that laboratory procedures documented in the files actually conform with written procedures maintained by the laboratory.[59]

Second, there were two significant projects sponsored by the NIJ in the 1980s on measuring the impact of scientific evidence. The first, *Forensic Evidence and the Police*, examined close to 2,700 randomly selected case files drawn from four jurisdictions nationwide—approximately 1,600 cases involving analysis of physical evidence and about 1,100 otherwise similar cases where no physical evidence was collected.[60] Excluding controlled substances, which make up seventy percent or more of laboratory caseloads, blood, hair, firearms, and fingerprints were the principal types of physical evidence most frequently collected and examined in the laboratory.[61] After controlling for the availability of suspects, eyewitnesses to the crime, and the elapsed time between discovery of the offense and its report to the police, clearance rates of offenses with evidence scientifically analyzed were *about three times greater* than in cases where such evidence was not used.[62]

A second companion study funded by the NIJ explored the uses and effects of scientific evidence in the charging, plea negotiation, trial, and sentencing stages of the criminal justice process.[63] The scientific evidence had a minimal effect on the charging stage of most felony cases, and guilty pleas were the norm in more than ninety percent of cases tracked in the five jurisdictions.[64] In cases where the scientific evidence strongly associated the defendant with the crime, prosecutors were *less* inclined to offer a plea bargain.[65] The second study also found that scientific evidence

58. *Id.*

59. *Id.*

60. Joseph L. Peterson et al., *Forensic Evidence and the Police: The Effects of Scientific Evidence on Criminal Investigations* iv, xvii (Natl. Inst. Just. 1984).

61. *Id.* at xix.

62. *Id.* at 138–140. Clearance can occur in a variety of ways, including arrest, determination that a case is unfounded, or the existence of exceptional circumstances such as the death of the suspect. *Id.* at 135.

63. Joseph L. Peterson et al., *The Uses and Effects of Forensic Science in the Adjudication of Felony Cases*, 32 J. Forensic Sci. 1730 (1987).

64. *Id.* at 1734–1738.

65. *Id.* at 1735–1738.

had a *very limited* role in decisions to convict a defendant, particularly compared with the effects of admissions, incriminating statements, and tangible, non-scientific evidence.[66] It was during the sentencing stage, however, that the forensic evidence had its major effect on the adjudication of felony cases.[67] While a defendant's prior record overwhelmed most other factors in the incarceration decision, laboratory reports generally led to higher rates of incarceration and were found to be the only type of evidence to influence the length of the sentence.[68]

Third, the National Science Foundation (NSF) funded another study in the 1980s that investigated ethical dilemmas in the forensic sciences. This project resulted in a symposium and several articles that appeared in the *Journal of Forensic Sciences* in 1989, which contrasted the aspirations of the field of forensic science with the realities of operating within the criminal justice system.[69] The forensic scientist's goals of being scientifically competent, being honest with respect to one's qualifications and findings, and presenting complete and impartial reports and testimony can be compromised in the adversarial process. For government analysts, who are faced with too few resources, housed within police agencies (physically and organizationally), and testifying on behalf of the prosecution most of the time, working conditions can undercut a scientist's good intentions. Forensic scientists working for the defense experience similar adversarial pressures. Such dilemmas have surfaced time and again, continuing to the present day, whenever scientists have failed to live up to one or more of these ethical guideposts.

The 1980s closed on a troubling note for the forensic sciences as legal scholars began to muster an assault in literature and in

66. *Id.* at 1739–1740.

67. *Id.* at 1744–1748.

68. *Id.* at 1744.

69. The following articles were part of the Symposium on Ethical Conflicts in the Forensic Sciences: Mark S. Frankel, *Ethics and the Forensic Sciences: Professional Autonomy in the Criminal Justice System*, 34 J. Forensic Sci. 763 (1989); Paul C. Giannelli, *Evidentiary and Procedural Rules Governing Expert Testimony*, 34 J. Forensic Sci. 730 (1989); Douglas M. Lucas, *The Ethical Responsibilities of the Forensic Scientist: Exploring the Limits*, 34 J. Forensic Sci. 719 (1989); Joseph L. Peterson & John E. Murdock, *Forensic Science Ethics: Developing an Integrated System of Support and Enforcement*, 34 J. Forensic Sci. 749 (1989); Michael J. Saks, *Prevalence and Impact of Ethical Problems in Forensic Science*, 34 J. Forensic Sci. 772 (1989).

the courts on the reliability of scientific evidence, which was largely based on the proficiency testing results published the decade before.[70] The attacks on handwriting examination were particularly fierce as several authors, relying on the previously mentioned proficiency test data, questioned the existence of handwriting expertise because the accuracy of some handwriting-examination proficiency results was little better than chance.[71]

IV. THE 1990s: RELIABILITY OF FORENSIC TESTING COMES CENTER STAGE

Crime laboratories at the state and local levels recognized that DNA typing was an important and powerful scientific technique and that there was a need for the enforcement of professional standards, adoption of procedures yielding reliable results, and coordination with the larger scientific and legal communities.[72] Reports issued by two national scientific bodies, the Office of Technology Assessment of the United States Congress and the National Research Council, addressed and answered many of the remaining scientific questions surrounding the widespread adoption of DNA-typing procedures in our criminal justice system.[73] While endorsing the use of DNA-testing procedures in criminal justice, both reports emphasized the importance of standards and quality assurance procedures, including proficiency testing.

The Combined DNA Index System (CODIS) began in 1990 as a pilot project involving fourteen state and local crime laborato-

70. Paul C. Giannelli, *The Admissibility of Laboratory Reports in Criminal Trials: The Reliability of Scientific Proof*, 49 Ohio St. L.J. 671, 688–689 (1988); Andre A. Moenssens et al., *Scientific Evidence in Civil and Criminal Cases* (4th ed., Found. Press 1995).

71. *See generally* D. Michael Risinger, Mark P. Denbeaux & Michael J. Saks, *Exorcism of Ignorance as a Proxy for Rational Knowledge: The Lessons of Handwriting Identification "Expertise,"* 137 U. Pa. L. Rev. 731 (1989) (questioning whether handwriting expertise exists).

72. Jan S. Bashinski, *Managing the Implementation and Use of DNA Typing in the Crime Laboratory*, in *Forensic DNA Technology* 201 (Mark A. Farley & James J. Harrington eds., Lewis Publishers 1991).

73. *See generally* Natl. Research Council, *The Evaluation of Forensic DNA Evidence* (Natl. Acad. Press 1996) (describing standards for evaluating DNA evidence in forensic laboratories); Natl. Research Council, *DNA Technology in Forensic Science* (Natl. Acad. Press 1992) (discussing the implications of using DNA technology in the forensic science field); Off. of Tech. Assessment, *Genetic Witness: Forensic Uses of DNA Tests* (U.S. Govt. Printing Off. 1990) (summarizing the policy concerns involved in DNA testing).

ries.[74] When Congress passed the Violent Crime Control and Law Enforcement Act of 1994, which included the DNA Identification Act of 1994, the FBI was authorized to fully implement a national index, which went online in 1998.[75] Funding was also authorized for state and local law-enforcement agencies and their forensic laboratories to establish their own DNA-testing capabilities.[76] The DNA Advisory Board, headed by Nobel laureate Dr. Joshua Lederberg, was also established under the DNA Identification Act and set testing standards for all DNA databasing activity that would follow.[77] In rapid succession, state legislatures approved steps to gather DNA from convicted offenders and place their profiles in the CODIS database.[78] Studies showing a high recidivism rate for individuals who commit nonviolent crimes and then progress to commit violent crimes persuaded legislatures to increasingly widen the DNA net.[79]

There was another major application of DNA testing in this decade with the work of the Innocence Project at Cardozo Law School[80] and the publication of *Convicted by Juries, Exonerated by Science* in 1996.[81] The latter study, with a preface by former Attorney General Janet Reno, included a series of case studies recounting the experience of numerous prisoners exonerated by DNA testing who had been previously convicted and incarcerated based on mistaken eyewitness accounts, coerced confessions, and

74. FBI, *CODIS Mission Statement and Background*, http://www.fbi.gov/hq/lab/codis/program.htm (accessed Aug. 15, 2007).

75. Pub. L. No. 103-322, §§ 210302, 210304, 108 Stat. 1796 (1994).

76. *See* Lawrence A. Presley, *The Evolution of Quality Standards for Forensic DNA Analysis in the United States*, Profiles in DNA 10, 10–11 (Sept. 1999) (explaining the development of standards for forensic DNA testing in the United States) (available at http://www.promega.com/profiles/302/profilesinDNA_302_10.pdf).

77. *Id.*

78. *See* FBI, *The FBI's Combined DNA Index System Program*, http://www.fbi.gov/hq/lab/codis/brochure.pdf (accessed Aug. 15, 2007) (describing the development of the CODIS database).

79. *See* Edwin Zedlewski & Mary B. Murphy, *DNA Analysis for "Minor" Crimes: A Major Benefit for Law Enforcement*, 253 Natl. Inst. Just. J. 2, 3 (Jan. 2006) (noting the correlation between committing property crimes and the potential to commit violent crimes).

80. *See* Cardozo L. Sch., *Innocence Project*, http://www.innocenceproject.org/ (accessed Aug. 15, 2007) [hereinafter *Innocence Project*] (describing the Innocence Project's work in "exonorat[ing] the wrongfully convicted through post[-]conviction DNA testing").

81. Edward Connors et al., *Convicted by Juries, Exonerated by Science: Case Studies in the Use of DNA Evidence to Establish Innocence after Trial* (Natl. Inst. Just. 1996).

faulty or nonspecific forensic evidence.[82] From 1992 through November 2006, the Innocence Project obtained 185 DNA exonerations and has also heightened the public's awareness of the ability of DNA tests to exonerate wrongly convicted defendants.[83] Newspapers and television broadcasts have given extensive coverage to the exoneration and release of over 300 inmates nationwide, about half of which cases involved DNA evidence.[84] As a result, the public became aware of the unreliability of certain mainstay evidence in our criminal justice system: eyewitness lineup identifications, coerced confessions, and other more subjective, pattern-based forensic evidence.

These exonerations also served to underscore the fallibility of trial evidence leading to the death penalty. Such DNA exonerations have grown throughout the United States, and DNA played a role in five of the thirteen death row exonerations in Illinois alone, eventually leading to clemency for all Illinois death row inmates.[85] These exonerations have led to substantial efforts to obtain post-conviction DNA evidence testing and have prompted serious questioning of the propriety and reliability of death sentences.[86] Cases from around the country have shown the power of DNA evidence to correct injustices based on erroneous evidence.[87] The National Commission on the Future of DNA Evidence, founded in 1998 in response to *Convicted by Juries, Exonerated by Science*, also did a great deal to further the implementation of DNA typing in the judicial process.[88] It addressed the use of DNA

82. *See generally id.* (explaining DNA testing's role in exonerating the innocent post-conviction).

83. *Innocence Project*, *supra* n. 80, at http://www.innocenceproject.org/Content/327.php (accessed Aug. 15, 2007).

84. Samuel R. Gross et al., *Exonerations in the United States 1989 through 2003*, 95 J. Crim. L. & Criminology 523, 524, 526 nn. 8–9, 534 nn. 23–24 (2005).

85. *Report of the Governor's Commission on Capital Punishment*, http://www.idoc.state.il.us/ccp/ccp/reports/commission_report/complete_report.pdf 51 (Apr. 15, 2002).

86. *See Innocence Project*, *supra* n. 80 (providing information on post-conviction exoneration through DNA testing and detailed case studies); *see generally* Natl. Coalition to Abolish the Death Penalty, *About the NCADP*, http://www.ncadp.org/index.cfm?content=2 (accessed Aug. 15, 2007) (citing the fallibility of the death penalty as one of the group's grounds for abolishing it).

87. *See Innocence Project*, *supra* n. 80 (providing detailed case studies of exonerated individuals).

88. Natl. Inst. of Just., *National Commission on the Future of DNA Evidence*, http://www.ojp.usdoj.gov/nij/topics/forensics/dna/commission/welcome.html (accessed Aug. 15, 2007) [hereinafter *DNA Evidence*].

evidence in post-conviction relief cases, the legal concerns of *Daubert*[89] challenges and discovery issues, the training of criminal justice personnel in properly collecting and using DNA evidence, essential laboratory capabilities, and the impact of future technologies on the use of DNA in the criminal justice system.[90]

The 1990s also began with the publication of an article by law professor Randolph Jonakait that was highly critical of the quality of testing in the nation's crime laboratories.[91] Jonakait relied on the results of the NILECJ proficiency testing program of the late 1970s and discussed various regulatory schemes for monitoring forensic laboratories.[92] After examining procedures used for evaluating clinical laboratories, he concluded that the cost of imposing standards like those under the Clinical Laboratory Improvement Act would be too expensive and unworkable.[93] Instead, he recommended a mandatory proficiency testing program.[94] He suggested using blind testing and making the results available to the public.[95] Testing performance would allow the field to conduct additional research on those areas with problematic results and would also permit the court system to evaluate test results and determine the weight that should be given to such tests in actual cases.[96] Peter Neufeld and Neville Colman also called for greater scrutiny of scientific evidence (particularly DNA evidence) in criminal cases, more proficiency testing, and the implementation of standards.[97]

But this decade would witness even greater assaults on the reliability of scientific testimony—in civil as well as criminal cases. Peter Huber's book, *Galileo's Revenge*, was published in

89. *Daubert v. Merrell Dow Pharms.*, 509 U.S. 579 (1993). For a further discussion of the holding in *Daubert* and its impact on scientific evidence, see *infra* notes 108–120 and accompanying text.

90. *DNA Evidence*, *supra* n. 88.

91. *See generally* Randolph N. Jonakait, *Forensic Science: The Need for Regulation*, 4 Harv. J.L. & Tech. 109, 109 (1991) (citing a "consistent pattern of unacceptable errors and inaccuracies" in forensic laboratories).

92. *Id.* at 109–124.

93. *Id.* at 178–182; *see also* Pub. L. No. 100-578, 102 Stat. 2903 (1988) (containing the clinical laboratory improvement amendments).

94. Jonakait, *supra* n. 91, at 182–190.

95. *Id.*

96. *Id.*

97. Peter J. Neufeld & Neville Colman, *When Science Takes the Witness Stand*, 262 Sci. Am. 46, 53 (May 1990).

1991, and although aimed primarily at the admission of questionable science in America's tort system, it was instrumental in sensitizing the entire legal system to "junk science"[98] and reassessing the standards of admissibility for scientific evidence in criminal and civil cases. One of Huber's arguments was that the "liberal" nature of the Federal Rules of Evidence (Rules 702 and 703), and their standard of "relevant and reliable" in place of the more conservative *Frye v. United States*[99] standard of "general acceptance," permitted the introduction of faulty science into the courts.[100] He cited the controversy over the use of the drug Bendectin by pregnant women, lawsuits alleging Bendectin caused birth defects, and the manufacturer Merrell Dow's decision to take the drug off the market in 1983 due to the threat of litigation.[101] Huber argued for stricter standards in admitting science into courts, and his arguments, along with other legal cases and scholarly writings, led to the most significant Supreme Court decision on scientific evidence ever, *Daubert v. Merrell Dow Pharmaceuticals*.[102]

Bert Black also published two articles that questioned the reliability of scientific testimony.[103] In his article, *A Unified Theory of Scientific Evidence*, Black argued that courts should examine both the validity of the reasoning employed by the expert in arriving at his or her results, as well as the reliability of the conclusions that were reached, to determine whether or not the expert's results should be presented to the factfinder.[104] While reliability is the ultimate legal concern, courts must also have experts "make their reasoning explicit" so that judges can evaluate the testimony "against accepted scientific practice."[105]

Paul Giannelli's 1993 essay, *"Junk Science": The Criminal Cases*, brought the junk-science debate clearly into the criminal domain, citing the unreliability of scientific criminal evidence, the

98. Peter W. Huber, *Galileo's Revenge: Junk Science in the Courtroom* (Basic Bks. 1991).

99. 293 F. 1013, 1014 (D.C. Cir. 1923).

100. Huber, *supra* n. 98.

101. *Id.*

102. 509 U.S. 579.

103. Bert Black, *A Unified Theory of Scientific Evidence*, 56 Fordham L. Rev. 595 (1988) [hereinafter Black, *A Unified Theory*]; Bert Black, *Evolving Legal Standards for the Admissibility of Scientific Evidence*, 239 Sci. 1508 (1988).

104. Black, *A Unified Theory*, *supra* n. 103, at 599.

105. *Id.* at 604.

need for imposing higher reliability standards for admitting expert evidence in criminal cases, and the importance of discovery to criminal defense attorneys to ferret out inferior scientific evidence.[106] Francisco Ayala and Bert Black contributed another influential article, *Science and the Courts*, in which they contended that judges must be able to recognize the reasoning of experts that "make[s] science scientific" and must require experts to employ the very standards in the courtroom that scientists would use in the outside scientific world.[107] Later in 1993, the United States Supreme Court delivered the first of three landmark decisions that led to a dramatic rethinking of how judges review scientific evidence.[108] Legal scholar Bert Black put on his litigation hat and defended Merrell Dow in this civil suit.[109]

The *Daubert* decision addressed the admissibility of scientific evidence regarding the anti-nausea drug Bendectin, and, as prior scientific and legal articles had advocated, called upon judges to be the gatekeepers of scientific evidence that entered their courtrooms.[110] The Court rejected the district court's reliance on the venerable *Frye* decision and decided that the more "liberal" Federal Rules of Evidence (FRE) applied.[111] Even though relying on the more liberal FRE, the Court, in explaining how judges were to interpret what expert evidence was both "relevan[t] and reliab[le]," added real scientific muscle to the standard.[112] The domain of scientific experts must be "scientific . . . knowledge," a term that "implies a grounding in the methods and procedures of science."[113] Judges were tasked with thinking more like scientists in reviewing the methods employed by experts in reaching their conclusions. It was up to the judge to determine "whether the reasoning or methodology underlying the testimony [was] scientifically valid."[114] Justice Harry Blackmun, writing for the majority,

106. Giannelli, *Junk Science*, *supra* n. 5.

107. Francisco J. Ayala & Bert Black, *Science and the Courts*, 81 Am. Scientist. 230, 230 (1993).

108. *Daubert*, 509 U.S. 579.

109. Natalie Angier, *Ruling on Scientific Evidence: A Just Burden*, N.Y. Times A12 (June 30, 1993) (stating that Bert Black filed a brief on behalf of the defendants).

110. *Daubert*, 509 U.S. at 583, 599.

111. *Id.* at 587.

112. *Id.* at 591–595.

113. *Id.* at 589–590.

114. *Id.* at 592–593.

offered not a strict set of rules, but four "general observations" as guidance.[115]

First, if the "theory or technique" in question is "scientific knowledge," it must have been tested.[116] The scientific method requires hypotheses to be formulated and tested empirically, in order to see if they can be "falsified" (i.e., whether they are testable).[117] Second, judges should consider "whether the theory or technique has been subjected to peer review and publication" (processes that should uncover "substantive flaws in methodology").[118] Third, courts "should consider the known or potential rate of error, . . . and the existence and maintenance of standards controlling the technique's operation."[119] Lastly, the Court said that "'general acceptance' can yet have a bearing on the inquiry."[120]

The second case in the *Daubert* "trilogy" was *General Electric Co. v. Joiner*,[121] which confirmed that it was not "an abuse of discretion" for judges to exclude expert testimony that they believe failed to meet the *Daubert* standard.[122]

In 1999, *Kumho Tire Co. v. Carmichael*[123] extended the general holding in *Daubert* to all forms of expert testimony—scientific and otherwise. The expert testimony in this case was from a tire-failure analyst who concluded that a tire's blowout, leading to a serious accident and the death of a passenger in a van, was due to a manufacturer's design defect.[124] The defense claimed that the blowout was the result of normal wear and tear.[125] The district court excluded the testimony on reliability grounds, citing *Daubert*, and granted summary judgment to the defendant.[126] The Eleventh Circuit Court of Appeals reversed the decision, holding that *Daubert* did not apply to such "skill- or ex-

115. *Id.* at 593.
116. *Id.*
117. *Id.*
118. *Id.*
119. *Id.* at 594.
120. *Id.*
121. 522 U.S. 136 (1997).
122. *Id.* at 139.
123. 562 U.S. 137 (1999).
124. *Id.* at 142.
125. *Carmichael v. Samyang Tires, Inc.*, 923 F. Supp. 1514, 1518 (S.D. Ala. 1996).
126. *Id.* at 1522.

perience-based" testimony and only applied to scientific testimony.[127] The United States Supreme Court, in an opinion authored by Justice Stephen Breyer, reversed the decision and held that the *Daubert* decision and reasoning applied to *all* forms of expert testimony, including the testimony of engineers and other experts who are not necessarily scientists.[128] In other words, the reliability requirement of *Daubert* was to be extended to all forms of expertise. This decision was particularly important for the forensic sciences because there are many forms of forensic expertise, such as pattern evidence comparisons, that are arguably not strictly scientific. In 2000, the Federal Rules of Evidence were modified to codify case law based upon the *Daubert*, *Kumho Tire*, and *Joiner* decisions.[129]

Today, scientific and legal literature contains thousands of *Daubert*-related articles. In 1991 and 2003, Giannelli examined the effects of *Daubert* and *Kumho Tire* on criminal cases and forensic evidence.[130] He assessed *Daubert*'s impact on criminal courts' reexamination of the reliability of some of the venerable, technical fields like handwriting analysis, fingerprinting, hair comparison, and firearms identification.[131] He also noted that *Daubert* successfully closed a significant loophole in the *Frye* decision that had excluded non-novel techniques from judicial scrutiny.[132] Finally, he observed how some of the *Daubert* "reliability" criteria had been increasingly used by state court judges in making admissibility decisions, even in so-called "*Frye* states."[133]

Another important article, *Asking the Gatekeepers: A National Survey of Judges on Judging Expert Evidence in a Post-*Daubert *World*, questioned if judges truly understood the *Daubert* decision.[134] The authors surveyed 400 state court judges and determined that judges accepted their "gatekeeping" role as articu-

127. *Carmichael v. Samyang Tires, Inc.*, 131 F.3d 1433, 1434–1435 (11th Cir. 1997).

128. *Kumho Tire Co.*, 526 U.S. at 151.

129. Fed. R. Evid. 702 (amended Dec. 1, 2000).

130. Paul C. Giannelli, *The Supreme Court's "Criminal"* Daubert *Cases*, 33 Seton Hall L. Rev. 1071 (2003).

131. *Id.* at 1096–1099.

132. *Id.* at 1099–1100.

133. *Id.* at 1100–1101.

134. Sophia I. Gatowski et al., *Asking the Gatekeepers: A National Survey of Judges on Judging Expert Evidence in a Post-*Daubert *World*, 25 L. & Hum. Behav. 433, 434 (2001).

lated in *Daubert*, but when they were asked to operationalize several of the key concepts expressed in *Daubert*, they could not.[135] Only six percent of respondents demonstrated a good understanding of the concept of "falsifiability,"[136] and just four percent had a clear understanding of error rate.[137] While there are certainly indications that standards for admitting expert testimony are higher,[138] there is also data suggesting that most judges may not even understand key elements of the decision that set the process into motion.[139]

Not long after the *Daubert* decision, in 1994, the Federal Judicial Center issued its initial edition of the Reference Manual on Scientific Evidence as an aid to judges interpreting complex scientific and technological evidence.[140] In 2000, Justice Breyer wrote the introduction to the second edition.[141] The second edition substantially expanded upon the material in the earlier edition and included new guides on medical testimony and engineering and a revised section on DNA evidence. The manual was part of the Federal Judicial Center's efforts to sponsor education and research activities to assist federal judges. In 1993, the Carnegie Commission on Science, Technology, and Government (the Commission) also examined the ability of the courts to handle "science-rich" cases in order to devise better procedures for training judges and resolving scientific disputes.[142] The Commission wrestled with the controversy over "junk science" and the fact that the field of science is continually changing, while legal players must "make decisions at a particular moment in time."[143] The Commission's work called for judges to take an active role in managing

135. *Id.* at 443.
136. *Id.* at 444.
137. *Id.* at 447.
138. *Id.*
139. *Id.* at 443.
140. *Reference Manual on Scientific Evidence* (Joe S. Cecil et al. eds., 1st ed., Fed. Jud. Ctr. 1994) (available at http://www.fjc.gov/public/home.nsf/pages/93).
141. *Reference Manual on Scientific Evidence* (Fern M. Smith ed., 2d ed., Fed. Jud. Ctr. 2000) (available at http://www.fjc.gov/public/home.nsf/pages/610).
142. Carnegie Commn. Sci., Tech. & Govt., *Science and Technology in Judicial Decision Making: Creating Opportunities and Meeting Challenges* 11 (Carnegie Commn. Sci., Tech. & Govt. 1993) (available at http://www.carnegie.org/sub/pubs/science_tech/judicial.txt) (accessed Aug. 15, 2007).
143. *Id.* at 12–13.

science in litigation[144] and to engage in more contact with various scientific communities[145] and ended on a note of optimism: most judicial decisions involving science are sound, and there are a growing number of programs available to improve judicial understanding of scientific and technological issues.[146]

Judges were called on to demonstrate their ability to make decisions about scientific evidence in the silicone-breast-implant litigation that raged in the courts in the mid-1990s as plaintiffs' experts attempted to prove that silicone breast implants caused connective tissue disease.[147] Many of the judges involved in these cases took a more assertive role in reviewing this evidence, played the position of gatekeeper, and relied more on panels of neutral scientists to advise the courts on which of the plaintiffs' and defendants' experts they should hear.[148] Neutral experts clearly can assist the courts in evaluating the testimony of partisan experts by focusing on the scientific reasoning and methodology used by the experts and helping the court to determine if the experts' conclusions and opinions are based on scientifically reliable data.

In 1995, Penelope N. Markham and co-author Peterson published their review of crime-laboratory proficiency testing results over the period of 1978 to 1991.[149] They found that laboratories were performing best in determining the origin of "finger and palm prints, metals, firearms" (bullets and cartridge cases), and footwear;[150] laboratories had moderate success in determining the source of bloodstains, questioned documents, toolmarks, and

144. *Id.* at 16.

145. *Id.* at 17.

146. *Id.* at 19.

147. Gina Kolata, *Three Breast Implant Makers Agree to Pay $3.7 Billion*, N.Y. Times A28 (Feb. 20, 1994).

148. Peter Fenn et al., *Scientific Experts: More Attention Needed*, 378 Nat. 754 (1995); Eliot Marshall, *New York Courts Seek 'Neutral' Experts*, 272 Sci. 189 (1996); Marc S. Reisch, *Science Has Its Day in Court*, 75 Chem. & Engr. News 21 (Feb. 3, 1997); James T. Rosenbaum, *Lessons from Litigation over Silicone Breast Implants: A Call for Activism by Scientists*, 276 Sci. 1524 (1997); Traci Watson, *Court-Appointed Scientists Provide Technical Expertise*, 358 Nat. 702 (1992).

149. Joseph L. Peterson & Penelope N. Markham, *Crime Laboratory Proficiency Testing Results, 1978–1991, I: Identification and Classification of Physical Evidence*, 40 J. Forensic Sci. 994 (1995) [hereinafter Peterson & Markham, *Identification and Classification*]; Joseph L. Peterson & Penelope N. Markham, *Crime Laboratory Proficiency Testing Results, 1978–1991, II: Resolving Questions of Common Origin*, 40 J. Forensic Sci. 1009 (1995) [hereinafter Peterson & Markham, *Resolving Questions*].

150. Peterson & Markham, *Resolving Questions*, *supra* n. 149, at 1028.

hair.[151] The third category, including paint, glass, fiber, and body fluid mixture comparisons, was more problematic and had ten percent or more of erroneous results.[152] Proficiency test results, although not a perfect device for determining a technique's or evidence type's likely error rate, assisted both the forensic and the legal communities in assessing the reliability of particular evidence testing areas.[153] Blind DNA proficiency testing was the subject of two other articles by co-author Peterson and others in 2003.[154] These articles described the results of a study in which fifteen blind proficiency tests were administered to forensic DNA-testing laboratories around the country.[155] Although the study indicated that blind DNA testing was technically feasible, the cost associated with such testing was very high and the administration of the tests was a complicated, labor-intensive exercise.[156] As a result, and because the profession already had a number of quality assurance programs underway, the advisory committee and principal investigators concluded that blind testing should not be implemented on a widespread basis at that time.[157]

Many state and local forensic laboratories began to establish their own DNA-laboratory-testing units during the 1990s. The admissibility of these new DNA techniques was argued in the literature[158] and in the courts, and although there were notable exceptions, a trend was soon established that the judiciary was prepared to admit these results. There was a flurry of cases, such as *People v. Castro*,[159] involving serious objections to the technique and procedures used in DNA testing. In 1994, Bruce Budowle and Eric S. Lander, former scientific adversaries on questions of DNA-evidence admissibility, published a joint article entitled *DNA Fin-*

151. *Id.*

152. *Id.*

153. Peterson & Markham, *Identification and Classification*, *supra* n. 149, at 994.

154. Joseph L. Peterson et al., *The Feasibility of External Blind DNA Proficiency Testing. I. Background and Findings*, 48 J. Forensic Sci. 21 (2003) [hereinafter Peterson et al., *Background and Findings*]; Joseph L. Peterson et al., *The Feasibility of External Blind DNA Proficiency Testing. II. Experience with Actual Blind Tests*, 48 J. Forensic Sci. 32 (2003) [hereinafter Peterson et al., *Experience with Actual Blind Tests*].

155. *Supra* n. 154.

156. Peterson et al., *Background and Findings*, *supra* n. 154, at 30.

157. *Id.*

158. R. C. Lewontin & Daniel L. Hartl, *Population Genetics in Forensic DNA Typing*, 254 Sci. 1745, 1746 (1991).

159. 545 N.Y.S.2d 985 (N.Y. Sup. Ct. 1989).

gerprinting Dispute Laid to Rest.[160] As the title suggests, the authors conceded that the scientific debate over DNA typing was settled, largely due to the reports by the National Research Council (NRC) that established standards and encouraged the formation of a committee to deal with any problems that might surface in the future.[161] The NRC's call for a committee was realized with the establishment of an FBI DNA advisory board.[162] There was a handful of early cases that met with judicial resistance, but later there was a cascading effect that led to the elimination of all legal barriers to the admission of DNA test results.[163] Many anticipated that the introduction of DNA test results in the O.J. Simpson case in 1995 would result in a huge legal battle, but Simpson's legal team chose not to challenge their admissibility.[164] By 2000, DNA evidence was uniformly accepted in courts all across the country.[165]

During this same time period, in 1995, Dr. Frederic Whitehurst, a scientist employed in the FBI laboratory, leveled charges of sloppy work, flawed report writing, and perjured court testimony affecting the explosives, chemistry-toxicology, and materials analysis units of the laboratory.[166] Under the supervision of Michael R. Bromwich, the United States Justice Department's Inspector General, and with the assistance of an external blue ribbon panel, an extensive eighteen-month investigation ensued, which uncovered very serious problems.[167] The investigation did not substantiate most of Whitehurst's allegations but did find numerous instances of "testimonial errors, substandard analytical

160. Eric S. Lander & Bruce Budowle, *DNA Fingerprinting Dispute Laid to Rest*, 371 Nat. 735 (1994).

161. *Id.* at 735.

162. *Id.* at 738.

163. *See id.* at 735 (stating that "[t]he DNA fingerprinting wars are over"); *see also* Ulmer, *infra* n. 165, at 1598 (stating that "[a]fter passing many rounds of judicial screening, . . . DNA evidence has been ruled admissible in all United States jurisdictions").

164. David Margolick, *Simpson Defense Drops DNA Challenge*, N.Y. Times A16 (Jan. 5, 1995).

165. Frank B. Ulmer, Student Author, *Using DNA Profiles to Obtain "John Doe" Arrest Warrants and Indictments*, 58 Wash. & Lee L. Rev. 1585, 1598 (2001).

166. Pierre Thomas & Mike Mills, *FBI Crime Laboratories Being Probed; Scientist Alleges Conclusions Were Altered to Help Prosecute Cases*, Wash. Post A1 (Sept. 14, 1995).

167. Off. Inspector Gen., *The FBI Laboratory: An Investigation into Laboratory Practices and Alleged Misconduct in Explosives-Related and Other Cases* (U.S. Dept. Just. 1997) (available at http://www.usdoj.gov/oig/special/9704a/).

work, and deficient practices."[168] The Inspector General's final report, issued in 1997, made numerous recommendations aimed at maintaining the independence of scientists in the crime laboratory and at protecting them from the influence of field investigators while conducting laboratory examinations, writing reports, and delivering testimony.[169] The report also recommended that the laboratory seek accreditation from the American Society of Crime Lab Directors in order to counter some of the "insular and parochial views" that the investigating panel found in the laboratory.[170] Work was already underway by the laboratory to achieve such accreditation, and it successfully attained this status in 1998.[171]

V. 2000: PRESSURE ON THE FIELD FROM ALL FRONTS

The twenty-first century has been marked by the continuation of several themes appearing in the previous three decades that are now being brought into sharper focus. The quality and reliability of laboratory results are continually in question, and there is pressure on the field to engage in the research needed to substantiate laboratory conclusions that lead examiners to individualize forensic evidence. In addition, high professional standards for individuals and facilities are needed throughout the forensic field. There is also greater public acceptance of forensic techniques, but along with it, greater pressure to perform at a high level. Lastly, there are calls for better funding support of public forensic laboratories in order to stem mounting backlogs.

A. Forensic Science in the Popular Culture

Over the past several years there has been growing public awareness and excitement over forensic science, influenced by the popular media's treatment of forensic investigations in television shows, magazine articles, and movies. The public's interest was particularly piqued by the television program "CSI: Crime Scene

168. *Id.* at http://www.usdoj.gov/oig/special/9704a/00exesum.htm.

169. *Id.* at http://www.usdoj.gov/oig/special/9704a/25part7a.htm.

170. *Id.* at http://www.usdoj.gov/oig/special/9704a/00exesum.htm.

171. Associated Press, *Panel Approves Accreditation for F.B.I. Lab*, N.Y. Times A20 (Sept. 23, 1998).

Investigation," introduced on CBS in the fall of 2000, and its progeny "CSI: Miami" and "CSI: New York."[172] All of the CSI programs have portrayed exaggerated forensic techniques and used violent and sexual themes to captivate their audiences. The creators claim that they make great efforts to produce programs based on real science, but they still take significant scientific liberties and employ embellished visuals to bring the viewer in close contact with the evidence.[173] As real-life practitioners will testify, CSI crams into forty-five minutes what it takes police and crime laboratories months to do. The program glosses over the painstaking, meticulous work that characterizes many forensic investigations. Science on television always seems to produce the answer, but this is something just not accomplished in real life. In turn, this has resulted in real-life problems for criminal justice officials. The public in general, and jurors in particular, expect local police and forensic laboratories to replicate what they have seen on CSI. Prosecutors are sometimes forced to present experts to explain to the jury why real life does not compare with CSI and why physical evidence was not, and cannot be, presented in their case. Scientific evidence, and DNA in particular, has become the *sine qua non* of the modern prosecution. So, while jurors are eager for forensic evidence, they may "punish" the state by acquitting a defendant if the evidence does not match their CSI expectations.

Police and prosecutors also watch CSI, and the evidence submissions to crime laboratories have increased accordingly. The DNA phenomenon has also led to increased submissions to crime laboratories, but the laboratories have not had the resources to keep pace. As detailed most recently in a study sponsored by the Bureau of Justice Statistics, in 2002, crime-laboratory backlogs topped 500,000 requests on a national basis.[174] Laboratory backlogs have also been underscored in journalistic investigations of

172. *E.g.* Houck, *supra* n. 4; Stefan Lovgren, *"'CSI' Effect" Is Mixed Blessing for Real Crime Labs*, Natl. Geographic News (Sept. 24, 2004), http://news.nationalgeographic.com/news/2004/09/0923_040923_csi.html; Kit R. Roane, *The CSI Effect*, 138 U.S. News & World Rep. 48 (Apr. 25, 2005); Richard Willing, *"CSI Effect" Has Juries Wanting More Evidence*, USA Today 1A (Aug. 5, 2004).

173. Jennifer Frey, *On Crime-Scene Shows: The Science Is Arresting*, Wash. Post 1 (Sept. 19, 2004).

174. Joseph L. Peterson & Matthew J. Hickman, *Census of Publicly Funded Forensic Crime Laboratories, 2002* 1 (U.S. Dept. Just. 2005).

why the processing of cases and defendants is delayed.[175] Lengthy DNA backlogs, in particular, have been cited in newspaper articles that highlight the resource and managerial deficiencies of crime laboratories and their inability to get results quickly into the hands of investigators, prosecutors, and factfinders.[176] The Christa Worthington murder case in Cape Cod, Massachusetts,[177] received national attention and outraged the public by highlighting a situation in which evidence sat untested in a laboratory for more than a year.[178] Because that laboratory and many others have months of backlogged cases, assailants are not immediately apprehended, leaving them free to commit other crimes.

An interesting spin on drawing attention to the resource problems of crime laboratories is the Crime Lab Project, a group of crime and mystery writers who are concerned about the chasm that exists between the public beliefs about forensic science and the under-funded resource realities of crime laboratories.[179] The group has established a website and begun a public information and letter-writing campaign to inform legislators about these problems and to encourage greater funding.[180] The Crime Lab Project expresses concern as to how this lack of support and funding affects law enforcement and the quality of justice in the United States.[181]

B. Investigative Journalists Turn Their Attention to Forensic Science

While Professor James Starrs was one of the first to publicly identify forensic "mountebanks" in 1988,[182] other problematic laboratories and scientists were investigated in the 1980s and 1990s by the *Dallas Morning News*, *USA Today*, and the *Seattle*

175. Maurice Possley et al., *Scandal Touches Even Elite Labs: Flawed Work, Resistance to Scrutiny Seen across U.S.*, Chi. Trib. C1 (Oct. 21, 2004).

176. *Id.*

177. Pam Belluck, *Slow DNA Trail Leads to Suspect in Cape Cod Case*, N.Y. Times A6 (Apr. 16, 2005).

178. *Id.*

179. Crime Lab Project, *What Is the Crime Lab Project?* http://www.crimelabproject.com (last updated Aug. 15, 2007).

180. *Id.* at http://www.crimelabproject.com/bulletins.html.

181. *Id.* at http://www.crimelabproject.com.

182. James E. Starrs, *Mountebanks Among Forensic Scientists*, in *Forensic Science Handbook* vol. 2 (Richard Saferstein ed., Prentice Hall 1988).

Times.[183] Few investigations, however, compare to the more recent efforts by the *Houston Chronicle*, *Chicago Tribune*, *Seattle Post-Intelligencer*, CNN ("Reasonable Doubt: Can Crime Labs Be Trusted?"), and the PBS Frontline program on DNA and the death penalty ("The Case for Innocence").[184] West Virginia newspapers were also central to exposing the work of Fred Zain, who falsified serology reports and gave perjured testimony for years to fit the needs of criminal investigators and prosecutors.[185] The article by Giannelli in 1997, *The Abuse of Scientific Evidence in Criminal Cases: The Need for Independent Crime Laboratories*, described the abuses of Zain and numerous other forensic scientists.[186] Giannelli identified the paradox of forensic science today: laboratories are touted for their scientific breakthroughs, but they are simultaneously criticized when unscrupulous examiners lie about their credentials and test results or use traditional techniques that lack firm scientific grounding.[187]

In terms of the popular press, prior to the twenty-first century, the content of most newspaper articles on forensic science largely focused on the technology of the laboratory and how scientific evidence aided law enforcement. Lately, however, more and more investigative journalists have zeroed in on crime-laboratory backlogs and examiner errors, such as the Chicago Tribune's 2004 series *Forensics: Under the Microscope*.[188] Reporters today are more knowledgeable, and investigations probe deeper into the details of the scientific assumptions that are the basis of forensic investigations. The *Seattle Post-Intelligencer* and *Houston Chronicle* have investigated questionable forensic practices, particularly at the local level.[189] Investigative journalists in the print

183. Becky Beaupre & Peter Eisler, *Crime Lab Crisis*, USA Today 1A (Aug. 20, 1996); Gayle Golden, *Scientific Justice*, Dallas Morning News (Apr. 3–7, 1988); Tomas Guillen & Eric Nalder, *Overwhelming Evidence: Crime Labs in Crisis* Seattle Times A1 (June 22, 1994).

184. *CNN Presents*, "Reasonable Doubt" (CNN Jan. 9, 2005) (TV broad.); *Frontline*, "The Case for Innocence" (PBS Oct. 31, 2000) (TV broad.); *infra* nn. 188–190 and accompanying text.

185. Paul C. Giannelli, *The Abuse of Scientific Evidence in Criminal Cases: The Need for Independent Crime Laboratories*, 4 Va. J. Soc. Policy & L. 439, 442–443 (1997).

186. *Id.* at 442–449.

187. *Id.* at 441.

188. Flynn McRoberts, Steve Mills & Maurice Possley, *Forensics under the Microscope: Unproven Techniques Sway Courts, Erode Justice*, Chi. Trib. C1 (Oct. 17, 2004).

189. *Endless Scandal: Crime Lab Special Investigator Turns Up More Tainted Evidence*

and electronic media have brought crime-laboratory problems to the attention of the public and have been responsible for initiating major governmental investigations.[190]

The Houston Police Department Crime Laboratory investigation began with televised investigative news reports broadcast in November 2002.[191] These reports severely criticized the work being performed in the serology section of the crime laboratory in several specific cases.[192] DNA work in the laboratory was suspended in 2003, and various audits of the laboratory were completed to verify the extent of the problem.[193] A local Stakeholders Committee of public officials, attorneys, and scientists was formed.[194] The Committee made the decision to conduct a complete, independent review of the laboratory, and a team from the law firm of Fried, Frank, Harris, Shriver & Jacobson, LLP, headed by former Inspector General Michael R. Bromwich, began its investigation in February 2005.[195] Bromwich's team, including several well-known forensic scientists from across North America,[196] has investigated over 2,000 cases throughout the laboratory.[197] The investigation found that the Houston Police Department and the City of Houston had failed to provide the laboratory with the resources it needed to perform competent scientific work, that the laboratory did not fulfill its quality assurance duties, and that it suffered from an absence of strong leadership.[198] The review of cases found "severe" and "pervasive" problems in the serology and DNA sections of the laboratory, and instances of scien-

While Questioning Motives of Analysts, Houston Chron. B8 (May 16, 2006) [hereinafter *Endless Scandal*]; Ruth Teichroeb, *Crime Labs Too Beholden to Prosecutors, Critics Say*, Seattle Post-Intelligencer A13 (July 23, 2004).

190. *E.g. Endless Scandal*, *supra* n. 189; Ruth Teichroeb, *Oversight of Crime-Lab Staff Has Often Been Lax*, Seattle Post-Intelligencer A1 (July 23, 2004).

191. Off. Indep. Investigator Houston Police Dept. Crime Laboratories & Prop. Room, *Background of the Investigation*, http://hpdlabinvestigation.org/about.htm (accessed Aug. 15, 2007) [hereinafter Houston Police Indep. Investigator] (noting that the reports resulted in televised news reports on KHOU—Channel 11, Houston).

192. *Id.*

193. *Id.*

194. *Id.*

195. *Id.*; Michael R. Bromwich, *Fifth Report of the Independent Investigator for the Houston Police Department Crime Laboratory and Property Room* (HBD Crime Lab. Indep. Investigation 2006) (available at http://hpdlabinvestigation.org/reports/060511report.pdf).

196. Bromwich, *supra* n. 195, at 2–4.

197. *Id.* at 7.

198. *Id.* at 83, 84.

tific fraud (drylabbing) in the drug section of the laboratory.[199] The public may view the interim reports on the investigation team's website, and the final report and recommendations are forthcoming.[200]

C. Defense Access to Scientific Results

Over the past century, scientific evidence has principally been a tool of government crime laboratories and used mostly to buttress criminal prosecutions. Almost eighty percent of crime laboratories are under police control and many laboratories will only perform their services for law-enforcement agencies.[201] Most laboratory employees are civilian scientists, however, and do their best to maintain independence and neutrality throughout the examination of evidence.[202] Legal discovery is a tool that criminal defense attorneys have increasingly used over the past thirty years to gain access to scientific evidence in the hands of prosecutors. It is only fair that, in order to prepare for trial, a criminal defendant and his defense counsel have access to the reports, notes, and test results that will be used to prosecute the defendant. Further, if the defendant has the resources, he may ultimately access the evidence for retesting. The reliability of test results is also at the top of the forensic agenda today, and discovery provides the means to examine and verify the work performed in government laboratories. Giannelli provided a detailed treatment of these various issues fifteen years ago and made a series of recommendations that are still relevant today.[203]

199. *Id.* at 16, 39; Michael R. Bromwich, *Third Report of the Independent Investigator for the Houston Police Department Crime Laboratory and Property Room* 3 (HBD Crime Lab. Indep. Investigation 2005) (available at http://hpdlabinvestigation.org/reports/050630report.pdf). Drylabbing is defined as "a form of egregious scientific fraud involving the fabrication and reporting of scientific results for tests" that were never actually conducted. Bromwich, *supra* n. 195, at 34, n. 54.

200. Houston Police Indep. Investigator, *supra* n. 191, at http://hpdlabinvestigation.org/reports.htm.

201. Peterson et al., *Criminalistics Laboratories*, *supra* n. 19, at 11.

202. *Id.* at 18.

203. Paul C. Giannelli, *Criminal Discovery, Scientific Evidence, and DNA*, 44 Vand. L. Rev. 791, 798–800, 816–819 (1991).

D. Forensic Science: Scientific, Public, and Political Issues

Forensic science has evolved over the past several decades on a dual track that has now emerged in full public view, unveiling both the field's strengths and weaknesses. On the one hand, the strengths show that forensic evidence can be without peer in identifying persons and using physical evidence to link offenders with their crime scenes and victims. Forensic evidence also has the power to exonerate a wrongly accused and innocent person. Theoretically, at least, forensic evidence should be neutral, with the scientist not having a stake in the outcome of the case. The field even has its own public-relations firm in the form of the media, which touts forensic methods at every opportunity. On the other hand, the field has numerous weaknesses: crime laboratories suffer from a lack of resources and substantial scientific and organizational shortcomings. These deficiencies threaten to limit forensic science's services to society and undercut its presumed scientific foundation.

The public knows that DNA technology's sophistication has grown by leaps and bounds and is now capable of linking an offender to his or her victim or crime scene with a fleck of blood, perspiration in underwear or the headband of a baseball cap, saliva on the rim of a cup or a postage stamp, or through "touch DNA" to a telephone receiver held by the suspect. Along with its added speed of results, precision, accuracy, and standards, Short Tandem Repeat (STR) analysis is responsible for many of these scientific advancements.[204] The development of the Polymerase Chain Reaction (PCR) procedure increased the sensitivity of analysis and allowed for the copying of these STRs to increase the quantity of DNA samples available for analysis.[205] The CODIS database has grown enormously as states have expanded the numbers of criminal offenders and arrestees who must contribute a DNA sample, and, as of November 2006, the database contained more than three million profiles and has contributed to more than

204. Fla. Dept. L. Enforcement, *Successful Use of Technology to Improve Public Safety: Implementation of DNA Short Tandem Repeat (STR) Analysis*, http://www.fdle.state.fl.us/publications/tech_success_stories/dna-str.htm (accessed Aug. 15, 2007).

205. Richard Saferstein, *Criminalistics: An Introduction to Forensic Science* 416–420 (6th ed., Prentice Hall 2004).

36,000 criminal investigations.[206] While exonerations continue to grow, so does a far greater number of successful prosecutions.

The scientific integrity and reliability of DNA testing have helped DNA replace fingerprinting and made DNA evidence the new "gold standard" of forensic evidence. Mark Hansen's 2005 article in the *American Bar Association Journal* describes how DNA evidence has actually shifted attention to the scientific weaknesses of other opinion-based, pattern evidence.[207] This shift is illustrated by the recent article *Correlation of Microscopic and Mitochondrial DNA Hair Comparisons*[208] in which authors Max Houck and Bruce Budowle described mitochondrial DNA (mtDNA) testing performed on hairs that had been associated microscopically in the FBI laboratory.[209] Nine of the eighty hairs associated were found to have dissimilar mtDNA and were therefore excluded as being from the same source.[210] In another forensic area, testing of saliva found on bitemarks that were originally thought to be from the same person using visual comparison found that the saliva samples actually had DNA of different origins.[211]

Therefore, although fingerprint, handwriting, and firearms-identification methods have strong practical and legal acceptance, they lack the same scientific and statistical foundation established for DNA typing. DNA evidence's reliability and the empirical statistical database allow forensic examiners to differentiate a suspect's DNA profile from others and give a quantitative estimate for a chance match, which fit well within the new *Daubert* standards.[212] Lastly, the social policy and scholarly writings about DNA and the quickly growing DNA databases have addressed the tough tradeoffs between the databases' important societal bene-

206. FBI, *supra* n. 74, at http://www.fbi.gov/hq/lab/codis/national.htm.

207. Mark Hansen, *The Uncertain Science of Evidence*, 91 ABA J. 48 (2005).

208. Max M. Houck & Bruce Budowle, *Correlation of Microscopic and Mitochondrial DNA Hair Comparisons*, 47 J. Forensic Sci. 964 (2002).

209. *Id.* at 964.

210. *Id.* at 966.

211. Flynn McRoberts, *Bite-Mark Verdict Faces New Scrutiny*, Chi. Trib. CN1 (Nov. 29, 2004).

212. David H. Kaye & George F. Sensabaugh, Jr., *Reference Guide on DNA Evidence*, in *Reference Manual on Scientific Evidence* 485, 555 (2d ed., Fed. Jud. Ctr. 2000) (available at www.fjc.gov/public/home.nsf/pages/610). For a discussion of the *Daubert* case, see nn. 108–118 and accompanying text.

fits and their potential threat to individual interests and civil liberties.[213]

Legislators are feeling pressure from their constituents to do something about the resource problems facing crime laboratories. There has been a range of legislation over the past several years to improve the quality and availability of forensic evidence.[214] The Consortium of Forensic Science Organizations (CSFO), made up of several professional forensic organizations, is working hard to inform Congress of the forensic community's needs.[215] Aside from appropriating special funds for forensic laboratories, a few state legislatures, including New York, Texas, and Oklahoma, have mandated that crime laboratories in their jurisdiction be accredited in order to examine physical evidence and deliver testimony.

The National Institute of Justice (NIJ) was directed by the United States Congress in 2004 to submit a report that addressed the needs of forensic service providers.[216] A wide range of views was discussed at an NIJ Summit gathering of forensic scientists in May 2004.[217] The NIJ Summit's report, submitted to the Senate Committee on Appropriations in August 2004, covers manpower and equipment needs, continuing education policies, professionalism and accreditation standards, and collaboration among federal, state, and local forensic science laboratories.[218]

213. *E.g.* R. Alta Charo, *Ethical and Policy Guidance*, in *DNA and the Criminal Justice System* 147 (David Lazer ed., MIT Press 2004).

214. *E.g. President's DNA Initiative*, *Executive Summary* (Mar. 11, 2003) (available at http://www.dna.gov/info/e_summary); Natl. Inst. Just., *Paul Coverdell National Forensic Science Improvement Act: Solicitation for Discretionary Funding*, FY 2003 (U.S. Dept. Just. 2003) (available at http://www.ncjrs.gov/pdffiles1/nij/sl000615.pdf); H.R. 5107, Justice for All Act of 2004, 108th Cong. (Sept. 21, 2004) (implementing many of the provisions of the President's DNA Initiative); H.R. 4640, DNA Analysis Backlog Elimination Act of 2000, 106th Cong. (June 12, 2000).

215. The Consortium of Forensic Science Organizations (CSFO) is an association of six forensic science professional organizations that work to influence public policy on forensic science issues at the national level. Information is available at http://www.thecfso.org.

216. Natl. Inst. Just., *Status and Needs of Forensic Science Service Providers: A Report to Congress* (U.S. Dept. Just. 2004) (available at http://www.ncjrs.gov/pdffiles1/nij/213420.pdf).

217. *Id.*

218. *Id.*

E. *Daubert* Evolves

Giannelli has written on post-*Daubert* criminal cases, the presumed new exacting standards of *Daubert*, and the fact that civil court judges have applied these standards far more rigorously to expert testimony than criminal court judges.[219] We do not know if civil court judges are more scientifically savvy or if criminal court judges are merely more content to rely on precedent in admitting traditional forensic techniques even though they would likely not pass *Daubert* muster. Though not applied uniformly across all cases, *Daubert* appears to have invigorated the *Frye* test and led to more consideration of reliability questions in the evaluation of forensic evidence. Giannelli proposes that if the government cannot fund the research necessary to gather data needed to support scientific techniques, the courts have no recourse but to reject these techniques.[220] Giannelli is also a major contributor to the ABA Criminal Justice Section's report, *Achieving Justice: Freeing the Innocent, Convicting the Guilty*, which focuses on those types of evidence (false confessions, eyewitness-identification procedures, and faulty forensic evidence) largely responsible for the wrongful conviction of the innocent.[221]

One of the reasons *Daubert* and *Kumho* have evolved is because defense counsel and expert witnesses have become more schooled at challenging long-accepted forensic techniques. The number of innocence clinics in law schools around the country has also expanded greatly and sharpened *Daubert* challenges. There are many more forensic scientists advising public defender offices, and many more defense experts are now available.[222] The *Daubert* case has allowed defense attorneys to challenge formerly indisputable cases involving fingerprints, hair, bitemarks, and firearms.[223] Bullet-lead-case challenges represent a significant vic-

219. *Supra* n. 130 and accompanying text.

220. Giannelli, *supra* n. 130, at 1111–1112.

221. ABA Crim. Just. Sec., *Achieving Justice: Freeing the Innocent, Convicting the Guilty*, *Report of the ABA Criminal Justice Section's Ad Hoc Innocence Committee to Ensure the Integrity of the Criminal Process* (ABA 2006) [hereinafter *Achieving Justice*].

222. *See* Natl. Assn. of Crim. Def. Laws., Inc., *Feature: A Short List of Reforms to Protect the Innocent*, 24 Champion 22 (2000) (stating that "[e]very public defender's office should have at least one lawyer who acts as a full-time forensic science specialist").

223. For more information on how *Daubert* has affected the legal community, consult Michael Specter, *Do Fingerprints Lie? The Gold Standard of Forensic Evidence Is Now*

tory for defendants. The National Academy of Sciences report challenged the FBI's scientific method of linking bullets to batches or boxes of ammunition in the defendant's possession.[224]

F. Pure Science Takes Notice of Forensic Science

In the summer of 2002, the National Academy of Science (NAS) addressed the applicability of the *Daubert* trilogy to a range of scientific, technical, medical, and regulatory matters.[225] In fact, NAS developed the new Science, Technology, and Law Program and, in the fall of 2003, organized several papers addressing the United States Supreme Court rulings on the forensic sciences.[226] Donald Kennedy and Richard Merrill discussed how the culture of academic research has "not been the norm" in forensic science and asked how scientific principles could be applied throughout the various forensic-science disciplines.[227] The papers were critical of the absence of reliable research databases, of law-enforcement and litigation-driven forensic research that lacked objectivity, and of the failure of many forensic specialties to satisfy the standards of *Daubert*.

The Arthur M. Sackler Colloquia of the National Academy of Sciences were presented in November 2005 and raised law-science conflicts to an even larger national stage.[228] One of the organizers, Steven Feinberg, said it was fair to say that forensic science was "under attack."[229] The presentations constituted a thoughtful and provocative addition to the collection of materials on the state of forensic science today.[230]

In a recent article, Michael J. Saks and Jonathan J. Koehler attacked the central assumption of "discernible uniqueness," or

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Being Challenged, New Yorker 96 (May 27, 2002) (available at http://www.michaelspecter.com/pdf/fingerprint.pdf).

224. Natl. Research Council, *Forensic Analysis: Weighing Bullet Lead Evidence* 113 (Natl. Acads. Press 2004).

225. Donald Kennedy & Richard A. Merrill, *Assessing Forensic Science*, Issues in Sci. & Tech. (Fall 2003) (available at http://www.issues.org/20.1/Kennedy.html).

226. *Id.*

227. *Id.*

228. *See* Natl. Acad. Scis., *Sackler Forensics Presentations*, http://www.nasonline.org/site/PageServer?pagename=sackler_forensic_presentations (accessed Aug. 15, 2007) (describing the symposium and listing links to the presentations at the symposium).

229. *Id.*

230. *Id.*

the ability of forensic examiners to individualize evidence such as fingerprints, firearms and cartridge-case striations, handwriting, and bitemarks.[231] Many forensic-evidence examiners believed that such evidence was capable of being individualized; however, the authors argued that the profession failed to provide empirical statistical proof supporting such a claim.[232] The authors argued that, since DNA typing has now become the new "gold standard" of forensic individualization (replacing fingerprints), other specialty forensic fields should take up the challenge of generating the quantitative information that would allow them to express the probabilities of random or chance matches.[233] Norah Rudin and Keith Inman, however, responded that many forensic-pattern-evidence fields do not permit the type of quantitative data statistics that are possible with DNA typing and that such research represents a formidable challenge.[234]

G. Context Effect

The last major theme emerging in this decade that this Article will address is the concern that the organizational context of forensic laboratories and the manner in which evidence and associated case information is presented to examiners can affect their results. For years, scholars have argued that police agencies were not an ideal location for crime laboratories and that these locations had the potential to taint examiners' objectivity. Many of the recent news reports cited in the previous section detailed how forensic examiners became biased, either unconsciously influenced by their involvement in a police investigation or simply wanting to contribute information that would help the case. Michael J. Saks and his co-authors were the first to address these dangers from a theoretical perspective.[235] In 2003, they published

231. Michael J. Saks & Jonathan J. Koehler, *The Coming Paradigm Shift in Forensic Identification Science*, 309 Sci. 892, 892 (2005).

232. *Id.*

233. *Id.* at 895.

234. Norah Rudin & Keith Inman, *The Shifty Paradigm, Part II: Errors and Lies and Fraud, Oh My!* Cal. Assn. of Criminalists Newsltr. 16 (1st Quarter 2006); Norah Rudin & Keith Inman, *The Shifty Paradigm, Part I: Who Gets to Define the Practice of Forensic Science?* Cal. Assn. of Criminalists Newsltr. 13 (4th Quarter 2005).

235. M.J. Saks et al., *Context Effects in Forensic Science: A Review and Application of the Science of Science to Crime Laboratory Practice in the United States*, 43 Sci. & Just. 77 (2003).

an article that discussed the well-established "psychological principle that the desires and expectations with which people approach the task of observation measurably affect their perceptions and interpretations of what they observe."[236] They argued that forensic examiners may be easily influenced by "extraneous, potentially biasing information" encountered in the course of a criminal investigation and laboratory examination.[237] They observed that many other scientific fields acknowledge these dangers and have taken steps to address them, but forensic laboratories have not.[238]

Shortly after the publication of the article by Saks and others, the Madrid terrorist bombing investigation revealed that the FBI had misidentified a latent fingerprint found in the aftermath of the bombing and incorrectly matched it to the fingerprints of an attorney in Oregon.[239] The Spanish authorities discovered the misidentification, and subsequently, the FBI admitted the error.[240] A review of the process occurred, resulting in a conclusion by the FBI's quality assurance unit that indeed the context of the investigation had led to a series of subsequent confirming misidentifications.[241] Soon after the report, Itiel Dror[242] conducted a study that further supported the existence of the context effect.[243] In his study, Dror had fingerprint examiners reexamine latent prints they had found to match five years earlier.[244] This time he presented the prints with the false information that they were the prints the FBI had mistakenly misidentified.[245] Four of the five examiners then reported that the prints did *not* match, contradicting their earlier conclusions.[246]

236. *Id.* at 78.
237. *Id.*
238. *Id.*
239. Robert B. Stacey, *Report on the Erroneous Fingerprint Individualization in the Madrid Train Bombing Case*, 7 Forensic Sci. Communs. 1 (2005) (available at http://www.fbi.gov/hq/lab/fsc/backissu/jan2005/special_report/2005_special_report.htm).
240. *Id.*
241. *Id.*
242. Itiel E. Dror, David Charlton & Ailsa E. Péron, *Contextual Information Renders Experts Vulnerable to Making Erroneous Identifications*, 156 Forensic Sci. Intl. 74 (2006).
243. *Id.*
244. *Id.* at 75.
245. *Id.* at 76.
246. *Id.*

H. The ABA's Criminal Justice Section Weighs In: An Apt Summary of the Present Law–Science Dilemma

The Ad Hoc Innocence Committee of the Criminal Justice Section of the ABA recently issued a report entitled *Achieving Justice: Freeing the Innocent, Convicting the Guilty*.[247] The report was an outgrowth of the Committee's review of the causes of wrongful convictions, and it addressed such issues as false confessions, eyewitness-identification problems, jailhouse informants, and forensic evidence. The report is an excellent guide to what federal, state, and local governments can do to assist in addressing many of the problems identified in this Article. Crime laboratories and medical examiner offices need to be accredited, examiners should be certified, and methods must be standardized. All forensic laboratories must be adequately funded. Defense experts should be appointed when "reasonably necessary." Finally, training in forensic techniques must be offered to both prosecutors and defense attorneys at a reasonable price, as they must develop the basic knowledge needed to try their cases competently.[248]

VI. CONCLUSION

The ABA Criminal Justice Section's report represents an excellent starting point as to how the legal profession can assist the forensic sciences to reach a desirable level of competence and offer timely delivery of services with fairness to all parties in the criminal justice system.[249] Only when resources are provided can forensic science realize its potential—to move from the science fiction of "CSI" to consistent, daily service to our criminal justice process. Forensic science should not be a game of charades, where opposing attorneys attempt to use the presence (or absence) of scientific evidence to their tactical advantage. Complete, competent, and impartial forensic-science investigations can be that "touchstone of truth" in a judicial process that works to see that the guilty are punished and the innocent are exonerated. This is only possible, however, if our government institutions provide the necessary resources.

247. *Achieving Justice*, *supra* n. 221.
248. *Id.*
249. *Id.*