A Test Both Lawyers and Scientists Can Live With: The Rigorous Five-Prong Test for the Admission of DNA Profiling Evidence Adopted in United States v. Matthew Sylvester Two Bulls, 918 F.2d 56 (8th Cir. 1990)

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I. INTRODUCTION

United States v. Matthew Sylvester Two Bulls1 was a case of first impression in the federal circuit courts2 addressing the admissibility of

* The author wishes to thank Shelly Watson and Steve Thomas for their help in the preparation of this Note. Shelly and Steve are good friends and great editors.
1. 918 F.2d 56 (8th Cir. 1990).
2. Since the decision in Two Bulls, there has been at least one other case involving the application of DNA profiling to forensics to reach a federal circuit court.
DNA (Deoxyribonucleic acid) profiling evidence. The United States Court of Appeals for the Eighth Circuit, implementing the common-sense standard adopted in *People v. Castro*, promulgated a five-prong test to be used by trial courts in pre-trial hearings when determining the admissibility of DNA profiling evidence. In doing so, the court assures that DNA profiling data offered into evidence in that circuit will be among the most highly scrutinized in the country.

This Note analyzes the court's holding and applauds its rationale. It begins by setting forth the facts, issue and holding in *Two Bulls*. Second, it delineates the commonly used standards for admission of novel scientific evidence in federal courts. Third, this Note examines the standards relied upon by the court in *Castro*, which were adopted by the court in *Two Bulls*. Finally, this Note analyzes the impact the additional prongs adopted by the Eighth Circuit will have on the reliability of the DNA evidence admitted into evidence in that circuit.

This Note concludes that the Eighth Circuit Court has promulgated a rigorous but fair five-prong test that assures the DNA profiling data offered into testimony will have been scrutinized for flaws. The court clearly has a grasp of the complex theories and techniques involved in DNA profiling. By applying its standard, the court will take advantage of a revolutionary technique without sacrificing protection of the defendant from prejudice due to misleading data.

II. FACTS, ISSUE, AND HOLDING IN *TWO BULLS*

Matthew Sylvester Two Bulls was charged with aggravated sexual abuse and sexual abuse of a minor after allegedly raping a fourteen-year-old girl on the Pine Ridge Indian Reservation in South Dakota. The Federal Bureau of Investigation (FBI) conducted DNA profiling on a semen stain isolated from the victim's underwear and compared it

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3. The term "DNA profiling" will be used throughout this Note. The type of DNA analysis used in *Two Bulls* also is commonly referred to as DNA fingerprinting, testing, typing or identification. Dan L. Burk, *DNA Identification: Possibilities and Pitfalls Revisited*, 31 JURIMETRICS J. 53, 57 (1990).

4. *People v. Castro*, 545 N.Y.S. 985 (Sup. Ct. 1989). Joseph Castro was accused of murdering Vilma Ponce and her two-year-old daughter. Castro was identified as the murderer by Ponce's common law husband, and also was alleged to have been linked to the victims by a spot of blood on his watch. The prosecution asserted that the blood was identified by DNA profiling as that of Ponce.


to the results from DNA testing performed on Two Bulls' blood. The
FBI concluded that there was a very high probability that the semen
was that of Two Bulls.\(^{10}\) Two Bulls made a motion for a suppression
hearing challenging the admissibility of the DNA profiling evidence.

On the basis of testimony presented by the government's first wit-
ness at the pre-trial hearing, the judge ruled that DNA evidence was
generally accepted by the scientific community and that it could be
presented to the jury.\(^{11}\) After the hearing, Two Bulls entered a condi-
tional guilty plea\(^{12}\) and was sentenced to 108 months in prison fol-
lowed by two years probation. On appeal, Two Bulls argued that the
trial court erred by applying the Federal Rule of Evidence 702\(^{13}\) stan-
dard in determining the admissibility of the DNA profiling evidence
rather than the \textit{Frye}\(^{14}\) standard or a more rigid standard. Though
\textit{Two Bulls} was a case of first impression in the federal circuit courts,
several state courts at that time had admitted DNA profiling
evidence.\(^{15}\)

Two Bulls asserted that the Eighth Circuit should adopt the test

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\(^{10}\) In this case, the statistical probability of someone other than Two Bulls providing
a match was one in 177,000 based on a Native American population data base. \textit{Id.}
n.2.

\(^{11}\) \textit{Id.}

\(^{12}\) A conditional plea is subject to Federal Rule of Criminal Procedure 11(a)(2). The
Rule provides:

\textit{With the approval of the court and the consent of the government, a
defendant may enter a conditional plea of guilty or nolo contendre, re-
serving in writing the right, on appeal from the judgment, to review of
the adverse determination of any specified pre-trial motion. A defend-
ant who prevails on appeal shall be allowed to withdraw the plea.}\n\textit{FED. R. CRIM. P. 11(a)(2).}

\(^{13}\) \textit{FED. R. EVID. 702} provides, "If scientific, technical, or other specialized knowl-
egde will assist the trier of fact to understand the evidence or to determine a fact
in issue, a witness qualified as an expert by knowledge, skill, experience, training,
or education, may testify thereto in the form of an opinion or otherwise."

\(^{14}\) \textit{Frye} v. United States, 293 F. 1013 (D.C. Cir. 1923). In \textit{Frye}, the D.C. Circuit con-
sidered the admissibility of polygraph evidence. In an oft-quoted passage, the
court commented:

\textit{Just when a scientific principle or discovery crosses the line between the
experimental and demonstrable stages is difficult to define. Somewhere
in this twilight zone the evidential force of the principle must be recog-
nized, and while the courts will go a long way in admitting expert testi-
mony deduced from a well-recognized scientific principle or discovery,
the thing from which the deduction is made must be sufficiently estab-
lished to have gained general acceptance in the particular field in which
it belongs.}\n\textit{Id.} at 1014. In its brief opinion, the \textit{Frye} court cited no authority nor did it fully
discuss the reasons for adopting the general acceptance standard. Nevertheless,
the test has dominated the admissibility of scientific evidence for 67 years.

\(^{15}\) \textit{See, e.g.,} Andrews v. State, 533 So. 2d 841 (Fla. 1988); Caldwell v. State, 393 S.E.2d
436 (Ga. 1990); Cobey v. State, 559 A.2d 391 (Md. 1989); State v. Schwartz, 447
N.W.2d 422 (Minn. 1989); People v. Castro, 545 N.Y.S.2d 985 (Sup. Ct. 1989); Peo-
used in Castro for the admissibility of DNA profiling evidence. The three steps from Castro are: 1) whether there is a theory generally accepted in the scientific community that supports the conclusion that DNA testing can produce reliable results, 2) whether the techniques or procedures currently available are capable of producing reliable results, and 3) whether the testing laboratory used the accepted techniques to analyze the samples in the particular case.

The Eighth Circuit agreed with the defense, holding that the conviction should be vacated and the conditional plea set aside. The case was remanded with instructions that a preliminary hearing should be held to determine whether the three requirements from Castro had been met. In addition to these requirements, the appellate court instructed the trial court to determine 1) whether the profiling evidence was more prejudicial than probative and, 2) whether the statistics on random probability offered into evidence were more prejudicial than probative. If the Castro requirements and the two additional requirements were satisfied, the evidence was to be admitted so that the jury could determine the weight that should be allocated to it.

By promulgating the five-prong test, the Eighth Circuit adopted the most rigorous standard for admission of DNA evidence in the United States. The test ensures that DNA profiling data admitted into evidence in the Eighth Circuit will be reliable.

III. ANALYSIS OF THE ADMISSIBILITY STANDARDS ADOPTED IN TWO BULLS

A. The Frye Standard

In determining the admissibility of novel scientific evidence, a majority of jurisdictions rely on the standard laid down in United States v. Frye. The Frye standard has been approached in two ways. The first is to ask whether "the [test] from which the deduction is made [has been] sufficiently established to have gained general acceptance

17. Id. at 987.
18. United States v. Two Bulls, 918 F.2d 56, 61 (8th Cir. 1990). Appellee's petition for rehearing was granted by the court and the case was scheduled for rehearing. On April 18, 1991, the United States moved to dismiss the appeal due to the death of Matthew Two Bulls. United States v. Two Bulls, 925 F.2d 1127 (8th Cir. 1991).
20. Id.
21. 293 F. 1013 (D.C. Cir. 1923). Frye was a case of first impression for the D.C. Circuit involving the admissibility of polygraph evidence. The court held that the polygraph had "not yet gained [general] standing and scientific recognition among physiological and psychological authorities." Id. at 1014. See also supra note 14.
in the particular field in which it belongs."\(^2\) By applying *Frye* in this manner, the underlying assumption is that general acceptance is an indication of reliability. For example, one court has gone so far as to conclude that because the techniques for DNA profiling are generally accepted, future *Frye* hearings are no longer necessary.\(^2\)

The second approach applies *Frye* as a three-prong test. A court so applying *Frye* would: 1) examine the underlying principle, 2) determine the validity of the technique applying that principle, and 3) determine whether proper application of the technique was used on a particular occasion.\(^2\) At least one court has used this approach to *Frye* to deal with DNA profiling evidence.\(^2\) Alternatively, another court, guarding the province of the trier of fact, has suggested that the third question be used in determining the weight of the evidence rather than admissibility.\(^2\) Whether the question is applied to determine weight or admissibility, the important issue of validity in the application of the technique in a particular case is addressed with the third prong. This is a more relevant inquiry than those found under the first approach. Nevertheless, *Frye* has been found to be flawed because "by focusing attention on the general acceptance issue, the test obscures critical problems in the use of a particular technique."\(^2\)

*Frye* has further been criticized because determining the particular field in which a technique belongs can be difficult. In the case of DNA profiling, should the field be molecular biology, where clean, plentiful samples are generally used? Or should it be forensics, where problems with contamination and the effects of adverse climate conditions on samples\(^2\) are more commonly encountered? If molecular biological techniques are applied to forensic cases, it makes sense for courts to require a general acceptance not only of the technique, but also of the application of the technique to forensics.\(^3\) Additionally, *Frye* has been criticized for allowing the scientific community, instead of the legal community, the final word on admissibility.\(^3\) This situation could be exacerbated if the scientists who testify as to "general

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24. State v. Ford, 392 S.E.2d 781, 784 (S.C. 1990). Under this approach, there is no pre-trial determination of whether proper application of the profiling technique was used on a particular occasion. This will expose the jury to evidence which may later be excluded due to lack of foundation. See infra text accompanying notes 70 and 71.
29. See infra text accompanying notes 72-74.
acceptance” have economic interests in the success of companies that market the technique.32

Thus, the approach to Frye and the particular application of the standards under Frye can make an enormous difference in determining whether certain evidence is admissible. At one extreme, acceptance of the general technique by scientists in the “field” is sufficient. At the other extreme, a majority of forensic scientists must agree that the tests performed in the specific case are acceptable.

B. The Federal Rules of Evidence Standard

In Two Bulls, the trial court applied Federal Rule of Evidence 70233 in determining the admissibility of the DNA profiling evidence, an application that the defendant appealed.34 The government argued that stringent standards necessitate long testimonial procedures before trial and that Rule 702 creates a liberal rule superceding Frye.35 The extent to which the Federal Rules overrule Frye has been the subject of debate,36 and the United States Supreme Court has done little to offer guidance.37 In Barefoot v. Estelle,38 a case decided after the adoption of the Federal Rules of Evidence, the Supreme Court utilized a relevancy approach without going so far as to expressly overrule Frye.

Courts which hold that the Frye test survives the adoption of the Federal Rules have some support from the legislative history.39 Those who argue that the Federal Rules supercede Frye focus on the language of the Rules. Rule 401 defines “relevant evidence”.40 Rule 402 states that all relevant evidence is generally admissible.41 Rule 403

32. See infra text accompanying note 81. See also Hoeffel, supra note 31, at 499; Thompson & Ford, supra note 30, at 59; People v. Young, 391 N.W.2d 270, 275-76 (Mich. 1986).
33. See supra note 13.
34. United States v. Two Bulls, 918 F.2d 56, 58 (8th Cir. 1990).
35. Id. at 59.
37. Giannelli, supra note 22, at 1229.
40. "'Relevant evidence' means evidence having any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence." FED. R. EVID. 401.
41. "All relevant evidence is admissible, except as otherwise provided by the Constitution of the United States, by Act of Congress, by these rules, or by other rules
allows relevant evidence to be excluded if it is overly prejudicial or confusing to the trier of fact. Finally, Rule 702 generally allows experts to testify if doing so would help the trier of fact understand and make a determination of fact based on the evidence. If the Federal Rules displace Frye, it would follow that the proponent of the evidence would have to show that the evidence has probative value and that it would not mislead the trier of fact.

Abandoning Frye and adopting the relevancy standard may indicate a court’s reluctance to defer to the scientific community for the last word on admissibility. In United States v. Williams, the court stated that the admissibility of scientific evidence should not be determined “solely on a process of counting [scientific] noses”, and that “courts cannot in any event surrender to scientists the responsibility for determining the reliability of that evidence.” Another reason for adopting the Federal Rules standard may be that the court may deem it better to admit relevant scientific evidence in the same manner as other evidence and allow its weight to be determined by the trier of fact after cross-examination, rather than exclude the evidence at a pre-trial hearing under Frye. Unfortunately, it is likely that juries will not be able to understand the nuances of a sophisticated technique, and therefore may not be able to adequately weigh the validity of the data in a specific case. As overheard after a presentation of scientific data at a hearing in Queens, “you can’t argue with science.” As discussed in the next sub-section, the Eighth Circuit approached the Frye and Federal Rules standards differently. While most courts have viewed the two standards as mutually exclusive, the Two Bulls prescribed by the Supreme Court pursuant to statutory authority. Evidence which is not relevant is not admissible.”

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FED. R. EVID. 402.

42. “Although relevant, evidence may be excluded if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury, or by considerations of undue delay, waste of time, or needless presentation of cumulative evidence.” FED. R. EVID. 403.

43. See supra note 13.

44. See supra note 27 and accompanying text.

45. 583 F.2d 1194, 1198 (2d Cir. 1978), cert. denied, 439 U.S. 1117 (1979). In Williams, the court permitted spectrographic voice analysis data to be admitted for the purpose of voice identification of a recorded telephone conversation in connection with the sale of narcotics.

46. Id. See also, United States v. Jakobetz, 955 F.2d 786, 796 (2nd Cir. 1992)(rejecting the Two Bulls standard in favor of the Federal Rules standard).

47. See United States v. Baller, 519 F.2d 463, 466 (4th Cir. 1975), cert. denied, 423 U.S. 1019 (1975). The Baller court admitted testimony identifying the defendant’s voice by spectrographic analysis where evidence presented in an extensive voir dire demonstrated spectrography’s probative value, expert witnesses testified as to the technique’s limitations, and tapes were played so that the jury could make aural comparisons.

court held that both standards require the same general approach to
the admissibility of new scientific evidence.\textsuperscript{49}

C. Two Bulls' Harmonizing of the Federal Rules and the Frye Standard

The two standards most commonly applied to the admissibility of
novel scientific evidence, the Frye test and the relevancy test under
the Federal Rules, are considered by most courts and commentators as
being either/or propositions.\textsuperscript{50} In this case, Two Bulls argued that the
trial court erred in applying Federal Rule of Evidence 702 rather than
the Frye test or a more rigid standard.\textsuperscript{51} However, the Eighth Circuit
harmonized the two standards:

In discussing the admissibility of DNA evidence, we find that Frye and
Rule 702 both require that a proper foundation be laid for any scientific test-
ing or laboratory procedure. Regardless of which rule may be followed, we
feel Rule 702 and Frye both require the same general approach to the admissi-
ability of new scientific evidence. Neither rule should permit speculative and
conjectural testing which fails normal foundational requirements necessary
for the admissibility of scientific testimony or opinion.\textsuperscript{52}

From this, it is clear the Eighth Circuit recognized, as did the court
in Castro, that passing the test under either standard alone would be
insufficient to place DNA evidence before a jury. A critical examina-
tion of the actual testing procedures performed in the specific case is
necessary.\textsuperscript{53} This examination is not required under either of the
standards.\textsuperscript{54} The examination of actual testing procedures is neces-
sary because it is possible for a technique to have gained general ac-
cceptance in the scientific community (Frye), or be relevant and
generally reliable (Federal Rules of Evidence), without having been
performed correctly in the case at hand.

D. Two Bulls' Adoption of the Standard Applied in Castro

1. Acceptance of the Underlying Theory

The Castro court held that DNA profiling evidence was admissible
under the first prong of Frye because DNA profiling is generally ac-
ccepted in the scientific community as being capable of producing relia-

\textsuperscript{49} United States v. Two Bulls, 918 F.2d 56, 60 (8th Cir. 1990).
\textsuperscript{50} See, e.g., Laurel Beeler & William R. Wiebe, Comment, DNA Identification Tests,
63 Wash. L. Rev. 503, 532 (1988); Giannelli, supra note 22, at 1200; People v. Cas-
\textsuperscript{51} United States v. Two Bulls, 918 F.2d 56, 58 (8th Cir. 1990).
\textsuperscript{52} Id. at 60.
\textsuperscript{53} Id. at 60; People v. Castro, 545 N.Y.S.2d 985, 999 (Sup. Ct. 1989).
\textsuperscript{54} This is true for the most part, although some courts have read Frye to include a
third test which evaluates the validity of the procedures used in the case at hand.
See Andrews v. State, 533 So. 2d 841 (Fla. 1988); Giannelli, supra note 22, at 1201;
supra text accompanying notes 21-24.
ble results.\textsuperscript{55} Castro quoted commentators William Thompson and Simon Ford stating, "There is nothing controversial about the theory underlying DNA typing. Indeed, this theory is so well accepted that its accuracy is unlikely even to be raised as an issue in hearings on the admissibility of new tests."\textsuperscript{56}

Deoxyribonucleic acid is found in all nucleated cells and contains the genetic information that provides the blueprint for all living things.\textsuperscript{57} DNA is packaged into chromosomes, of which there are twenty-three pair in humans. Every cell of an individual contains the same DNA, and a person's DNA remains constant throughout his or her lifetime. The feature of DNA that makes it important for forensic purposes is that no two individuals, except identical twins, have the same DNA.

The DNA molecule is a helix resembling a twisted ladder. The rails of the ladder are the repetitive sugar-phosphate components of the molecule, and the rungs are comprised of one pair of nitrogenous bases. There are four different bases: adenine (A), guanine (G), cytosine (C), and thymine (T). The bases pair according to the "base-pair rule": A pairs only with T, and vice versa, and G pairs only with C, and vice versa. No other combination will commonly occur. Thus, the order of the bases on one side of the rung of the DNA ladder determines the order on the other side.

The sequence of base pairs provides the information for producing proteins needed by the cell. Most sequences of base pairs vary little from one individual to another within the same species. Consequently, it is the areas of DNA that vary that are significant in the forensic setting. These variations or "polymorphisms" are the basis for DNA profiling or identification. Alternative polymorphisms of a gene are called alleles. While some genes exhibit only two alternative forms, others are hypervariable and have many alternative forms.\textsuperscript{58} Of the approximately three billion base pairs contained in human DNA, roughly three million are thought to be polymorphic.\textsuperscript{59} A hypervariable locus will have the same core sequence of base pairs but will vary in length due to the number of these core sequences present.\textsuperscript{60} Though an individual does not have an unique polymorphism at

\textsuperscript{57} Id. at 988. For background information concerning DNA and DNA profiling see Thompson & Ford, supra note 30 and JAMES D. WATSON, ET. AL., RECOMBINANT DNA: A SHORT COURSE (1983).
\textsuperscript{58} See Thompson & Ford, supra note 30, at 62.
\textsuperscript{59} See Neufield & Colman, supra note 48, at 50.
\textsuperscript{60} Polymorphisms are determined by the number of repeated core segments of base
any one locus, the frequency with which two individuals exhibit the same eight or ten alleles on four or five genes is significantly lower. The statistical probability of such a match can be calculated using data gathered from past testing using the same test probe on many individuals and extrapolating the data to fit the entire population or subpopulation of interest.

Although the underlying theory is unlikely to be challenged in a Frye hearing, the reliability of some of the techniques and procedures used in DNA profiling is likely to be questioned.61

2. Acceptance of Techniques and Procedures Used

The testing in Two Bulls was conducted by the FBI. The FBI and other laboratories that perform DNA profiling utilize Restriction Fragment Length Polymorphism (RFLP) analysis, which essentially involves six steps. First, DNA is extracted from the evidentiary and known (control) samples and purified. Next, the DNA is digested by restriction endonucleases, which are enzymes that act as a sort of molecular scissors.62 Restriction endonucleases recognize a specific, usually six-base sequence of bases. When the correct sequence is recognized, the restriction endonuclease will cut the DNA. The process severs the DNA molecule at all sites along the three billion base pair length where the targeted base pair sequence occurs. The length of these cut segments can vary depending on the number of core sequences present.

The third step separates by size the fragments of molecules created by the restriction digestion. This procedure involves placing the sample in an agarose gel63 and applying an electrical current. Because
DNA is negatively charged, the RFLPs will migrate toward the positive electrode. The distance travelled through the gel depends on length, with shorter fragments able to travel farther. Fragments of known base pair lengths, molecular weight markers, are placed in separate lanes of the gel to allow measurement comparison of the RFLPs.

The RFLPs are transferred from the gel to a nylon membrane sheet in the fourth step. This procedure is commonly known as a Southern blot or transfer. During this procedure, the nylon membrane is placed in contact with the gel and the RFLPs move onto the membrane by capillary action. The RFLPs are then denatured, a process where the base “rungs” become unpaired. These unpaired bases can then pair with another complementary molecule. This concept is the basis for step five.

In step five, a radioactive probe is used to locate a specific locus of a polymorphic region of DNA. The probe is a single-stranded (one-rail ladder) segment of DNA designed to complement the sequence of the RFLP. Since the probe contains the corresponding half of the RFLP, it will bond with RFLPs of all sizes containing the core sequence. In the final step, the membrane is placed against a piece of x-ray film. The radioactive probes will expose the film at their respective locations. Thus, the film is an exact copy of the locations of the RFLPs on the gel. The RFLPs are revealed on the film as a series of bands resembling a railroad track with irregularly spaced ties. This film is referred to as an autoradiograph. It is the pattern of bands on the autoradiograph produced by the suspect’s DNA that is compared to the pattern of the unknown sample taken from the crime scene.

Despite the warnings of some early commentators, forensic application of DNA profiling quickly gained acceptance in the court system. Michael Baird, an employee of Lifecodes, one of the private testing centers in the United States, stated, “If you’re a criminal, it’s like leaving your name, address, and social security number at the scene of the crime. It’s that precise.” The theory behind the protocols is sound if performed properly; unfortunately, in practice, it is not always done so. Variables present when performing the techniques, and human error in both procedure and interpretation, can undermine
the result by producing false negatives and false positives, though false positives are much less likely. The next section will explore some of the "pitfalls" of reality that impair the application of the theories.

3. Application of the Techniques in the Particular Case

The Eighth Circuit correctly focused on the issue of application of the particular technique in the specific case as being the most important factor when determining the admissibility of DNA profiling evidence. The court recognized the possibility of prejudice to the defendant that would result from the court only exploring the scientific acceptability and the reliability of acceptable testing procedures in camera, with the proponent of the evidence then failing to show that the lab tests conformed to reliable procedures at trial. At that point, the court would have to exclude the evidence for lack of foundation, yet the jury would have been exposed to prejudicial data and left to speculate as to why the defendant opposed the result.

Like all technology, RFLP analysis is subject to imperfections in practice. A primary concern when applying the technique to forensic samples is the integrity of the sample collected from the crime scene. These samples are obtained from a variety of less-than-sterile materials that are subjected to sunlight, moisture, or desiccation. Samples also can be contaminated with other genetic material from bacteria, plants or animals. In the research lab, this is annoying because the experiment must be started over. In the forensic lab, however, there is often a limited amount of sample, and if it is degraded or contaminated with spurious genetic material, it may not be usable. Fortunately, many of the problems resulting from contamination can be overcome by using appropriate control procedures.

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69. In forensic testing, the trend has been to use probes that involve as many as 50 to 100 alleles that detect fragments of similar lengths. Problems such as partial digestion, cross-hybridization, loading errors, density or salinity inconsistencies in the gel, and probe contamination can lead to a displacement of fragments known as band shifting and other errors. Proper scientific controls make it possible to recognize such situations.

Most band shifts result in false non-matches, where bands in one lane of the gel are shifted out of position. It is unlikely that many bands will be shifted into positions that coincidentally match another sample to create a false positive. Yet false positives could occur if samples are mislabelled or incorrectly loaded on the gel. See generally U.S. Congress, Office of Technology Assessment, Genetic Witness: Forensic Uses of DNA Tests, (Washington, D.C.: U.S. Government Printing Office, July 1990), at 59-66.

70. For an in-depth discussion of problems with the use of DNA testing in forensics, see Hoeffel, supra note 31, at 477-494. See also Lander, supra note 61, and infra text accompanying notes 72-74.

71. United States v. Two Bulls, 918 F.2d 56, 60 (8th Cir. 1990).

72. See OTA report, supra note 69, at 59.

73. Burk, supra note 3, at 59-60.

74. Thompson & Ford, supra note 30, at 92.
There also can be problems in the procedures themselves. For example, old or denatured batches of restriction enzymes may not completely digest a DNA sample; shifting of the bands on the gel may occur due to impurities in the sample, overloading the sample, or salinity or density inconsistencies in the gel; bands may not transfer from the gel to the nylon membrane due to a lack of direct contact between the two; and improper conditions may cause a probe to bind to the wrong band. In addition, samples can be mislabelled, mixed or loaded into the wrong wells in the gel. Careful training of personnel and implementation of laboratory procedures can eliminate most of these problems. Yet, as in any technology, human error cannot be eliminated entirely, and refinements to the techniques may bring their own attendant problems.

Interpretation of results is an area of procedure that is likely to be questioned. Visual matching of bands is a subjective process susceptible to examiner bias, particularly when the scientist performing the test has a financial stake in the outcome. But even with computer matching, problems may arise due to the methods forensic DNA laboratories employ to arrive at their probability calculations.

First, most of the data have not been published in peer review journals or independently validated. Commercial laboratories are reluctant to publish data or use uniform probes and enzymes because they consider their RFLP system to be a proprietary trade secret. Second, on the basis of the in-court testimony from the commercial laboratory involved in Castro and papers introduced into evidence, it was noted that a less stringent matching rule was used to determine whether one forensic sample matched another than was used to determine the probability that such a match could occur at random. This results in increased matches, with total probabilities grossly under-

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75. Id. at 93-94. See also People v. Castro, 545 N.Y.S.2d 985, 993-95 (Sup. Ct. 1989) (where the court discusses additional experiments, techniques, and controls that can be used to ensure reliable profiling results).

76. Burk, supra note 3, at 62.

77. Hoeffel, supra note 31, at 481.

78. Thompson & Ford, supra note 30, at 73 n.133.


80. Id. at 63-66.

81. See generally Lander, supra note 61. In this commentary, Dr. Lander writes, "In my opinion, visual matching is inappropriate in DNA fingerprinting . . . ."

82. Neufeld & Colman, supra note 48, at 52.

83. Id.

84. The commercial laboratory that was employed to do the testing and offered evidence for the prosecution was Lifecodes Corp., one of three commercial testing laboratories in the United States. Marcia Barinaga, Pitfalls come to light, 339 Nature 89 (1989).

85. Id.
In this case, the statistical probability data offered indicated that the likelihood that someone other than Two Bulls could provide a match was one in 177,000, based on a Native American population data base. Statistical probabilities that have been offered into evidence for matches in other cases—one in several billion,\(^8^7\) one in 840 million,\(^8^8\) and one in 35,000,\(^8^9\)—could be extremely prejudicial. The concern about prejudice prompted the court in \textit{State v. Schwartz}\(^9^0\) to disallow statistical evidence altogether. The \textit{Schwartz} court stated, "[W]e remain convinced that juries in criminal cases may give undue weight and deference to presented statistical evidence and [we] are reluctant to take that risk."\(^9^1\) Finally, another serious flaw is that an assumption of population equilibrium is made in the probability calculation, but it is known that some subpopulations are not in equilibrium.\(^9^2\)

The Eighth Circuit adopted an approach that adequately addresses the preceding issues. The approach requires the court to satisfy itself that the evidence meets the three tests proposed in \textit{Castro} in a pretrial meeting. In addition, the court reserved the right to use its discretion in allowing preliminary cross-examination by the defendant or to allow on voir dire the defendant's counter evidence.\(^9^3\) The \textit{Two Bulls} court held that the trial court erred in admitting the DNA evidence without first determining whether the testing was done properly in that case, and that the admissibility should be determined only after hearing testimony from experts on both sides. In doing so, the court found a way to protect the rights of the defendant against persuasive but possibly misleading scientific data, while protecting the admissibility of the data if it is found to meet the court's criteria.

\section*{E. \textit{Two Bulls'} Additional Prongs}

1. \textit{Whether the Profiling Data is More Prejudicial Than Probative}

The \textit{Two Bulls} court, in listing the factors under which the trial court should determine admissibility of the DNA profiling evidence on remand, added two prongs to the \textit{Castro} test.\(^9^4\) The first of these, whether the evidence of the match is more prejudicial than probative
in the case, is an attempt by the court to incorporate the Federal Rule standard into its test. This prong is important in view of what is known about DNA profiling evidence.

When an autoradiograph is examined for interpretation, it is sometimes quite clear that there is a match. At other times, it is less clear. When experts are polled, it is likely an expert will be found to offer a favorable opinion for each side in a sort of "battle of the experts." During the Frye hearing, the court can visually examine the evidence to see how clearly it demonstrates a match or lack thereof between the suspect's banding pattern and that of the perpetrator. If the autoradiograph is not clear, the court can choose not to admit it since, in such an instance, it is more likely to be prejudicial than probative.

Under this fourth Two Bulls prong, a court also would have the option to admit the evidence and let the jurors examine the data themselves. The court in United States v. Jakobetz stated, "[L]ike the voice spectrographs held admissible in Williams, the jury can visually inspect the [autoradiographs] to compare not only the bands of the defendant with the bands produced from the forensic sample, but to contrast their clarity and respective positions with the bands produced from the victim's DNA." Though the principle and techniques behind DNA profiling can be difficult to grasp, examination of an autoradiograph can be illuminating even to lay persons.

Hence, the Two Bulls court has established a fourth prong that allows the court to not only make a determination as to whether the procedure was done correctly (third prong), but also allows the court to inspect the data to see if it proves what it is being offered to prove without undue prejudice. If so, it can be offered into evidence. The fourth prong retains the flexibility of allowing the evidence to be admitted and permitting the jury to physically inspect the data to decide what weight it should be given.

2. Whether the Statistics are More Prejudicial Than Probative

The aspect of DNA profiling that draws the most fire from critics is the evidence offered on the statistical probability of a match. The Two Bulls court correctly recognized that DNA profiling data offered

95. See autoradiographs reproduced in HENRY C. LEE & R.E. GAENSSLIN, DNA AND OTHER POLYMORPHISMS IN FORENSIC SCIENCE, at 32, and 71 (1990), and the OTA report, supra note 69, at 47, 85, and 118.
96. See autoradiographs reproduced in Neufield & Colman, supra note 48, at 51.
98. United States v. Williams, 583 F.2d 1194, 1199-1200 (2d Cir. 1978).
100. See supra notes 95 and 96.
101. See Neufeld & Colman, supra note 48, at 53; Lander, supra note 61, at 505; Hoeffel, supra note 31, at 485-82; supra text accompanying notes 82-89.
as evidence do not have to be offered as a package, but can be split into two components: The match data from the autoradiograph, and the statistical data of the random frequency of such a match.\textsuperscript{102}

That is not to say that statistical data should never be offered into evidence. In \textit{State v. Brown},\textsuperscript{103} the defendant argued that the statistics, which indicated that the likelihood of a match was one in several billion, should not have been admitted into evidence because they removed the issue of guilt from the jury. In rejecting this argument the court commented:

[A]doption of an argument such as Brown's will exclude statistical probability testimony where it is the most cogent, and allow it in evidence only where there remains a degree of doubt because of the inconclusiveness of the numbers. . . . [T]his makes little logical sense. Indeed, it might lead to the exclusion of fingerprint evidence, which also is based on the mathematical theory of probabilities that the chance of two individuals bearing the same fingerprint (or prints) is so infinitesimally [sic] small as to be negligible.\textsuperscript{104}

By requiring this final prong, it is clear the Eighth Circuit recognized the value of statistical probabilities offered as evidence, but perceived the difficulties inherent in this aspect of DNA profiling as well. In examining the assumptions made and the procedure used in generating the statistics apart from other evidence, a court is more likely to scrutinize this statistical data more effectively. By recognizing the probative and prejudicial value of each portion of the profiling evidence individually, an equilibrium is more likely to be found between the application of a powerful new technique and the possibility of injury to a defendant due to faulty data.

\textbf{IV. CONCLUSION}

The Eighth Circuit has promulgated a rule that demonstrates its understanding of the highly complex realm of DNA profiling evidence. The court has harmonized the \textit{Frye} and Federal Rules standards. It recognized the importance of a test evaluating the validity of the application of technique to the particular case at hand. Additionally, the court recognized that the band matching data from the autoradiographs and the probability statistics should be separately evaluated to determine admissibility.

By promoting so progressive a standard, the Eighth Circuit has demonstrated its understanding of the impact of DNA profiling evi-

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\textsuperscript{102} The court in \textit{State v. Schwartz}, 447 N.W.2d 422 (Minn. 1989), recognized this important distinction, allowing autoradiograph data to be introduced into evidence if it is found that the laboratory complied with appropriate standards, while excluding the statistical data due to the "potentially exaggerated impact on the trier of fact." \textit{Id.} at 428. \textit{See also} Caldwell v. State, 393 S.E.2d 436 (Ga. 1990)(court did not allow evidence of statistics to be admitted).

\textsuperscript{103} 470 N.W.2d 30 (Iowa 1991).

\textsuperscript{104} \textit{Id.} at 33 (quoting Martinez v. State, 549 So. 2d 694, 697 (Fla. 1989)).
The court has taken the lead in assuring that this revolutionary technique, if performed properly, will live up to its reputation. The decision should be applauded because it allows utilization of an important scientific technique in courts of law while maintaining a realistic perspective of its limitations, thereby protecting defendants' rights.

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