SCIENTIFIC EVIDENCE: TOWARD PROVIDING THE LAY TRIER WITH THE COMPREHENSIBLE AND RELIABLE EVIDENCE NECESSARY TO MEET THE GOALS OF THE RULES OF EVIDENCE

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INTRODUCTION

The Problem

We live in an era in which we increasingly rely upon science to help us make important decisions which affect our daily lives. This is reflected in the great amount of science-related evidence that is presented in our courts. As cases become more complex and technical, the trier of fact increasingly needs science-based assistance to understand the facts presented and to reach an informed determination — assistance in the form of "scientific evidence" that is normally presented through supposed "experts" in the field. Yet there are numerous indications that much of this "scientific evidence" offered to the lay trier is unreliable.[1] This evidence is most frequently admitted into evidence, thus forming a basis for the trier's determination.

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1. Documentation of the potential unreliability of various types of scientific evidence abounds. In 1978, a Laboratory Proficiency Testing Program sponsored by the Law Enforcement Assistance Administration and conducted on more than 200 crime laboratories found unacceptable response rates for common test samples ranging from a low of under two percent to a high of sixty-eight percent. The report concluded that "a wide range of proficiency levels among the nation's laboratories exists, with several evidence types posing serious difficulties . . . for the laboratories. . . ." Giannelli, *The Admissibility of Laboratory Reports in Criminal Trials: The Reliability of Scientific Proof*, 49 OHIO ST. L.J. 672, 688-89 (1988) [hereinafter *The Reliability of Scientific Proof*]. Giannelli notes, in reviewing the report, however, that reasons other than incorrectly identifying the sample (such as wrong reason or unsupported response) might have led to concluding the result was unacceptable. *Id.* at 689 n.155. *See also* Toufexis, *Coroners Who Miss All the Clues*, TIME, Aug. 14, 1989, at 61 (detailing the inadequacy of the medical examiner system).

A review of recent studies by the Forensic Science Foundation of handwriting identifications by variously qualified examiners found that incorrect identifications outnumbered correct identifications, and concluded, "the studies failed to reveal that certification or experience enhanced accuracy." Risinger, Denbeaux & Saks, *Exorcism of Ignorance as a Proxy for*

While the potential benefits to be derived from scientific evidence are great, the risks of its misuse are also great: scientific evidence in particular, and expert evidence in general, pose more substantial dangers to accurate factfinding than ordinary evidence presented by lay witnesses. Scientific evidence is particularly susceptible to misuse because it lies beyond the common experience of the lay trier of fact. The trier lacks the necessary background to evaluate the reliability of the specialized information.

The lay trier's inability to evaluate such evidence on her own is particularly serious because the adversary system frequently fails to present the evidence in a comprehensible manner and/or expose any inherent weaknesses in an opponent's evidence. Many lawyers, primarily as a result of lack of training in scientific methodology, are inept in presenting and opposing scientific information. Even when the lawyer is skilled in presenting such evidence, however, she will ordinarily present only those aspects of the evidence which favor her client. Consequently, if the opposing party fails to critically scrutinize the evidence by adequate cross-examination and/or presentation of her own expert, the judge or jury is deprived of the necessary tools for understanding and evaluation.

Both legal commentators and the judiciary are aware of the need for and potential promise of scientific evidence, and the danger of its misuse and inaccurate factfinding. Recognition of the need for and potential promise of scientific evidence is reflected in an extremely liberal standard for admissibility — a standard which typically requires only that the expert be minimally qualified and that her evidence be relevant to understanding or deciding an issue in

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Rational Knowledge: The Lessons of Handwriting Identification 'Expertise,' 137 U. PA. L. REV. 731, 749 (1989) [hereinafter Risinger].

Similarly, DNA blood typing, used to identify defendants by comparison with blood samples of assailants found at a crime scene, has been shown to be unreliable on occasion. Lewin, *DNA Typing Is Called Flawed*, 245 SCI. 355 (1989) [hereinafter *DNA Typing Is Called Flawed*]. In a recent nationally reported case in which DNA typing was presented as evidence, the application of the underlying principles was shown to be flawed. Schmeck, *DNA Findings Are Disputed by Scientists*, N.Y. Times, May 25, 1989, at B1, col. 5. Of note is the fact that experts for *both* the defense and the prosecution concurred in their doubts about the reliability of the particular procedure utilized. *Reliability of DNA Testing Challenged by Judge's Ruling*, N.Y. Times, Aug. 15, 1989, at B1, col. 4. *See also* People v. Castro, 144 Misc. 2d 956, 545 N.Y.S.2d 985 (1989); *infra* note 20 and accompanying text.

Both the Risinger article and a recent article examining the expertise of psychologists and psychiatrists conclude that the accuracy of professional judgments does not necessarily surpass that of lay persons. Faust & Ziskin, *The Expert Witness in Psychology and Psychiatry*, 241 SCI. 31, 32 (1988).

The problem of unreliability is not necessarily confined to forensic techniques and/or applications, but extends as well to pure scientific "theory." Although probably infrequent, there is what the New York Times called "a steady trickle of fraud in academic science." *Credit and Credibility in Science*, N.Y. Times, July 26, 1987, at E26, col. 1. For example, "[o]fficials representing federal agencies who fund military research told Congress . . . that they are investigating 87 cases of science misconduct." *Misconduct Cases Probed*, 136 SCI. NEWS 20 (1989). Similarly, the New York Times reported a recent concession by *Science* — a respected journal and a "long time proponent of the view that science fakery is extremely rare . . ." — in which *Science* acknowledged that it had published a scientific article in which the results were taken from another researcher and supported with fake data. *Question of Scientific Fakery is Raised in Inquiry*, N.Y. Times, July 12, 1989, at A16, col. 4.

The most exhaustive treatment of scientific fraud is W. BROAD & L. WADE, BETRAYERS OF THE TRUTH (1983). The authors document known or strongly suspected fraud from the ancient Greeks to modern times and suggest a number of factors to explain the fraud.

the case. Recognition of the danger of misuse is typically reflected in an oversimplified and erroneous expression of concern: that the jury will be awestruck by the expert and/or her "science" and, unable to critically evaluate the evidence, will uncritically accept the evidence as offered by the expert. Only rarely is this concern utilized to override the liberal admissibility standard. When this trump card *is* played, the vast majority of courts have hidden behind one or another vague test and made ad hoc and largely intuitive decisions that the evidence at issue failed the applicable test.

This article finds that the prevalent approaches to admissibility neither meet the great promise of scientific evidence nor avoid the risks of its misuse, and suggests realigning the approach to admissibility with the purposes of our procedural system and the rules governing expert testimony. Specifically, we should adopt an approach to admissibility which reasonably ensures that the evidence "will assist" a lay trier to fulfill her role of accurate factfinding. To this end, the article presents better defined, more meaningful and more workable criteria for admissibility, and suggests that the court require the proponent *demonstrate* that the evidence will be *comprehensible* to the trier of fact and *reliable* in the particular context at issue. Additionally, the article recommends that the judge work actively with the parties to "enhance" the evidence, wherever possible, to meet the trier's needs, thus preserving the benefits of the liberal admissibility standard while mitigating the inherent dangers of misuse.

Part I of this paper examines common concerns about scientific evidence reflected in the existing approaches to admissibility of scientific evidence. Part II addresses the legitimate concern for the jury's ability to understand and evaluate such evidence in light of jury studies and inquiries into the requirements of the jury's truth-finding function. Part III goes on to evaluate the lawyer's ability to meet these needs, as well as to discuss the attorney's unfamiliarity with scientific methodology, resource limitations of the parties, and adversarial pressures in our trial system.

Parts IV, V, and VI present the thesis of this paper. Part IV examines the key rules governing scientific evidence, and concludes that the current piecemeal interpretation and isolated application of these rules loses sight of the intended role of scientific evidence in accurate factfinding and fair determinations. Part IV suggests that the judge should *require*, as a standard for admissibility, that scientific evidence be comprehensible and reliable or, at least, be presented in a manner which allows the trier to evaluate its reliability. Part V suggests a number of ways by which the court can "enhance" the evidence in a minimally obtrusive fashion to ensure that the evidence meets the suggested standard. This "enhancement" strategy urges less reliance on the exclusionary sanction in favor of a more flexible approach aimed at improving the quality of the evidence. Finally, Part VI presents what may be the first systematic examination of the questions a lawyer or judge should address in determining whether the reliability threshold has been met. This examination is based on the typical inquiries utilized by a neutral scientist in evaluating scientific theories, techniques, and/or specific applications of theory or technique in the context at issue.

I. ADMISSIBILITY OF SCIENTIFIC EVIDENCE: EXISTING APPROACHES AND UNDERLYING CONCERNS

Scientific Evidence as a Subset of Expert Evidence

Because scientific evidence lies beyond the experience and "expertise" of the lay person, it is almost always admitted through the medium of the expert witness. Thus, before describing the two prevalent standards for admissibility of scientific evidence, the larger topic of expert evidence — which subsumes the topic of scientific evidence — must be discussed. Confusion often results from focusing on one of the existing standards for scientific evidence while neglecting the underlying purpose of expert evidence.[2]

The expert witness is a creature of necessity. She is allowed to testify because her specialized knowledge assists the trier of fact. Her knowledge is a *form* of evidence which allows the trier to understand and evaluate other testimony and to draw conclusions from the evidence.[3] The prevalent test for admissibility of expert evidence has a dual focus: whether the expert is qualified[4] to give the particular evidence, and whether the proffered testimony will assist the trier "to understand the evidence or determine a fact in issue."[5] Unfortunately, the very different foci of the two prevalent approaches to the admissibility of scientific evidence can distract a court from the purpose of expert testimony, to assist the jury in understanding the evidence and/or determine the facts in issue.[6] The earlier approach, the *Frye* test, focuses on general acceptance of the evidence within the relevant scientific community. Both *Frye* and the more recent approach, the "relevance" approach embodied in Federal Rules 401-403, largely overlook the expert evidence considerations of Article VII of the Rules. The "relevance" test employs a different focus from either the *Frye* test or the Article VII criteria for admissibility of expert evidence and considers whether the evidentiary material proffered is, on balance, "probative" of the issues in the case.

A. *The* Frye *Test*

The older of the two approaches to the admissibility of scientific evidence and one which still commands many adherents among the courts, albeit often in a more modern and sophisticated form,[7] is the *Frye* test. In *Frye v. United*

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2. The purpose of expert evidence and the controlling rules are discussed in detail in Part IV(B). *See infra* notes 139-77 and accompanying text.

3. FED. R. EVID. 702.

4. *Id.*

5. *Id.*

6. Both of the prevalent tests for admissibility of scientific evidence have been characterized as "judicial exclusion" approaches to admissibility; *i.e.*, the judge utilizes her discretion to exclude evidence when the offer does not meet the test. *See, e.g.*, Elliot, *Toward Incentive-Based Procedure: Three Approaches for Regulating Scientific Evidence*, 69 B.U.L. REV. 487, 493 (1989) (it should be noted that Elliot disagrees as to the tests which characterize the approach).

7. For refinements of the *Frye* test, see People v. Collins, 94 Misc. 2d 704, 405 N.Y.S.2d 365 (N.Y. App. Div. 1978); People v. Kelly, 17 Cal. 3d 24, 549 P.2d 1240, 130 Cal. Rptr. 144 (1976).

States,[8] the Court of Appeals for the District of Columbia established the "general acceptance" standard in now famous language:

> Just when a scientific principle or discovery crosses the line between the experimental and demonstrable states is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while the courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, *the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.*[9]

In *Frye*, the court held that evidence based upon a crude predecessor of the polygraph test had "not yet gained such standing and scientific recognition among physiological and psychological authorities . . . ."[10] Subsequently courts applied *Frye* to a wide variety of hard and soft evidence,[11] primarily in criminal cases.[12]

Although *Frye*'s attempt to ensure that the scientific theory or application underlying the testimony has received substantial recognition by the appropriate scientific community is laudable, the "general acceptance" test embraces a number of difficult problems of application. First, courts must decide what "particular field" must find the procedure acceptable.[13] Because modern developments typically involve more than one discrete discipline,[14] it is difficult to establish *the* relevant community.[15]

Second, courts must ascertain who is entitled to *speak* for the appropriate community. Unfortunately, the courts frequently rely on the proponent's partisan expert to make the determination whether the evidence has been

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8. 293 F. 1013 (D.C. Cir. 1923).
9. *Id.* at 1014 (emphasis added).
10. *Id.*
11. By hard evidence, I mean evidence which is based upon empirical or tangible data and involves a minimum of interpretation by the expert; for example, a blood test based upon pristine samples and generally accepted guidelines. By soft evidence, I mean evidence which is based upon less tangible data and involves a great amount of interpretation by the expert; for example, much psychiatric evidence. Hardness or softness is a question of degree. They are relative, not absolute, concepts.
12. *Symposium on Science and Rules of Evidence*, 99 F.R.D. 188, 190-91 (1983) (background paper prepared by Paul C. Giannelli for the National Conference of Lawyers and Scientists) [hereinafter *Symposium I*].
13. Giannelli, *Admissibility of Novel Scientific Evidence: Frye v. United States a Half-Century Later*, 80 COLUM. L. REV. 1197, 1208 (1980) [hereinafter *Frye v. United States a Half-Century Later*] (reviewing the difficulties with *Frye*).
14. Moenssens, *Admissibility of Scientific Evidence — An Alternative to the Frye Rule*, 25 WM. & MARY L. REV. 545, 548-49 (1984).
15. Although the problem is particularly acute with respect to "novel" scientific evidence, it does not disappear with less innovative forms of evidence. Even with the latter forms, there may be turf battles — for example, whose specialized knowledge is most on point? Identifying the relevant communit(ies) to establish reliability of specialized evidence is thus a relative problem. Moenssens notes that the court must consider the interdisciplinary nature of theory and relevant branches to provide an adequate basis for consideration of the technique. Moenssens, *supra* note 14, at 565.

generally accepted within that community.[16] The difficulty of identifying appropriate experts to assess the reliability, although inherent in any attempt to screen scientific evidence, undermines the claim that Frye allows the *appropriate* persons; *i.e.*, the *relevant* scientific community, to determine the question of admissibility.

Third, the court must define *what* must be generally accepted. What aspects of the scientific evidence should be the focus of the test? "Scientific evidence" is itself a broadly ambiguous term which has never been precisely defined, and is used to describe a wide range of empirical and non-empirical attempts to systematize knowledge. The ambiguity of the term is exacerbated by the fact that the evidence is typically introduced by a partisan advocate. To promote her theory of the case, the advocate chooses the most favorable credible "scientific" claim and attempts to push the science-oriented witness to the limits of the scientific position the witness purports to represent. Adversarial pressures thus stretch the concept of "scientific."

Finally, ambiguity is enhanced because "scientific evidence" describes evidence based on at least three different levels of science: scientific *theory*, scientific *technique*, and the *application* of the theory or technique.[17] Reliability problems occur at each of these three levels.[18]

Although reliance on the first level, scientific theory, is relatively rare, an advocate occasionally attempts to introduce scientific theory as the sole basis for an inference. For example, a toxic tort plaintiff may attempt to introduce epidemiologic studies to establish a relationship between the alleged cause of injury and the injury.[19] More frequently, however, a particular offer of scientific evidence implicates concerns at more than one level. An offer of novel scientific evidence implicates concerns both about whether the technique has a basis in general scientific theory, and about whether the technique which utilizes that theory is valid and properly applied.

Consider the current controversy surrounding DNA evidence in criminal cases. At the theory level, the premises of DNA fingerprinting must rest upon valid general scientific findings about the uniqueness of an individual's DNA. And the particular technique must reliably isolate unique components of the DNA for comparison of the known and unknown specimens and provide adequate standards for making the comparison. Further, even assuming a reliable

16. The concern is reflected in remarks made at *Symposium I*. *See Symposium I*, *supra* note 12, at 203-04 (remarks of P. Giannelli); 214 (remarks of S. Saltzburg concerning reliance on single source).

17. *See* United States v. Downing, 753 F.2d 1224 (3rd. Cir. 1985). Scientifically inclined readers would probably use the words "science" (or "pure science"), "technology" (or "applied science"), and "forensic science" respectively, to describe these levels.

18. Part VI, *infra*, will explain in detail the typical reliability problems with which the court must be concerned at each of these three levels.

19. In toxic tort cases, plaintiffs frequently try to offer studies demonstrating a significant relationship between various carcinogens and the onset of cancer. Similarly, a defendant may utilize studies demonstrating an absence of statistically significant relationships between the alleged causal agent and the plaintiff's condition. *See, e.g., In re* Agent Orange Product Liability Litigation, 611 F. Supp. 1223 (E.D.N.Y. 1985), *aff'd on other grounds*, 818 F.2d 145, 174 (2d Cir. 1987), *cert. denied sub nom.* Pinkney v. Dow Chemical Co., 108 S. Ct. 695 (1988) (at trial Judge Weinstein granted summary judgment for the defendants largely on such studies).

technique, were all the procedures and standards required for a "match" followed upon a particular occasion?[20]

Although *Frye* is helpful in attempting to ensure reliability at the levels of theory and general technique, *Frye* fails to indicate which level(s) merit the court's concern. More importantly, the test fails to even consider what is often the crucial reliability question — whether the technique was properly utilized. This is the most important objection to *Frye*.[21]

Given the problems in defining and applying the *Frye* test, few courts have attempted to define the proper approach for establishing general acceptance under its mandate. Among those courts that have made an effort to do so, there is no consensus.[22] The problems are reflected in a number of difficulties. First, courts which subscribe to the *Frye* test may or may not apply the test to

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20. There is a consensus that DNA typing is based upon substantial research indicating that the process promises to be extremely powerful. In *People v. Castro*, 144 Misc. 2d 956, 545 N.Y.S.2d 985 (1989), DNA typing was said to demonstrate that a spot of blood on the defendant's watch matched the victim's blood with a likelihood of error of one in 189,200,000. Lewin, *DNA Typing on the Witness Stand*, 244 SCI. 1033 (June 2, 1989) [hereinafter *DNA Typing on the Witness Stand*]. Lifecodes, the company involved, indicated that the test had been used nationwide in 1,500 criminal cases. Schmeck, *supra* note 1, at B1, Col. 1. *See also Castro*, 144 Misc. 2d 956, 545 N.Y.S.2d 985.

Nonetheless, the Lifecodes process was based upon a faulty application of the underlying scientific principles. Both parts of the technique — the molecular biology and the population genetics — proved to be flawed applications of the principles. *See DNA Typing Is Called Flawed, supra* note 1. In *Castro*, experts for the defense and prosecution met to discuss the scientific merits of the evidence. Subsequently, they drafted a statement expressing serious doubts about the reliability of the procedure and departures from the procedure in that case. Ultimately the trial court excluded the evidence but noted that DNA testing could be reliable where proper controls were utilized. *Castro*, 144 Misc. 2d at 979, 545 N.Y.S.2d at 999. *See also Reliability of DNA Testing Challenged by Judge's Ruling*, supra note 1, at B1, col. 6. Numerous convictions based on DNA typing may now be under attack. *Id.*

The FBI laboratory has begun to use the test, Malcolm, *FBI Opening Door to Wide Use of Genetic Testing in Solving Crimes*, N.Y. Times, June 12, 1989, at A1 col. 1, even though some leading molecular biologists say the technique is still too unreliable for use in court, *Some Scientists Doubt the Value of the Genetic Finger Print Evidence*, N.Y. Times, Jan. 29, 1990, at A1, col. 2. Nevertheless, the FBI's DNA evidence was recently admitted after thorough consideration for what is apparently the first time in federal court. United States v. Jacobetz, No. 89-65 (D. Vt. Sept. 20, 1990).

A relatively short, understandable explanation of the problems associated with the technique is contained in Neufeld & Coleman, *When Science Takes the Witness Stand*, 262 SCI. AM. 46 (May 1990).

Consider also the much debated voiceprint or spectrogram, a technique which purports to identify an unknown voice. To validate the technique, one would expect to see basic research which establishes a theory of individual voice uniqueness and greater inter-speaker variability than intra-speaker variability. *Symposium I, supra* note 12, at 193 (comments of Paul Giannelli). If research substantiated this theory, the particular technique applying the scientific theory must measure what it purports to measure, the similarities and differences. Although a number of courts jumped on the bandwagon and admitted the technique, neither the underlying theory or the technique was adequately validated according to a study by National Academy of Sciences. A. MOENSSENS, F. INBAU & J. STARRS, SCIENTIFIC EVIDENCE IN CRIMINAL CASES § 12.06 (3rd ed. 1986) [hereinafter SCIENTIFIC EVIDENCE IN CRIMINAL CASES].

21. *Frye v. United States a Half-Century Later*, *supra* note 13, at 1226.

22. *See id.* noting that "[t]he resulting standard, something greater than acceptance by the expert himself but less than acceptance by all experts in the field, is obviously somewhat lacking in definiteness." *See also* Strong, *Questions Affecting the Admissibility of Scientific Evidence*, 1970 U. ILL. L.F. 1, 9 (1970) [hereinafter *Questions Affecting the Admissibility of Scientific Evidence*].

the same evidence.[23] Second, even if they apply *Frye* to similar types of evidence, they frequently reach different results.[24] Both difficulties result in considerable inconsistency among courts dealing with novel scientific evidence. Finally, in spite of the breadth of the language of the test, most courts apply it only in criminal cases[25] and resort to the more relaxed requirements for expert evidence in civil cases.[26] The vagueness of the *Frye* test and the difficulties with its application prompt some commentators to suggest that "general acceptance" is a rationalization for the courts intuition about the reliability of the evidence.[27]

A number of the courts which adhere at least to the rough skeleton of *Frye* have attempted to provide a justification for its use.[28] Some argue that *Frye* "may well promote a degree of uniformity of decision."[29] In light of the discrepancies among courts purporting to apply the *Frye* test,[30] however, this claim has little merit. Others contend that it eliminates the need for time-consuming hearings on the validity of innovative techniques.[31] However, the test is ambiguous and difficult to apply,[32] and where the evidence is opposed, experts are likely to disagree about acceptance.[33] A third claim, that *Frye* fosters a high degree of reliability because the "requirement of general acceptance in the scientific community assures that those most qualified to assess the general validity of a scientific method will have the determinative voice,"[34] is similarly without basis. The ambiguities in the test make it difficult to identify the most qualified experts to appear as the foundational witnesses. But more important, the parties' witnesses, upon whom the judge must ordinarily rely for assessment of "general acceptance," are not typically chosen for their objectivity and frequently may be the only ones to address the acceptance question.[35]

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23. *See, e.g., Frye v. United States a Half-Century Later, supra* note 13, at 1219-21.

24. The voiceprint or spectrogram cases are an example. *See* discussion of the cases in *Frye v. United States a Half-Century Later, supra* note 13, at 1218-19; 1 D. LOUISELL & C. MUELLER, FEDERAL EVIDENCE § 105, at 828-29 (1977 & Supp. 1989); SCIENTIFIC EVIDENCE IN CRIMINAL CASES, *supra* note 20, at 664-73. For another example discussing hypnotically refreshed memory, see *Symposium I, supra* note 12, at 193 (paper by P. Giannelli).

25. *See Frye v. United States a Half-Century Late, supra* note 13, at 1218-19.

26. *Id. But see* Huntington v. Crowleyn, 64 Cal. 2d 647, 414 P.2d 388, 51 Cal. Rptr. 254 (1966).

27. *See, e.g., Frye v. United States a Half-Century Later, supra* note 13, at 1221; Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595, 628 (1988) [hereinafter *A Unified Theory of Scientific Evidence*].

28. *See Frye v. United States a Half-Century Later, supra* note 13, at 1206-07; McCormick, *Scientific Evidence: Defining a New Approach to Admissibility*, 67 IOWA L. REV. 879, 883-86 (1982) (both authors discuss these rationales in detail). Both Giannelli and McCormick see the attempts to provide a rationale for *Frye* as following criticisms of *Frye* and a realization of the unreliability of much admitted scientific evidence.

29. People v. Kelly, 17 Cal. 3d 24, 31, 549 P.2d 1240, 1247, 130 Cal. Rptr. 144, 151 (1976).

30. *Symposium I, supra* note 12, at 193.

31. Reed v. State, 283 Md. 374, 388, 391 A.2d 364, 378 (1978).

32. *See supra* text accompanying notes 12-17.

33. *See, e.g.*, Henderson, *The Admissibility of Hypnotically Enhanced Testimony*, 6 J. LEGAL MED. 293 (1985).

34. *Frye v. United States a Half-Century Later, supra* note 13, at 1207 (*citing* United States v. Addison, 498 F.2d 741, 743-44 (D.C. Cir. 1974)).

35. If the scientific basis for the testimony "does not 'have a track record', the court will rely, of necessity, on the opinions of experts who testify at the particular trial." *Symposium*

Some *Frye* adherents also argue that the requirement of general acceptance guarantees a pool of experts who can "critically examine the validity of a scientific determination in a particular case because general acceptance presumes wide familiarity."[36] If the *Frye* test *were* consistently interpreted and applied to require acceptance in the relevant community, the test would ensure an adequate pool. But such is not the case.

Finally, it is argued that *Frye* tends to shield juries from the "aura of infallibility" which is assumed to surround both scientific evidence and the testifying expert.[37] While this is doubtful because of the problems described earlier, the desire to shield the trier of fact does reflect a legitimate concern — that the courts *only* admit evidence which is reliable and subject to adequate scrutiny.[38]

I, supra note 12, at 203 (P. Giannelli, position paper *In Defense of Frye*). *See also* NATIONAL ACADEMY OF SCIENCES, ON THE THEORY AND PRACTICE OF VOICE IDENTIFICATION 41, 49 (1979) (finding that in a large proportion of trials the only voiceprint experts were those called by state). The DNA cases prior to *Castro* reflect a similar experience. *See supra* note 19.

36. *Frye v. United States a Half-Century Later, supra* note 13, at 1207 (citing United States v. Addison, 498 F.2d 741, 744 (D.C. Cir. 1974)).

37. Imwinkelried, *Judge Versus Jury: Who Should Decide Questions of Preliminary Facts Conditioning the Admissibility of Scientific Evidence?*, 25 WM. & MARY L. REV. 577, 580 (1984) [hereinafter *Judge Versus Jury*]. Imwinkelried notes that one of the prime rationales for the *Frye* rule is the assumption that lay jurors are incompetent to evaluate scientific proof critically:

> The *Frye* test rests on the premise that most lay jurors overestimate the probative value of scientific evidence and, therefore, need the protection of a screening by the trial judge. Like the debate over *Frye*, the proper procedure for determining the admissibility of scientific evidence is related to the capacity of the jury. If lay jurors cannot judge the weight of scientific proof properly, entrusting them with the final determination of the validity of the underlying proof is dangerous.

Id.

38. At a 1983 symposium on Science and the Rules of Evidence, leading scholars noted that *Frye* served a helpful, conservative, prophylactic function, especially in criminal cases where the resource disparity among parties is typically great, reducing the risk of admitting unreliable evidence. *Symposium I, supra* note 12, at 207 (Giannelli, *In Defense of Frye*), 213 (Saltzburg, *Frye and Alternatives*). The disparity of resources theme was a major one at Symposium I. *Id. passim.* A different standard, however, may be mandated when the evidence is offered by a criminal defendant. *See, e.g.*, Rock v. Arkansas, 483 U.S. 44 (1987).

Stephen Saltzburg put the matter succinctly: "Courts like the Frye court accept scientific evidence when they are satisfied that a *jury or judge can assess it* and that their assessment represents a reasonable judgment as to the weight it should be given." *Symposium I, supra* note 12, at 213 (Saltzburg, *Frye and Alternatives*) (emphasis in original). *See also* Doyle, *Applying Lawyer's Expertise to Scientific Expertise: Some Thoughts About Trial Court Analysis of the Prejudicial Effects of Admitting and Excluding Expert Scientific Testimony*, 25 WM. & MARY L. REV. 619, 636 (1984).

While there is no doubt that *Frye* sometimes has the desired conservative effect, many cases suggest the effect is far from a consistent one. The classic example of using *Frye* to bootstrap admission of unvalidated novel evidence is Coppolino v. State, 223 So. 2d 68 (Fla. Dist. Ct. App. 1968), *appeal dismissed*, 234 So. 2d 120 (Fla. 1969), *cert. denied*, 399 U.S. 927 (1970), where Dr. Helpern invented a test to detect a theretofore untraceable poison. Even *Frye* courts often jump on the bandwagon before a representative band has been assembled to constitute "general acceptance."

Related to the prophylactic claim is the criticism of *Frye* that it sometimes excludes reliable scientific evidence. If courts must await general acceptance, there will be a time lag between the evolution of reliable technique and admissibility. *See, e.g., Downing*, 753 F.2d at 1236-37. Many consider this conservative approach the principal advantage of *Frye*, especially in criminal cases where we have chosen to err on the side of caution with respect to defendants and a great difference in resources between the state and the defendant often exists.

While *Frye*-bashing is easy, the impetus to assure reliability is appropriate and the critic must acknowledge that some courts which adhere to *Frye* have engaged in useful and thoughtful admissibility analyses.[39] There are situations where the admissibility of a basic scientific study can be addressed by asking whether the study has received general acceptance within the appropriate community.[40] Although *Frye* fails as a bright-line test[41] for the admissibility of scientific evidence, some of the difficulties which arise in the application of *Frye* will prove resilient and reappear in any approach to admissibility of scientific evidence.

B. The "Modern" Relevance Test

The rival to the *Frye* "general acceptance" test is the relevance test incorporated in Federal Rules of Evidence 401-03.[42] The relevance rules apply to any offer of evidence but have been the focus of particular attention with respect to scientific evidence. Unlike the *Frye* test, the relevance test does not purport to expressly distinguish between "novel" scientific evidence and ordinary scientific evidence. The operative mechanism is the discretion of the judge to exclude evidence even when such evidence has a tendency to prove or disprove an important issue in the case. The judge may exclude probative evidence when the probative value is outweighed either by probable distortion of the factfinding process (*i.e.*, when it is unduly prejudicial, confuses the issues, or misleads the jury) or by efficiency concerns (*i.e.*, when the evidence is unnecessarily cumulative or otherwise unnecessarily time-consuming).[43]

The major concern with scientific evidence is that the jury will be awed by, and unwilling or unable to evaluate the reliability of the evidence.[44] Under

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39. *See, e.g.*, People v. Collins, 94 Misc. 2d 704, 405 N.Y.S.2d 365 (N.Y. App. Div. 1978) (discussing both reliability and general acceptance requirements in the context of spectrograms); People v. Shirley, 31 Cal. 3d 18, 641 P.2d 775, 181 Cal. Rptr. 243 (1982) (containing an in-depth discussion of hypnosis).

40. *See In re Agent Orange*, 611 F. Supp. at 1239-41, 1250 (discussing an epidemiologic cancer study). *See also supra* note 19. Consider also the recent cases dealing with unreliability of eyewitness identification where admissibility would be largely dependent on the study's acceptance. *Compare Downing*, 753 F.2d 1224 *with* United States v. Fosher, 590 F.2d 381 (1st Cir. 1979) (an earlier, still frequently cited case rejecting expert evidence). The general studies could be used to cast doubt upon eyewitness identifications made under conditions in which accurate perception is unlikely or made after memory has so diminished as to make the identification suspect.

41. *See supra* note 22 and accompanying text. Other commentators have called the standard "remarkably vague," C. WRIGHT & K. GRAHAM, FEDERAL PRACTICE AND PROCEDURE § 5168, at 87 (1978), or "undefinable," *Questions Affecting the Admissibility of Scientific Evidence, supra* note 22, at 14.

42. The origin of this test is associated with Professor McCormick. *Frye v. United States a Half-Century Later, supra* note 13, at 1223 (citing C. MCCORMICK, MCCORMICK ON EVIDENCE 363-64 (1954)). Recent advocates of the approach also include Weinstein and Berger. J. WEINSTEIN & M. BERGER, WEINSTEIN'S EVIDENCE ¶ 702[03], at 702-34 to 702-44 (1990). These authors suggest a number of questions to help focus the rather vague relevance analysis. Bert Black sees the development of a "reliability test" as a result of applying the traditional relevancy standard to scientific evidence. *See A Unified Theory of Scientific Evidence, supra* note 27, at 641. Thus, this test, like the *Frye* test, is really not a single clearly defined test but a compilation of related approaches to the admissibility of scientific evidence.

43. FED. R. EVID. 403. This Rule is discussed in more detail at part IV B, *infra*.

44. *See supra* note 37 and accompanying text.

the relevance analysis, this concern may be translated into a finding that the evidence would either mislead the jury or confuse the issues.

Like the *Frye* test, there are significant difficulties in applying Rule 403 to scientific evidence. Part of the difficulty lies in the nature of the Rule itself: Rule 403 is a broad rule which recognizes the large discretionary role of the judge in controlling the introduction of evidence.[45] Tailoring such a broad rule to a specific form of evidence creates problems.

Part of the difficulty is attributable to the language of the Rule. Rule 403 and the advisory committee's note do not define the key terms with any precision, but merely provide a laundry list of six factors to be weighed against probative value. The commentary and judicial opinions also provide little assistance. The courts have in fact utilized "misleading the jury" (especially) or "confusion of the issues" to exclude scientific evidence in a substantial number of cases. Nonetheless, the tendency of the courts is to merely recite that the evidence would run afoul of one or more of these counter-factors rather than to analyze the impediments to effective utilization of the evidence by the trier, and thus provide a thoughtful decision.[46]

The lack of definition is exacerbated by an apparent directive to balance incomparables — the probative value of the evidence against ill-defined dangers and considerations.[47] The appropriate balancing process is described neither by the rule nor the note. The commentary frequently does little more than suggest three obvious steps: assessing probative value, assessing the dangers and considerations, and then balancing them to determine whether the dangers and considerations substantially outweigh the probative value. Thus, while Rule 403 is clearly a vehicle for exclusion of unreliable scientific evidence, the gloss provides only occasional hints at how the exercise ought to be conducted, and fails to provide guidance as to how the preference for relevant evidence should be fostered.

Moreover, the Rule does not address the difference between criminal and civil cases, and the relevant jurisprudence contributes little. The courts do not directly address the constitutional values in criminal cases which have sometimes led to a higher standard for admissibility of the state's scientific evidence and to a lower standard for that of the defendant.[48] Typical Rule 403 analysis has not considered the context in which the evidence is being offered,[49] most notably whether the defendant can challenge the evidence through full discovery and recourse to expert assistance. This failure often results in admitting unchallenged state's evidence in criminal cases.[50]

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45. WEINSTEIN'S EVIDENCE, *supra* note 42, ¶ 403[01], at 403-9.

46. Gold, *Limiting Judicial Discretion to Exclude Scientific Evidence*, 18 U.C. DAVIS L. REV. 59, 63 (1984).

47. Lewis, *Proof and Prejudice: A Constitutional Challenge to the Treatment of Prejudicial Evidence in Federal Criminal Cases*, 64 WASH. L. REV. 289, 315 (1989).

48. *Compare with* the discussion of *Frye*, *supra* text accompanying notes 25-26. Rule 403 applies to all offers.

49. Lewis, *supra* note 47, at 318-19.

50. *See* D. LOUISELL & C. MUELLER, FEDERAL EVIDENCE §106, at 849-50 for examples of admitting unchallenged evidence in criminal cases. Both DNA and spectrogram analysis techniques were found to be of doubtful reliability when scientists other than the propo-

Adherents of the relevance test argue that a special rule is not needed to deal with scientific evidence and that thoughtful analysis can be promoted by using the familiar concepts of the relevance analysis which apply to all evidence.[51] A liberal statement of this position, postulated by the Fourth Circuit, is as follows:

> Unless an exaggerated popular opinion of the accuracy of a particular technique makes its use prejudicial or likely to mislead the jury, it is better to admit relevant scientific evidence in the same manner as other expert testimony and allow its weight to be attacked by cross-examination and refutation.[52]

This liberal approach to scientific evidence is often justified by resort to the language of Federal Rules 401-03: relevant evidence, which need only have *any* tendency to make the proposition more probable,[53] *is admissible*,[54] although it *may* be excluded if its probative value is *substantially* outweighed by the danger of one of the counterfactors.[55] Although the language of the Rules would appear to support liberal admissibility generally, many proponents assert that the Rule 403 relevance approach can *best* ensure that the evidence is in fact reliable.[56]

As with the *Frye* test, the terms and the methodology of Rule 403 are ill-defined, particularly as applied to scientific evidence. While probative value is ordinarily assessed by rough logic and common experience,[57] attempts to evaluate the probative value of scientific evidence must go beyond the usual crude measures. Some courts and commentators have attempted to provide a list of factors which directly address the reliability of the scientific evidence to ensure more thoughtful consideration in the 403 analysis.[58] They argue that the goal should be to sharpen the admissibility analysis without abandoning the

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nents of the technique conducted a thorough analysis. *See also supra* note 35 for additional authorities discussing these examples.

51. McCormick, *supra* note 28, at 880.

52. United States v. Baller, 519 F.2d 463, 466 (4th Cir.), *cert. denied*, 423 U.S. 1019 (1975).

53. FED. R. EVID. 401 provides: "'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."

54. FED. R. EVID. 402 provides that "[a]ll relevant evidence is admissible, except as otherwise provided. . . ."

55. FED. R. EVID. 403 provides: "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."

56. *See* McCormick, *supra* note 28, at 911.

57. Probative value is a measure of the tendency of the existence of fact A to make the existence of fact B more likely or probable than it would be if A did not exist. E. MORGAN, BASIC PROBLEMS OF STATE AND FEDERAL EVIDENCE 167-68 (J. Weinstein 5th ed. 1976). The evaluation of the relationship between fact A and fact B — the inferences which must be drawn from fact A to infer fact B — requires the application of rough logic and our common experience. *Id.*

58. The most comprehensive list of factors can be found in David McCord's review of the cases and commentary. McCord, *Syndromes, Profiles, and Other Mental Exotica: A New Approach to the Admissibility of Nontraditional Psychological Evidence in Criminal Cases*, 66 OR. L. REV. 19, 93-94 (1987). For less exhaustive lists but more expansive discussion of the factors, see WEINSTEIN'S EVIDENCE, *supra* note 42, at ¶ 491; McCormick, *supra* note 28, at 911.

caution that *Frye* called for but did not necessarily attain.[59] Those who have attempted to fine-tune the relevance analyses to scientific evidence were also responding to critics who charged that the "approach does not attempt to assure the reliability of novel scientific evidence prior to admission."[60] *Frye* adherents stress the need for a screening function. They see abrogating *Frye* as removing a needed barrier to admissibility which allows time for science to properly set the stage for the courts to admit evidence.[61] A particular concern is that few criminal defendants have their own experts and that the language of Rule 403 intimates that a partisan prosecution witness alone can open the door to admissibility by testifying that the evidence is reliable.[62] The "relevance" critics fear that without the resources to hire experts[63] and the opportunity for adequate discovery in criminal cases,[64] many opponents will be unable to effectively challenge the testimony once admitted.[65] This exacerbates the alleged jury tendency to over-credit scientific evidence.

There is, however, no indication in the legislative history that the Federal Rules supplant *Frye*.[66] In spite of its vague language and the criticism of *Frye* by commentators, many jurisdictions reaffirmed their allegiance to *Frye* after the Federal Rules were adopted.[67] Some courts pay lip-service to *Frye* but have admitted evidence under the modern approach applying both tests or merging the tests.[68] Leading commentators have recently asserted that the tide may be turning toward a restrictive approach, with or without *Frye*.[69]

The foregoing discussion of the two prevalent approaches to the admissibility of scientific evidence illustrates several important points. There is no

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59. McCormick, *supra* note 28, at 908-09.

60. P. GIANNELLI & E. IMWINKELRIED, SCIENTIFIC EVIDENCE § 1-6(D), at 34 (1986).

61. *See, e.g., Symposium I, supra* note 12, at 212-13 (Saltzburg, *Frye and Alternatives*).

62. *Id.* Saltzburg points out that some indication of reliability must exist independent of the single expert called to testify. Contrast the great number of DNA cases now subject to challenge where the evidence was largely unopposed, *supra* note 19, and *DNA Typing on the Witness Stand, supra* note 20. The *Castro* case is the *first* time the reliability of DNA fingerprinting was seriously and extensively challenged in the courts. 144 Misc. 2d 956, 545 N.Y.S.2d 985.

63. With respect to the disparity issue, see *supra* note 38.

64. *See* Giannelli, *Observations on Discovery of Scientific Evidence*, 101 F.R.D. 599, 622 (1984) [hereinafter *Observations on Discovery of Scientific Evidence*].

65. *See, e.g., Symposium I, supra* note 12, at 213 (Saltzburg, *Frye and Alternatives*).

66. *See* Mengler, *The Theory of Discretion in the Federal Rules of Evidence*, 74 IOWA L. REV. 413, 448 (1989).

67. P. GIANNELLI & E. IMWINKELRIED, *supra* note 60, § 1-5(F), at 28.

68. *See, e.g.*, United States v. Smith, 869 F.2d 348 (7th Cir. 1989). *See also* Hanson's court-by-court analysis in Hanson, *James Alphonzo Frye Is Sixty-five Years Old; Should He Retire?* 16 W. ST. U.L. REV. 357, 372 (1989).

69. *See, e.g.*, Black, *Evolving Legal Standards for Admissibility of Scientific Evidence*, 239 SCI. 1508 (1988) (perceiving "a trend toward more thorough judicial review of scientific claims"); Holden, *Science in Court*, 243 SCI. 1658 (March 3, 1989) (perceiving both a permissive and a strict scrutiny camp: "Although the more permissive attitude is now the more prevalent one, the strict scrutiny camp seems to be an accelerating modern movement and is the direction of the future.") (citing Paul Rothstein in a report of the recent workshop on scientific evidence in toxic tort cases). Note also the concern for laxity expressed by the recent ABA Committee Report. A.B.A. CRIMINAL JUSTICE SECTION, COMMITTEE ON RULES OF CRIMINAL PROCEDURE AND EVIDENCE, FEDERAL RULES OF EVIDENCE: A FRESH REVIEW AND EVALUATION 70-71 (1987).

one approach which commands the support of a clear majority of jurisdictions. Moreover there is no approach to the admissibility of scientific evidence which satisfies the concerns of a preponderance of the commentators. Both the *Frye* test and the modern "relevancy" approach have adherents, but even thoughtful adherents acknowledge that neither approach ensures that the evidence is reliable or helpful to the trier of fact. Adherents' claims typically focus on less crucial purported advantages, and criticisms of one approach frequently apply to the other. Certainly there are a number of cases which carefully analyzed the reliability of the evidence in determining admissibility and utilized the basic framework of each approach.[70] But it is *because* the courts focused on the underlying question of reliability, in addition to applying either of the two tests, that these opinions are noteworthy.

All thoughtful commentators appear to share the concerns that unreliable scientific evidence may be admitted under the existing standards, that the inadequacy may not be sufficiently exposed to the trier of fact, and that the trier may overvalue the evidence. Sometimes the concern is primarily on ensuring reliability. The most prevalent concern, however, is that the jury will "overvalue" the scientific evidence. One's preference for *Frye* or the relevance approach may depend upon whether one believes that the jury could adequately comprehend and evaluate scientific evidence.[71] The concern is that because the jury cannot understand the evidence from its own prior experience, it will tend simply to credit the evidence because of a belief in science or the impressiveness of the expert's credentials or presentation. In the Rule 403 balancing analysis, this purported "aura of infallibility" surrounding scientific evidence is clearly the most widely perceived source of the exclusion.

These concerns apply to *all* scientific evidence because of the trier's relative unfamiliarity with the evidence and the typical partisan status of the expert and her evidence. The concern is particularly acute with respect to novel scientific evidence because of the relative paucity of familiar experts and relevant literature. Nonetheless, courts must be concerned with "established" as well as novel scientific developments because the danger of unreliability exists at all three "levels" of scientific evidence.[72]

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70. With respect to *Frye*, see *supra* note 38. With respect to the relevancy approach, see *Downing*, 753 F.2d 1224. Additionally, McCormick discusses a number of thoughtful relevance treatments. *See* McCormick, *supra* note 28, at 895-902.

71. *Symposium I*, *supra* note 12, at 218 (remarks of Barbara Underwood); *Judge Versus Jury*, *supra* note 37, at 580.

72. There are also important meta-evidentiary concerns which, although beyond the scope of this paper, contribute to the concerns developed earlier in this section and should be briefly acknowledged. These concerns, reflected in a wide range of literature devoted to the role of the courts, science and procedure, can probably best be described as symbolic values. Our system of justice is concerned with fair process and giving a litigant individual treatment. *See, e.g.*, Brillmayer & Kornhauser, *Quantitative Methods and Legal Decision* 46 U. CHI. L. REV. 116, 149 (1978) (reviewing M. FINKELSTEIN, QUANTITATIVE METHODS IN LAW: STUDIES IN THE APPLICATION OF MATHEMATICAL PROBABILITY AND STATISTICS TO LEGAL PROBLEMS (1978)). More basically, science and law have very different goals and methods which often conflict. A clear and brief statement of the cultural differences can be found in Huber, *A Comment on "Toward Incentive-Based Procedure: Three Approaches for Regulating Scientific Evidence,"* 69 B.U.L. REV. 513, 513-15 (1989). Commentators, including some judges, are concerned that these values may be lost if science plays too large a role. *See, e.g.*, Markey, *Jurisprudence or 'Juriscience'?* 25 WM. & MARY L. REV. 525, 526 (1984). Technocratic val-

This author suggests that the purpose of the rules governing expert evidence, and the goals of the rules of evidence generally, can be utilized to address the prevalent concerns in a more thoughtful and efficacious manner. What is needed is an approach which analyzes the admissibility of all scientific evidence in terms of the core concerns underlying *the use* of that evidence — that the evidence is reliable and that the trier can comprehend it, evaluate it, and utilize it in making determinations of fact.

II. THE JURY: A CAPABLE TRIER IF PROVIDED THE NECESSARY TOOLS

The dominant strategy embodied in both prevalent approaches to the admissibility of scientific evidence is exclusion; *i.e.*, the penalty for failure to meet the standard is that the evidence is excluded altogether. That strategy is largely premised upon the assumption that the jury is likely to be awed by an "aura of infallibility" of scientific evidence and/or the scientific expert, and will uncritically adopt the evidence. That assumption is based upon jury mistrust, a fear that the jury can not or will not properly evaluate the weight to be accorded the evidence. Although this attitude is reflected in jury control devices such as directed verdicts and new trials[73] and many of the rules of evidence,[74] the underlying mistrust does not always come to the fore. Rather, the mistrust coexists with the recognition that we must attempt to make the constitutionally-mandated jury system work. Thus devices such as the doctrine

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ues and processes may overwhelm the very values which give legitimacy to our trial system. A particular focus of concern has been the underlying apparent mathematical precision of much of scientific evidence. Tribe, *Trial by Mathematics: Precision and Ritualism in the Legal Process*, 84 HARV. L. REV. 1329, *passim* (1971); Nesson, *The Evidence or the Event? On Judicial Proof and the Acceptability of Verdicts*, 98 HARV. L. REV. 1357, 1378 (1985). Both authors focus on mathematical or probability evidence. The notion of confidence levels or tests of statistical significance brings a mathematical aspect to most scientific evidence. For a recent discussion of the relationship between statistical and legal errors, see Radford, *Statistical Error and Legal Error: Type 1 and Type 2 Errors and the Law*, 21 LOY. L.A.L. REV. 843 (1988). Additionally, the frequent skepticism about the role of science vis-a-vis humanistic and democratic values and about the limits of science and the technocratic process cannot help but inform our approach to scientific evidence. *See, e.g.*, Carter, *Separatism and Skepticism*, 92 YALE L.J. 1334 (1983). *See also* Krier & Gillette, *The Uneasy Case for Technological Optimism*, 84 MICH. L. REV. 405 (1985). Finally, decisions about admissibility often determine who *will* prevail. *See, e.g.*, *Viterbo v. Dow Chemical Co.*, 646 F. Supp. 1420, 1424 (E.D. Tex. 1986), *aff'd.*, 826 F.2d 420 (5th Cir 1987) ("examination [of expert testimony] is especially important in the toxic tort context, where presentation to the trier of theories of causation depends almost entirely upon expert testimony"). In admitting evidence, the court is implicitly making a value judgment that the decision may be based upon the offered evidence in the many cases where the scientific evidence plays a pivotal role. The admissibility question thus carries a considerable amount of weighty baggage, and it is hardly surprising that a legal formula is invoked after a complex, highly intuitive admissibility decision has been made.

73. *See* Stephens, *Controlling the Civil Jury: Towards a Functional Model of Justification*, 76 KENT L.J. 81 (1987).

74. It has become commonplace, although doubtful, to assert that the hearsay rule and other exclusionary rules of evidence are attributable to the role of the jury as factfinder. Nance, *The Best Evidence Principle*, 73 IOWA L. REV. 227, 277 (1988) (author traces the development of the dubious idea that the jury is the reason for the exclusionary rules to Thayer and Wigmore).

of limited admissibility[75] and the use of jury instructions[76] reflect the balance between jury mistrust and pragmatism.[77]

An important premise of this paper is that, contrary to the "aura of infallibility assumption," the jury *can* perform its role of accurate factfinding even in the face of complex scientific evidence. The trier of fact is charged with making accurate findings of fact and correctly applying the law to its findings. To do this, the trier must perform three basic functions. First the trier of fact must understand the evidence and the law. Second, the trier must be able to evaluate the evidence. With scientific evidence, the witness is providing information which is largely beyond the experience of the lay person. Thus evaluation is more difficult than it would be with lay evidence within the realm

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75. In spite of the exclusionary rules, the Rules provide that the excludable evidence will ordinarily be admitted for another relevant purpose subject to an instruction limiting the trier's use of the evidence to the admissible purpose. FED. R. EVID. 105. This doctrine of "limited admissibility" is, however, subject to Rule 403 which provides discretion to exclude the evidence where "probative value is substantially outweighed by the danger of unfair prejudice, . . ." FED. R. EVID. 403.

The assumption that jurors can ignore the evidence for the excluded purpose ignores studies which indicate that limiting instructions are of limited effect. Note, *The Frye Doctrine and Relevancy Approach Controversy: An Empirical Evaluation,* 74 GEO. L.J. 1769, 1786 n.124 (1986); V. HANS & N. VIDMAR, JUDGING THE JURY 120 (1986). *But see* R. HASTIE, *infra* note 86, at 231, where the authors noted that the jury heeded limiting instructions while under observation by social scientists, but questioned generalizability of the data to real juries.

76. The jury receives lengthy, seemingly opaque general instructions necessary to apply the evidence which researchers indicate are virtually unfathomable. A. ELWORK, B. SALLS & J. ALFINI, MAKING JURY INSTRUCTIONS UNDERSTANDABLE ch. 1 (1982). These authors suggest that instructions can be simplified and clarified so that they are comprehensible. Emperical evidence supports this suggestion. *See* Severance & Loftus, *Improving the Ability of Jurors to Comprehend and Apply Criminal Jury Instructions,* 17 LAW & SOC'Y REV. 153 (1982).

77. In the scientific evidence area, the ambivalence is reflected by the fact that Frye and the "aura" concerns are used to justify exclusion in some cases and swept under the table or aside in others. The fears typically surface in criminal cases and are largely overlooked in civil cases. This suggests that concerns other than simply jury competence are at stake. *See supra* text accompanying note 26.

Another example is the exclusion of a large percentage of the jurors who would probably be best able to understand scientific evidence, the highly educated. *See* H. ABRAHAM, THE JUDICIAL PROCESS 115 (3d ed. 1975). The ABA standards recognize that vocational disqualifications other than those for judges and lawyers should be narrowly confined. ABA COMMITTEE ON STANDARDS OF JUDICIAL ADMINISTRATION, STANDARDS RELATING TO TRIAL COURTS § 2.11 (1976). A recent treatment of disqualifications, exceptions, and excusing jurors in the federal courts is J. GEORGE, D. GOLASH & R. WHEELER, HANDBOOK ON JURY USE IN THE FEDERAL DISTRICT COURTS 24-28 (Fed. Jud. Ctr. 1989). There is a relationship between education and the ability to comprehend new material and a critical posture toward the material. Note, *The Frye Doctrine and Relevancy Approach Controversy: An Empirical Evaluation,* 74 GEO. L.J. 1769, 1785-86 (1986); Saks & Wissler, *Legal and Psychological Bases of Expert Testimony: Surveys of the Law and of Jurors,* 2 BEHAV. SCI. & L. 435, 446 (1985).

A final example of our ambivalence toward the jury which has substantial implications for the use of scientific evidence is the passive role we require the jury to play in contrast to our concern for jury comprehension. The jury must sit passively by as attorneys present greatly different, highly selective versions of complex science and do so at parts of the trial separated by long periods of time.

Any thoughtful student of evidence and the trial process cannot avoid the conclusion that, while the goal of the procedural system is accurate factfinding, we tend to ignore significant impediments to that goal. The author has attempted to eliminate some of the ambivalence by focusing on the factfinders' legitimate needs and the goals of our procedural system.

of the trier's ordinary experience. Third, the trier must apply the scientific evidence to the other facts in the case.[78] The extent to which the jury can perform these basic functions has been the subject of heated debate.[79] Much of this debate has ignored the available data. Studies of jury capabilities and related literature of small group decision-making processes, however, indicate that the jury is both *willing* and *able* to perform its designated role. Notwithstanding some methodological problems and doubts about generalizing from some of the simulations,[80] the thrust of the literature and the conclusions drawn therefrom is that, given adequate help from lawyers, the jury performs the *three designated functions* well.[81]

In terms of the first function — understanding the evidence and the law, a number of studies give the jury high marks for comprehension and recall. *The American Jury*, the classic 1966 jury study based on a mammoth survey of judges conducted after conclusion of actual trials, showed that the judge agreed with the jury result in seventy-five percent of cases.[82] The authors found that the vast majority of those few cases in which judge and jury did disagree were

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78. The modern approach to expert evidence allows the expert to render an opinion which addresses the so-called "ultimate opinion" in the case; *i.e.*, telling the jury how to decide an issue. FED. R. EVID. 704(a). Congress, however, acted recently to bar an "opinion or inference as to whether the defendant did or did not have the mental state or condition constituting an element of the crime charged or of a defense thereto." FED. R. EVID. 704(b) (as amended by Pub. L. 98-473, § 406, 98 Stat. 2067 (1984)).

79. Much of the debate centers on the question of whether there should be a "complexity" exception to the seventh amendment right to a jury trial in civil cases. *See* Kirst, *The Jury's Historic Domain in Complex Cases*, 58 WASH. L. REV. 1, 1-2 nn.2-6 (1982).

80. *See, e.g.*, Richard Lempert's discussion of difficulties with interviews and simulations, the two most common methods used in jury studies. Lempert, *Civil Juries and Complex Cases: Let's Not Rush to Judgment*, 80 MICH. L. REV. 68, 98-99 & 100-01 (1981). Similarly, Shari Diamond has traced the history of jury research through the early 1980's, pointing out the difficulties with many of the earlier and some of the later studies. Diamond, *Growth and Maturation in Psychology and Law*, 17 LAW & SOC'Y REV. 11 (1982). *See also* MacCoun, *Experimental Research on Jury Decision-Making*, 244 SCI. 1046 (June 2, 1989). MacCoun cites studies comparing mock juries with real juries which indicate that some of the problems with simulations may not be as serious as critics suggested. *Id.* at 1046.

A significant problem with the research according to Michael Saks is that there is negligible direct comparison between the judge and jury. The most helpful research would be of alternative decisionmakers under similar circumstances. M. SAKS, SMALL GROUP DECISION MAKING AND COMPLEX INFORMATION TASKS 57 (Fed. Jud. Cent. Rep. 1981). For a limited discussion of the comparative issue, see *infra* notes 113-17 and accompanying text.

81. I have relied most heavily on large sample studies and those which utilized realistic simulation procedures. I do not claim that studies prove competence; only that a number of quite good studies collectively suggest that the jury can be an effective fact-finder when given appropriate tools. Hence, I have not attempted to undertake a discussion of the methodological features of each study referred to, but only briefly describe the more significant studies to give the reader some general sense of the strengths or weaknesses.

82. H. KALVEN, JR. & H. ZEISEL, THE AMERICAN JURY 152 (1966). The original study involved only criminal trials but the authors subsequently undertook a second study of civil trials. *Id.* at ch.3 & preface. Twenty-eight percent of the criminal trials included in the study utilized expert testimony. *Id.* at 139. That figure is undoubtedly low in comparison with today's extensive use of forensic laboratories.

Furthermore, while this Chicago Jury Project findings are considered to be "our best evidence on the issue of jury competence in light of the enormity of the data" and "the thoroughness and insightfulness of the analysis," the findings should be considered in light of other changes over the past twenty-five years which "have a bearing on the ability of juries to carry out the tasks assigned to them." Vidmar, *Foreword: Empirical Research and the Issue of Jury Competence*, 53 LAW & CONTEMP. PROBS. 1, 4 (1989).

not attributable to jury misunderstanding.[83] They conclude that jurors sensitively perceive difficult cases: they note that in difficult cases jurors come back more frequently for additional instructions and deliberate a longer period of time.[84] The authors found no greater degree of disagreement between judge and jury in the "very difficult" cases than in simpler ones, which led them to reject the argument that juries cannot understand difficult information.[85]

A more recent simulation study conducted by Hastie and his colleagues utilizing realistic trial procedures and juries drawn from jury pools in three counties,[86] found the recall ability of the jury group to be quite impressive:

> The reconstruction of the testimony and the construction of plausible narrative schemes to order, complete, and condense the trial evidence occur with thoroughness and precision. These accomplishments in jury deliberation are especially impressive when compared with the performance of even the most competent individual jurors. The view of the evidence by deliberation processes is invariably more complete and more accurate than the typical individual juror's rendition of the same material.[87]

As a group, the Hastie juries recalled ninety percent of the evidence and eighty percent of the judges' instructions correctly.[88] There are indications that jurors may have trouble with specific instructions,[89] but much of the difficulty is a function of legal jargon and poor drafting.[90]

A third study directed by Bettyruth Walter used questionnaires administered to civil jurors after verdict in thirty-eight trials in three different courts.[91] Although subject to some skepticism,[92] the responses indicate that the jurors believed they understood and remembered the evidence. Ninety-nine percent felt they had a good or very good understanding of the case and eighty-nine percent individually recalled hearing a specific item of testimony.[93]

A substantial number of jury studies also suggest that jurors can adequately perform the second necessary function — to evaluate expert evidence rather than merely deferring to the expert. Several of the studies involving the use of polygraph evidence found that jurors often render verdicts inconsistent with the expert evidence.[94] Peters, the author of one such study, concluded that

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83. H. KALVEN, JR. & H. ZEISEL, *supra* note 82, at 152.
84. *Id.* at 155-56.
85. *Id.* at 157.
86. R. HASTIE, S. PENROD & N. PENNINGTON, INSIDE THE JURY 45 (1983) [hereinafter R. HASTIE].
87. *Id.* at 230.
88. *Id.* at 81.
89. V. HANS & N. VIDMAR, *supra* note 75, at 120.
90. *Id.* at 121-24. *See also supra* note 76.
91. J. GUINTHER, THE JURY IN AMERICA 284 (1988). The study involved a broad range of civil cases, the vast majority of which would involve expert evidence. *Id.* at 291-92.
92. One can argue that jurors tend to overstate their understanding of the evidence either because they do not really comprehend what it means to understand the evidence or they were not being frank.
93. J. GUINTHER, *supra* note 91, at 347.
94. The studies are summarized in Imwinkelried, *The Standard for Admitting Scientific Evidence: A Critique from the Perspective of Juror Psychology*, 28 VILL. L. REV. 554, 567-68 (1982) [hereinafter *A Critique from the Perspective of Juror Psychology*]. Recent anecdotal

"juries are capable of weighing and evaluating all evidence and rendering verdicts that may be inconsistent with the polygraph evidence."[95] Studies of the insanity defense indicate that an overwhelming majority of jurors similarly understood the psychiatric evidence and based their verdicts on all evidence in the case rather than deferring to the expert's opinion and testimony.[96] The Simon study's conclusion is typical: jurors are not bowled over by the experts.

> [T]he jury [is] quite sophisticated in differentiating its role in the trial from that of medical experts. The jury understood the advisory capacity in which the experts' testimony was to be evaluated and showed awareness of how the experts' special knowledge and experience are likely to influence the testimony they offer.[97]

In the context of ordinary medical experts who jurors are likely to credit more highly than psychiatrists, studies continue to find that juries are appropriately skeptical of expert evidence. Even when jurors initially rated doctors highly after testifying, it is reported that the ratings typically declined by the time of deliberation.[98] Austin, in a case study of two juries trying the same antitrust case involving considerable expert evidence on electronics and economics, found that "[t]he jurors . . . generally were skeptical of the experts."[99] Elizabeth Loftus, in a simulated trial involving both lay and scientific methods of identification of the defendant, found that the jurors were more likely to convict based upon the lay evidence.[100]

As Imwinkelried points out, it would be foolish to conclude that jurors definitely undertake critical evaluation, but the weight of the data questions the assumption that scientific evidence overwhelms the typical juror.[101] The conclusion of jury studies is reinforced by broader studies of the decision-making process which indicate that people who must make decisions under conditions of imperfect information tend to utilize simplifying or heuristic strategies and underutilize precision-oriented mathematical approaches.[102] This is especially true when jurors are faced with sharply differing expert opinions

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evidence can be found in *Jury Finds Guilt in Rape Despite DNA Test*, Boston Globe, April 8, 1990, at 65, col. 1 (Jury preferred eyewitness testimony to an FBI forensic scientist's evidence that DNA testing of blood stains exonerated the defendant.).

95. Peters, *A Survey of Polygraph Evidence in Criminal Trials*, 68 ABA J. 162, 165 (1981).

96. R. SIMON, THE JURY AND THE DEFENSE OF INSANITY (1967); Simon & Shackleford, *The Defense of Insanity: A Survey of Legal and Psychiatric Opinion*, 29 PUB. OPINION Q. 411 (1965). The material in the book relevant to jury understanding of experts is summarized in R. SIMON, THE JURY: ITS ROLE IN AMERICAN SOCIETY 57-63 (1980) [hereinafter THE JURY: ITS ROLE IN AMERICAN SOCIETY].

97. THE JURY: ITS ROLE IN AMERICAN SOCIETY, *supra* note 96, at 69.

98. Sonaike, *The Influence of Jury Deliberation on Juror Perception of Trial, Credibility, and Damage Awards*, 1978 B.Y.U. L. REV. 889, 905.

99. Austin, *Jury Perceptions on Advocacy: A Case Study*, 8 LITIGATION 15, 16 (Summer 1982).

100. Loftus, *Psychological Aspects of Courtroom Testimony*, 347 ANNALS N.Y. ACAD. SCI. 27, 33 (1980).

101. *A Critique from the Perspective of Juror Psychology*, *supra* note 94, at 570.

102. Saks & Kidd, *Human Information Processing and Adjudication: Trial by Heuristics*, 15 LAW & SOC'Y REV. 123, 127 (1980); Walker & Monahan, *Social Frameworks: A New Use of Social Science in Law*, 73 VA. L. REV. 559, 576 n.52 (1987).

on the same issue.[103] Ironically, in a survey by Saks, attorney respondents thought a slightly higher percentage of judges than jurors found scientific evidence more credible than other evidence.[104]

Students of the jury also give the jury high marks for the third function — application of the evidence and law. Reskin and Visher note that jurors appropriately use evidence in reaching decisions, and confirm Kalven and Zeisel's conclusion that resort to factors other than those mandated by the jury instructions are largely confined to ambiguous cases.[105] Jury verdicts are usually based upon the amount of evidence brought forth at the trials.[106] The jurors in the Walter study indicated that the law (forty-six percent) and fact (fifty percent) were most important in making their decision. Only a few jurors (four percent) cited closing speeches.[107] Thus the jurors' perceptions appear to agree with the students of the jury.

Hastie found that "juries perform efficiently and accurately" in fact finding.[108] He found that jurors' decision-making did not falter when confronted by abstract legal concepts,[109] suggesting that the jury possesses the ability to apply complex materials. Similarly, the previously noted fact that judge-juror disagreement on result did not increase in complex cases indicates an ability to apply difficult concepts.[110]

Although not conclusive, the available research clearly suggests the jury can fulfill its factfinding role.[111] These studies reinforce the constitutional drafters' conviction that the jury is a "presumptively rational factfinder."[112]

Those who would reverse the historical/constitutional presumption of competence conveniently ignore that fact that any assessment of the jury's ability should be a comparative one. The judge is probably no better, and arguably worse than the jury as a factfinder.[113] Many judges do not understand scientific evidence.[114] They are likely to give the evidence more credit than jurors would.[115] Richard Lempert's observations in the context of the "complex case exception" controversy are applicable:

> Just as a jury may not include people likely to comprehend the details of complex cases, so a judge assigned at random, may not be

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103. Blazevic, *When Science and the Law Go Head to Head*, 11 LITIGATION NEWS 3, 24 (1986).
104. M. SAKS & R. VAN DUIZEND, THE USE OF SCIENTIFIC EVIDENCE IN LITIGATION 5-6 (1983).
105. Reskin & Visher, *The Impacts of Evidence and Extralegal Factors in Jurors' Decisions*, 20 LAW & SOC'Y REV. 423, 436 (1986). The authors are critical of studies which indicate that jurors were influenced by sentiment but which fail to control for the strength of the evidence. *Id.* at 424.
106. V. HANS & N. VIDMAR, *supra* note 75, at 120.
107. J. GUINTHER *supra* note 91, at 320. Unfortunately, the questionnaire allowed the jury only the three choices cited above, thus limiting the utility of the responses.
108. R. HASTIE, *supra* note 86, at 230.
109. *Id.* at 231.
110. *Id.*
111. *See supra* text accompanying notes 80-81.
112. County Court v. Allen, 442 U.S. 140, 157 (1979).
113. *See, e.g.*, Walker & Monahan, *supra* note 102, at 588 n.96; Lempert, *supra* note 80, at 91.
114. Lempert, *supra* note 80, at 92.
115. M. SAKS & R. VAN DUIZEND, *supra* note 104, at 5-6.

> well equipped to cope with complexity. Many judges are bright and diligent, but others are much less so, and a legal education does not mean that one will have more than a layperson's understanding of such subjects as economics and statistics. Furthermore, a judge lacks the advantages of collective decision-making, such as group memory and a mix of biases.[116]

Another important consideration in the comparative assessment is the fact that the lawyers' process of distilling complex material into a comprehensible form is not fully pursued in bench trials.[117] Thus, the judge possesses neither the broad experience of the jury nor its collective decision-making skill, and additionally may not receive as well presented a case as the jury.

III. THE ATTORNEY: A LIMITED PROVIDER OF THE NECESSARY TOOLS

Despite the empirically demonstrated capabilities of the jury, the trier of fact simply cannot function effectively without the tools needed to perform its task. Two factors are of particularly critical import with respect to scientific evidence. First, scientific evidence must be presented in a manner that is *comprehensible — i.e.*, capable of being understood, evaluated, and applied by lay persons. Second, what is presented must either be reliable or its defects must be sufficiently exposed through the adversary system to the lay trier. A number of commentators acknowledge that these critical factors are often not met in the utilization of partisan expert evidence.

Hastie pointed out the important role of attorneys in developing good jurors.[118] Saks, in a recent review of the literature on jurors and expert testimony, was more specific: he found that when attorneys educate the jury about how much weight the scientific evidence is entitled to receive, juries listen, understand and react to such information in processing trial evidence.[119] Similarly, Saltzburg discussed scientific evidence in terms of the relationship between reliability and partisan proof:

> In most cases cross-examination and impeachment are effective antidotes for witness exaggeration and effective tools for exploring witness uncertainty.
>
> When scientific or expert evidence . . . is offered, we need to look for equivalent safeguards. . . . A court must assure itself that the experts most likely to find fault with a theory or principle have had sufficient time to assess it so that it is unlikely that subsequent inquiries will reveal that reliance by the court on an expert's testimony was greatly mistaken. . . .

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116. Lempert, *supra* note 80, at 91. *See also* M. SAKS, *supra* note 80, at 26 (finding decisions and judgments by groups to be "superior"). Note also Hastie's observations regarding collective decision-making. R. HASTIE, *supra* note 86, at 230.

117. Higginbotham, *Continuing the Dialogue: Civil Juries and the Allocation of Judicial Power*, 56 TEX. L. REV. 47, 54 (1977). Judge Higginbotham opines that counsel tend to rely on the judge to ascertain the relevance of the evidence in court-tried cases. *Id.*

118. R. HASTIE, *supra* note 86, at 230.

119. Saks & Wissler, *supra* note 77, at 438. *See also* Note, *The Frye Doctrine and Relevancy Approach Controversy: An Empirical Evaluation*, 74 GEO. L.J. 1769, 1786 (1986).

> A foundation is needed that establishes sufficient reliability for a test to remove fears that later developments will suggest that an inaccurate and unjust result was reached at trial because the test was used. This is not because juries are too quick to prefer scientific or expert evidence to other evidence. It is because juries, *and judges also*, are likely to accept evidence that is *unchallenged at trial*. If evidence is *unchallenged and inaccurate, a jury or judge* is entitled to rely upon it, but subsequently may regret doing so.[120]

The role of the attorney from the perspective of accurate factfinding is threefold: to utilize scientific evidence when it assists the trier to decide important issues in the lawsuit; to present reliable scientific evidence; and to do so in a comprehensible manner.[121] Despite the clarity of the need by the trier for comprehensible and reliable evidence, significant impediments to fulfillment of the ideal exist in the real world. A brief examination of the limitations imposed by attorney resources and abilities, as well as by the adversarial system itself, demonstrates *why* the ideal is not achieved and *why* the trier is frequently deprived of the necessary tools to adequately perform.

Ironically, scientific evidence is generally underutilized. Saks concluded that, in spite of the seeming ubiquity of scientific evidence, it is frequently not utilized in situations where it would be helpful.[122] Commentators, however, typically decry the purchase of a mendacious expert's opinion or the unwitting use of unreliable evidence. Thus, we are plagued by the competing problems of failure to utilize appropriate evidence and partisan use of unreliable evidence.

Both problems, especially underutilization, are partly attributable to the scientific naivete of lawyers. There appears to be unanimity among commentators that lawyers are deplorably ill-informed about science and scientific methods.[123] And this appears to be the norm.[124] The lack of proper training is the biggest problem with respect to non-utilization of scientific evidence.[125]

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120. *Symposium I*, *supra* note 12, at 216-17 (S. Saltzburg) (emphasis added).

121. As Saltzburg points out above, we could theoretically dispense with the reliability requirement where the opponent adequately challenges the evidence.

122. M. SAKS & R. VAN DUIZEND, *supra* note 104, at 8.

123. *See, e.g.*, *Symposium I*, *supra* note 12, at 232 (remarks of Michael Graham). *See also* the comments of Joseph Nicol, in what is probably the harshest of a number of similar criticisms.

> An even more important consideration is the inability of the defense bar to handle scientific matters. The sad truth is that those attorneys simply are incapable by education, and all too often by inclination, to become sufficiently familiar with scientific evidence to discharge their responsibilities toward the administration of justice. The scientific illiteracy of nearly all lawyers is a disgrace to their profession. The fault lies equally with the individual lawyers and with the legal profession, including law schools and bar associations.

Id. at 221.

124. Some suggest that the tendency to view law as a largely self-sufficient system, combined with the negligible attention given to "science" as an empirical effort, gives the tacit if not explicit message that scientific methodology, unlike legal methodology, is unimportant. *See, e.g.*, W. LOH, SOCIAL RESEARCH IN THE JUDICIAL PROCESS 733 (1984). The problem of lawyer unfamiliarity with science methodology cannot be laid primarily at the door of law schools; law schools inherit scientific illiteracy from primary and secondary institutions. The National Science Foundation indicates that the tenth grade is the last time most United States high school students are exposed to science. Fiske, *Searching for the Key to Science Literacy*, N.Y. Times, Jan. 4, 1987, § 12 (Education Life), at 20, 21. Thus, the would-be scientist and

The lack of training affects another prerequisite to proper use of scientific evidence — the ability to oppose an offer of evidence. Even when the proponent recognizes that scientific evidence would be helpful, the evidence frequently goes unchallenged, contrary to the assumptions of the adversary system. As illustrated by the DNA cases, attorneys frequently fail to challenge the admissibility of unreliable evidence.[126]

Constrained by ignorance and/or the admonitions of the trial practice doyens, the opponent typically fails to test the scientific evidence through cross-examination.[127] Limited by resources, she also fails frequently to offer her own expert.[128] Relevant science thus is frequently only partially communicated and is done so under circumstances which cast *considerable* doubt upon the validity of the only evidence offered and consequently, of the decision rendered by the court.

Lack of training also inhibits the lawyer's ability to communicate the evidence in an understandable manner. Saks and Van Duizend found that lawyers ineffectively prepared their experts for testimony and prepared poorly for cross-examination of the opponent's expert.[129] This is despite clear advice in the trial practice literature that one must contact the expert early, carefully orient the expert to the legal issues, communicate frequently with the expert to ensure that the lawyer understands the science, prepare the expert for direct examination and prepare to cross-examine the opponent's expert. *If* the lawyer follows these mandates, becomes science literate, and appreciates the ethical constraints on the ability of the true expert to give the desired testimony, the relevant material *can* be effectively presented.[130]

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the would-be lawyer are soon separated. But perhaps more important is the fact that the emphasis in science courses is typically on the conclusions of science rather than its methods. The latter are very difficult to pick up on one's own. "Science is not a list of facts and principles to learn by rote; it is a way of looking at the world and asking questions." *Id.* at 22 (quoting James Rutherford of the American Ass'n for the Advancement of Science). *See also* THE USE/NONUSE/MISUSE OF APPLIED SOCIAL RESEARCH IN THE COURTS chs. 8-9 (M. Saks & C. Baron eds. 1980).

125. Sperlich, *Social Science Evidence and the Courts: Reaching Beyond the Adversary Process*, 63 JUDICATURE 280, 282 (1980).

126. *See supra* note 20. *See also* discussion of the National Academy of Science study of voice prints, *supra* note 35.

127. Doyle, *Applying Lawyers' Expertise to Scientific Experts: Some Thoughts About Trial Court Analyses of the Prejudicial Effects of Admitting and Excluding Expert Scientific Testimony*, 25 WM. & MARY L. REV. 619, 642 & n.103 (1984). Contrast Schwartz, *There is No Archbishop of Science — A Comment on Elliot's TOWARD INCENTIVE-BASED PROCEDURE: THREE APPROACHES FOR REGULATING SCIENTIFIC EVIDENCE*, 69 B.U.L. REV. 517, 522 (1989) (concluding that scientific evidence is especially amenable to the use of cross-examination and rebuttal testimony.)

128. *Symposium I*, *supra* note 12, at 233 (remarks of Margaret Berger) (noting the relationship between naivete and resources, and finding that the resource imbalance can be more easily remedied than the naivete problem).

129. M. SAKS & R. VAN DUIZEND, *supra* note 104, at chs. 3 & 4. *See also Symposium I*, *supra* note 12, at 130 (remarks of Michael Graham, finding a "lack of mutual understanding" between lawyers and scientists as "account[ing] in large part for the inability of lawyers and scientists to explain to jurors the true import of the evidence").

130. Federal Rule of Evidence 705 does away with the requirement of a hypothetical question and provides for flexibility, subject to judicial discretion, in presenting an opinion. *See also* FED. R. EVID. 703. These rules provide great flexibility in eliciting the basis for and the form of the expert's opinion. If the lawyer understands her material, can translate the material

The attorney must become more familiar with scientific methodology and the limits of responsible science to fulfill her difficult role. But it would be both unfair and unwise to put the entire responsibility for reliable and comprehensible scientific evidence on the attorney. Attorneys cannot be expected to narrow the science competence gap on their own. Becoming well-versed in effective utilization of scientific evidence will require a great deal of time and effort by individual attorneys, the bar and law schools. Further, in criminal cases attorneys often have inadequate resources to effectively utilize their abilities. Recent studies of judicial appointments of experts for indigents[131] indicate that there are clearly inadequate resources for criminal defendants who are entitled to state-provided defense services.

Even *if* the resources and competency problems of attorneys are alleviated — an unlikely prospect for the near future — the attorney's ability to meet the trier's needs is still limited by the partisan nature of expert proof. We cannot realistically expect that attorneys will be motivated to present scientific evidence in a fair or comprehensible fashion. The system allows them to present evidence in a way which they believe best advances the cause of their clients.[132] Thus, the attorney is immersed in a system in which the expert frequently oversteps the limits of her legitimate data,[133] either pushed by the adversarial party, by her possible involvement in assisting a party[134] or by her own ego.[135] Lawyers, however, tend to blame the vain or mendacious expert for going beyond the limits of her "science" while they "shop" for a willing expert and give her the push needed to provide the desired testimony.[136]

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into understandable English, present a common sense basis for the opinion, and organize the presentation into a coherent manner, most information can be effectively presented.

131. *See, e.g.*, Decker, *Expert Services in the Defense of Criminal Cases: The Constitutional and Statutory Rights of Indigents*, 51 U. CIN. L. REV. 574, 599-615 (1982); Note, *A Question of Competence: The Indigent Criminal Defendant's Right to Adequate and Competent Psychiatric Assistance after Ake v. Oklahoma*, 14 VT. L. REV. 121 (1989) (constitutional mandate in insanity defense cases).

132. The system appears to be self-perpetuating. Exposure to partisan use can be used to rationalize the attorney's particular use of unreliable evidence and has probably bred skepticism about the reliability and utility of scientific evidence. In fairness to the legal system, however, I should point out that this skepticism and diffidence is in part due to reaction to the extravagant claims of some "apostles" of science whose promises of a cure for cancer, cheap trouble-free nuclear power and a clean, safe environment have gone largely unfulfilled. *See, e.g.*, Krier & Gillette, *supra* note 72. *See also* Huber, *supra* note 72.

133. Wasyliw, Cavenaugh & Rogers, *Beyond the Scientific Limit of Expert Testimony*, 13 BULL. AM. ACAD. PSYCHIATRY & L. 147 (1985) (discussing the reasons for overextension of the experts' science).

134. Jones, *Men of Science v. Men of Law: Some Comments on Recent Cases*, 26 MED. SCI. L. 13, 15 (1986). "Experts are also required to act as advisors, passing notes to and from counsel, advising on possible questions for cross-examination. In this capacity they are paid to be partisan, whilst as soon as they step into the witness box itself they are suddenly expected to act in an impartial manner."

135. Some doubt the ability of an expert to be impartial once she takes a position. *See, e.g.*, Diamond, *Fallacy of the Impartial Expert*, 3 ARCHIVES CRIM. PSYCHODYNAMICS 221 (1959) (probably the most extreme position).

136. Many experts are unwilling to participate as witnesses because they feel that the adversary system typically asks them to go beyond what the state of their specialty allows. The expert and his specialty may also be exposed to competency attacks and sarcasm or ridicule, depending upon the knowledgeability and tactics of opposing counsel.

This system of partisan proof exerts a powerful pressure to rationalize and scapegoat. While many lawyers castigate the jury for failure to critically evaluate evidence, they also tend to blame the expert for proffering the unreliable evidence. If we are to move beyond the current approach where the rare exclusion of scientific evidence provides little incentive for the attorney to utilize reliable and comprehensible evidence needed by the trier, we must frankly and objectively assess the needs, abilities, and constraints of the key actors in the jury system.

In summary, the jury *is* capable of accurate factfinding when provided with evidence presented in a comprehensible manner, which is either reliable, or adequately opposed. Attorneys, however, through lack of training, lack of resources, or adversarial pressures, frequently present evidence which does not meet these requirements for accurate factfinding. The existing approaches to scientific evidence fail to adequately screen unreliable or unevaluatable scientific evidence. And because these standards are linked solely to the infrequently used exclusionary sanction, they fail to provide the necessary incentive for attorneys to provide comprehensible, reliable and/or evaluatable scientific evidence. Thus, we must consider whether the rules of evidence and existing procedure permit an approach to admissibility which will provide the trier with the reliable and comprehensible scientific evidence necessary to accurately perform its function, and which can compensate for attorney disability and lack of motivation.

IV. THE RULES REQUIRE RELIABLE, COMPREHENSIBLE EVIDENCE AND OFFER "ENHANCEMENT" ALTERNATIVES TO JUDICIAL EXCLUSION

This part presents the thesis that the Federal Rules, when viewed in light of the purpose of the Rules, do suggest an approach which facilitates admission of reliable, comprehensible scientific evidence. The prevailing approaches erroneously focus on a single test for admissibility and lose sight of both the basic "will assist the trier" requirement for expert evidence and the goal of the Rules to facilitate accurate factfinding. The myopic existing approaches also ignore a number of related rules which suggest concern for reliable[137] and comprehensible evidence. This author advocates a holistic view of the Rules, one informed by the underlying concerns of Part I and the analysis of the limits, abilities, and needs of the trial system actors of Parts II and III. The starting point for discussion begins with Rule 702 which reflects *the primary or threshold* inquiry to be undertaken.[138]

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137. Reliability must be understood to comprehend the alternative that the evidence, although unreliable, is subject to sufficient exposure through comprehensible cross-examination and/or opposing witness(es) to permit the jury to adequately evaluate such unreliability.

138. The inquiry demanded by Rule 702 is *the basic* inquiry which must be undertaken under the rules with respect to scientific evidence. McCord, *supra* note 58, at 91. Despite the mandate of Rule 702, few courts conduct the "will assist" inquiry satisfactorily. McCord identifies two problems. "First, many courts do not realize that the 'will assist' inquiry is not only the dominant inquiry to be made, but in fact the *only* inquiry to be made" vis-a-vis expert testimony. *Id.* at 91 (footnotes omitted) (emphasis added). It subsumes all other questions of relevance, unfair prejudice, and reliability. "The second problem with the courts' application of the 'will assist' inquiry is that it is usually superficially performed, which leads to conclusory results that

A. Article VII and the "Will Assist" Requirement; The Heart of the Analysis

The basic modern requirement for expert and scientific evidence is Federal Rule 702.

> If scientific, technical, or other specialized knowledge *will assist the trier of fact to understand the evidence or 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.[139]

Rule 702 removes the requirement imposed by some older cases that the subject matter be "beyond the ken" of the jury and requires only that the specialized knowledge "will assist" the trier of fact.[140] The Rule appropriately recognizes that even though the trier may have some familiarity with the subject matter of the proposed testimony, an expert may be able to shed further light on the subject or may possess skills in processing the information and drawing inferences therefrom not possessed by the trier.[141] Several factors suggest however that the Rule does not imply that expert evidence should be admitted uncritically simply because a qualified expert can be found to testify about a potentially helpful subject matter.[142]

The expert's knowledge must *improve* the ability of the trier of fact "to understand the evidence or to determine a fact in issue." The advisory committee note reflects this requirement:

> "There is no more certain test for determining when experts may be used than the common sense inquiry whether the untrained layman would be qualified to determine intelligently and to the best possible degree the particular issue without enlightenment from those having a specialized understanding of the subject involved in the dispute.". . . When opinions are excluded, it is because they are *unhelpful* and therefore superfluous and a *waste of time*.[143]

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are more matters of gut-level feeling than informed analysis." *Id.* at 92. While McCord's article refers specifically to psychological evidence, his analysis is applicable to scientific evidence in general.

139. FED. R. EVID. 702 (emphasis added).

140. C. MCCORMICK, MCCORMICK ON EVIDENCE § 13 (E. Cleary 3d ed. 1984) [hereinafter MCCORMICK ON EVIDENCE]. California Evidence Code § 801(a) provides what may be the clearest definition of the standard: the testimony is related to a subject that is "sufficiently beyond common experience that an opinion of an expert would assist the trier of fact."

141. FED. R. EVID. 702 advisory committee's note. *See also* Frazier & Borgida, *Juror Common Understanding and the Admissibility of Rape Trauma Syndrome Evidence in the Court*, 12 LAW & HUM. BEHAV. 101, 102 (1988); Handler, *The Judicial Pursuit of Knowledge: Truth and/or Justice*, 41 RUTGERS L. REV. 1, 8 (1988).

142. One of the major problems in application of the admissibility standards for scientific evidence is the tendency to allow one who is familiar with a helpful subject matter to testify about a subject which is potentially helpful. *See, e.g.*, Mannino v. Int'l. Mfg. Co., 650 F.2d 846 (6th Cir. 1981) (not necessary that expert have knowledge of or experience with the particular subject matter if she has general background).

143. FED. R. EVID. 702 advisory committee's note (citing Ladd, *Expert Testimony*, 5 VAND. L. REV. 414, 418 (1952)) (emphasis added). McCormick states the matter affirmatively: "Rule 702 should permit expert opinion even if the matter is within the competence of the jurors

The specialized knowledge is thus "unhelpful and a waste of time" where the trier can do as good a job without the expertise.

This type of specialized evidence is thus, by definition, different from evidence presented by ordinary witnesses. We assume that the trier of fact can evaluate ordinary evidence. But we recognize that in some situations, the assistance of someone with specialized knowledge will maximize the trier's role of factfinding. The trier *must* be largely unfamiliar with the substance of the expert evidence or it is redundant. This potential of the specialized evidence to assist the trier comes with a concomitant potential to mislead the trier because of the trier's relative unfamiliarity.[144]

The argument that all scientific testimony from a qualified witness should be admitted is simply wrong. The rationale behind this liberal admissibility argument is that flawed testimony will fall of its own weight or that flaws will be exposed by cross-examination and opposing witnesses.[145] But the requirement of Rule 702 that the expert testimony be *beyond* the common experience of the trier suggests that the evidence will seldom fall of its own weight. And the earlier discussions of lawyer limitations and inequality of resources demonstrate that impediments also exist to effective challenge of scientific evidence. Thus the rationale behind the liberal admissibility position is badly flawed because it ignores the important differences between scientific evidence and ordinary evidence. The checks which normally exist for ordinary evidence most often do not apply to scientific evidence.[146]

While the drafters of Rule 702 recognized that expertise should be encouraged where it is helpful to the trier, they were undoubtedly aware of the problems of scientific evidence in drafting Article VII. The drafters did not state that the evidence is admissible when it *might* help the trier. Rather, they urged that such expertise *facilitate* an "intelligent evaluation of [the] facts."[147] The drafters required that the specialized knowledge "*assist* the trier . . . *to understand* the evidence or to *determine a fact in issue*. . . ."[148] The choice of language reflects a belief that the specialized knowledge may, but will not necessarily, assist the trier. Unreliable and incomprehensible scientific

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if specialized information will be helpful." MCCORMICK ON EVIDENCE, *supra* note 140, § 13, at 33.

144. In fact, misleading evidence can have substantial dysfunctional consequences. Johnston identifies three such consequences. Johnston, *Court-Appointed Scientific Expert Witnesses: Unfettering Expertise*, 2 HIGH TECHNOLOGY L.J. 249 (1988) (discussing the high institutional costs of allowing merely competent expertise). First, where incompetent, underqualified or seriously biased expertise is admitted, the system loses credibility as a truth finder. Second, the factfinder becomes more cynical about the value of expert testimony and tends to ignore the testimony where it is necessary. Third, when the experts' expertise is often sacrificed to partisan presentation, we settle for competence rather than trying to assist the trier by gaining understanding. *Id.* at 251-52.

145. 2 J. WIGMORE, WIGMORE ON EVIDENCE § 659, at 897 (J. Chadbourn rev. ed. 1979).

146. The question of checks or safeguards is one of degree. The problem of competence and lack of adequate resources affects the presentation of and opposition to ordinary evidence as well. Yet the problems are exacerbated when the attorney neither understands the subject matter nor has the resources to hire the services of someone who can assist her. The problem seems most acute when the offer involves highly specialized and novel evidence, *i.e.* largely inaccessible scientific evidence.

147. FED. R. EVID. 702 advisory committee's note.

evidence simply will not assist the trier to understand the evidence or accurately determine a fact in issue; such evidence obfuscates rather than leads to an "intelligent evaluation" of the facts.

Rule 703 reinforces the notion that the court should require that the scientific evidence be reliable.[149] The Rule impliedly allows for two types of expert testimony: testimony where the underlying basis is itself admissible, and testimony in the form of an opinion where the underlying basis is *not* necessarily admissible.[150] Under the first type, if the underlying evidence is admissible, it must meet the hurdles imposed by the Rules which ensure that the trier of fact is insulated from unreliable evidence.[151] Hearsay,[152] which might be used as the basis for an expert's testimony, is prohibited primarily because the out-of-court evidence is not subject to cross-examination which could expose the possible unreliability of the evidence.[153]

With the second type of testimony, Rule 703 provides for an option upon which the expert may base her opinion: "If of a type *reasonably relied* upon by experts in the particular field in forming opinions or inferences upon the subject, the facts or data *need not be admissible* in evidence."[154] Rule 703 recognizes that some of this "underlying" evidence which could not be introduced or could be introduced into evidence only at great cost is in fact frequently used by reputable experts.[155] The advisory committee opined that an expert's validation of the evidence in the form of her reasonable reliance, subject to cross-examination, "ought to suffice for judicial purposes."[156] The rule says that reasonable utilization by experts in the field can serve as a surrogate for rules of evidence concerned with ensuring reliable evidence and/or cross-examination of the original source of the evidence. While intending to expand the basis for expert testimony the drafters acted to ensure that the

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148. FED. R. EVID. 702 (emphasis added).

149. FED. R. EVID. 703.

> The facts or data in the particular case upon which an expert bases an opinion or inference may be those perceived by or made known to the expert at or before the hearing. If of a type reasonably relied upon by experts in the particular field in forming opinions or inferences upon the subject, the facts or data need not be admissible in evidence.

Id.

150. The authority for allowing expert opinions is inferred from the second sentence of Rule 703: "If [the underlying facts or data are] of a type reasonably relied upon by experts in the particular field . . . the facts or data need not be admissible into evidence." The advisory committee's note to Rule 702 explains the traditional bases for the expert's opinion.

151. The rules of evidence serve a number of functions, one of which is to address the concern for presenting reliable evidence. The concern has commonly been attributable, at least since Thayer, to the use of lay jurors. *See, e.g.*, R. CARLSON, E. IMWINKELRIED & E. KIONKA, MATERIALS FOR THE STUDY OF EVIDENCE 13 (2d ed. 1986) [hereinafter R. CARLSON]. For a recent critique of this concern and of its continuing attribution to the use of lay jurors, see Nance, *The Best Evidence Principle*, 73 IOWA L. REV. 227, 278-94 (1988).

152. *See* FED. R. EVID. 801-02.

153. MCCORMICK ON EVIDENCE, *supra* note 140, § 245, at 728.

154. FED. R. EVID. 703 (emphasis added).

155. Rule 703 permits experts to rely on facts or data "reasonably relied upon" by other experts in the field. This category amounts to formal recognition, not openly sanctioned until adoption of the Rules, of what has long been the reality: "*Necessarily*, experts rely on facts and data that receive no mention at trial." C. MUELLER & L. KIRKPATRICK, EVIDENCE UNDER THE RULES 720 (1988) [hereinafter EVIDENCE UNDER THE RULES].

156. FED. R. EVID. 703 advisory committee's note.

expert's validation be reasonable as measured by prevailing standards in the particular field. Rule 703 thus calls upon the court to require a showing by the proponent that the underlying facts or data are reliable.[157]

Rule 703 has recently been the focus of a number of cases in which the courts excluded expert evidence on the basis of lack of reliability. The seminal influence is the opinion in the Agent Orange case.[158] Judge Weinstein noted that the plaintiffs' medical diagnoses were largely based upon selective medical data collected by their attorneys and failed to account for epidemiologic evidence. He ruled that the opinions were inadmissible and summary judgement was proper.[159]

In another toxic tort case, the Fifth Circuit recently sustained the exclusion of an osteopathic physician's testimony relating to the issue of causation.[160] The lower court acknowledged that "courts have afforded experts wide latitude in picking and choosing the sources on which to base opinions", but pointed out that "Rule 703 nonetheless requires [the] courts to examine the reliability of those sources."[161] In affirming, the circuit court stressed the relationship between reliability and "assisting the trier":

> This opinion simply lacks the foundation and *reliability* necessary to support expert testimony. As an unsupported opinion, it does not serve the purposes for which it is offered, that is, *objectively to assist the jury in arriving at its verdict.*[162]

The courts have thus begun to examine the "will assist" requirement of Rule 702 in conjunction with the more explicit concern for reliability expressed in Rule 703.[163]

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157. The extent to which the court can second-guess the reasonableness of the reliance by the expert is not clear. As Mueller and Fitzpatrick note, "the intent of Rule 703 is to be generous in admitting expert testimony, . . . [b]ut courts have not always accepted expert opinions as reasonably based." EVIDENCE UNDER THE RULES, *supra* note 155, at 720-21.

158. *In re Agent Orange*, 611 F.Supp. 1223.

159. *Id.* at 1243-55. Judge Weinstein also ruled that, even if admissible under Rule 703, the opinions had so little probative value as to warrant exclusion under Rule 403. *Id.* at 1255-56.

160. Viterbo v. Dow Chemical Co., 826 F.2d 420 (5th Cir. 1987).

161. Viterbo v. Dow Chemical Co., 646 F. Supp. 1420, 1424 (E.D. Tex. 1986), *aff'd*, 826 F.2d 420 (5th Cir. 1987).

162. *Viterbo*, 826 F.2d at 424 (emphasis added).

163. *See, e.g.*, Richardson v. Richardson-Merrell Inc., 857 F.2d 823 (D.C. Cir. 1988) (one of several recent cases rejecting expert opinion based upon animal, test tube and chemical structure studies, on opinion that was contradicted by a scientific consensus based upon epidemiological studies). *Compare In re* Japanese Elec. Prod. Antitrust Litig., 723 F.2d 238, 276 (3d Cir. 1983) (presenting a more deferential approach to the expert's opinion — allowing the court little latitude to second guess the expert's "reasonable reliance" under Rule 703), *rev'd on other grounds sub nom.* Matsushita v. Elec. Indus. Co. Ltd. v. Zenith Radio Corp., 475 U.S. 574 (1986).

I do not endorse an overly expansive use of the power to exclude expert evidence under the "will assist" and "reasonable reliance" criteria of Rules 702 and 703. The above cases may represent a backlash to the overly expansive approach criticized earlier in this section. *See supra* note 142 and accompanying text. The analysis in this part suggests that Rule 703 reinforces the basic reliability concern of Rule 702, not that Rule 703 was intended as an antidote to the potentially poisonous Rule 702.

Given the plaintiff's burden of demonstrating causation and the typical unavailability of conclusive scientific evidence, too restrictive an approach to admissibility typically favors the

The fact that the drafters of the Federal Rules not only did not eliminate *Frye*, but selected the wording of Rule 703 — "of a type reasonably relied upon by experts in a particular field" — to track, in a more modern form, the general acceptance concept of *Frye*, reaffirms the drafters' concern for reliable evidence. Because the drafters made no explicit mention of *Frye*,[164] commentators debate whether they intended to do away with *Frye*. The more plausible explanation is that the drafters intended to give the judge ample discretion to exclude unreliable evidence, at least where novel scientific evidence was being presented.[165]

In addition to the reliability concerns embodied in Rules 702-03, Rule 705 explicitly gives the judge discretion to require that the proponent elicit the "underlying facts or data" for the expert's opinion prior to presentation of that opinion.[166] The drafters were primarily concerned with eliminating the need to employ the much-criticized hypothetical question.[167] The drafters note that elimination of this requirement was fair in light of discovery and cross-examination.

Rule 705 does not enumerate situations in which the court should require exposition of the underlying facts or data.[168] Rule 611, however, provides the necessary guidance:

> The court *shall* exercise reasonable control over the mode and order of interrogating witnesses and presenting evidence so as to (1) make the interrogation and presentation effective for the ascertainment of the truth. . . .[169]

The advisory committee's note to Rule 611 indicates that the Rule reflects "the power and obligation of the judge as developed under common law principles" and that "[t]he ultimate responsibility for the effective working of the adversary system rests with the judge."[170] The import of Rules 705 and 611 is that the judge has the *duty* to intervene to ensure that the presentation of scientific evidence is effective for the ascertainment of truth — *i.e.*, both reliable and comprehensible.[171]

The concern that scientific evidence must enable the trier to perform effectively is further reflected in Rule 706 which allows the court to appoint its own expert. That Rule,[172] intended to moderate partisan excess, empowers the

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defendant. For this reason, some advocate admitting relatively controversial evidence, such as animal studies. *See, e.g.*, FOURTH INTERIM REPORT OF THE MASS. SPECIAL LEGISLATIVE COMM. ON LIABILITY FOR RELEASES OF OIL AND HAZARDOUS MATERIALS 64-65 (1986).

164. FED. R. EVID. 702 advisory committee's note.

165. Mengler, *supra* note 66, at 448-49.

166. FED. R. EVID. 705.

167. FED. R. EVID.705 advisory committee's note. The hypothetical question required the proponent of opinion evidence to direct a question to the expert incorporating all of the crucial facts that served as the bases for the expert's opinion. While this exposes the underlying bases for the trier's scrutiny and facilitates cross-examination, the hypothetical is poorly utilized by some lawyers and exploited by skillful practitioners. The format led to frequent objection, argument, and appeal as well as lengthy questions which confused rather than assisted the trier.

168. *Id.*

169. FED R. EVID. 611(a) (emphasis added).

170. FED. R. EVID. 611 advisory committee's note.

171. *See* FED R. EVID. 102. *See also* Part IV(B), *infra*.

172. FED. R. EVID. 706.

court to take positive steps to enhance the quality of the evidence rather than to merely apply the exclusionary sanction.

Two recent proposals for amendment of the Rules must be noted. These proposals reflect both the concern for reliability *and* the ability of Article VII to meet this need. In the second *Symposium on Scientific Evidence* commentators proposed amendments addressing the inadequacies of the Rules. One proposal inserted the word "reliable" before the words "scientific, technical, or other specialized knowledge" in Rule 702.[173] The second proposal added the following sentence to Rule 702:

> In the case of expert testimony based upon a scientific theory or technique, the court shall find that the theory or technique in question is scientifically valid for the purposes for which it is tendered.[174]

Both commentators assert that while there is uniform agreement that all scientific evidence ought be reliable, the prevalent approach to the Rules provides insufficient guidance to the courts as to how to ensure such reliability.[175] Lederer and many others assert that unless Rule 702 is viewed as providing a reliability requirement, the meager demands of logical relevancy and the language of Rule 403 pose significant risks that unreliable evidence will be admitted.[176] An amendment to Rule 702, however, is unnecessary if the courts carefully look to the language of Article VII and consider what will assist the jury.[177]

Most analyses of the problem fail to focus on what is required to implement the basic "will assist" requirement for scientific evidence. The drafters were aware of the legitimate concerns about scientific evidence and its potential

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173. Lederer, *Resolving the Frye Dilemma—A Reliability Approach*, 26 JURIMETRICS J. 240, 241 (1986).

174. Starrs, *Frye v. United States Restructured and Revitalized: A Proposal to Amend Federal Evidence Rule 702*, 26 JURIMETRICS J. 249 (1986).

175. Unfortunately, Lederer or Starrs provide little discussion of how reliability or validity is to be defined. *See supra* notes 173-74. This paper relies on the conceptual standard of the neutral scientist — whether a *qualified, neutral* scientist would regard the underlying scientific principles and procedures as sufficiently validated by his peers to merit serious recognition in the particular context in which the evidence is being offered. The utilization of this standard is described in depth at Part VI, *infra*.

176. Lederer, *supra* note 173, at 242. A third proposal would place the burden on the proponent to demonstrate a high degree of probative value to eliminate the risk of unreliable scientific evidence. Berger, *A Relevancy Approach to Novel Scientific Evidence*, 26 JURIMETRICS J. 245 (1986). Berger proposes amending Rule 702 to require that where "a scientific principle or technique has not previously been accorded judicial recognition, the testimony shall be admitted if the court determines that its probative value outweighs the dangers specified in Rule 403." *Id.* at 245.

Unfortunately, Berger does not specify the locus, extent or quality of judicial recognition required. An inquiry into this ill-defined area might be unproductive and might detract from the more important concern that evidence is sufficiently reliable and is presented in a manner which facilitates rather than detracts from the trier's task of accurate factfinding. The dangers are not confined to "novel" scientific evidence. Prior judicial recognition can be a poor indicator of reliability and, even if it was an accurate indicator, such recognition may not have arisen in a situation analogous to the current one. *See* Part VI, *infra*, at note 314 and accompanying text.

177. An amendment to Rule 702 which would define reliability more clearly than the two suggested amendments would be helpful. However, any such amendment should require that the evidence be reliable and that the *form of presentation* ensure comprehensibility.

to help or befuddle the trier. While they wanted to facilitate use of expert evidence, they chose the "will assist" language to ensure that evidence meets the larger goals of fairness and accurate factfinding. They reinforced that language with a "deemed reliable by experts in the field" requirement for evidence not admitted and subject to traditional reliability criteria. They failed to abrogate the *Frye* test, and used the language of Rule 703 to track *Frye*'s concern for reliable evidence. The drafters also addressed the *form* of the evidence, allowing the judge to require alteration of the form of the offer to *ensure* that the evidence be comprehensible. Finally, the drafters authorized the judge to take an *active* role in enhancing the quality of the evidence: she has the ultimate responsibility for maximizing the truth-finding process, and to this end to utilize a number of tools to ensure that truly helpful evidence is presented.

B. Rule 403: An Approach Which Meets the Goals of the Rules and Tracks Rule 702.

Rule 403, as currently utilized, has proved ineffective in and of itself in assuring reliable and comprehensible evidence.[178] Yet Rule 403 can be effective in assuring reliable, comprehensible evidence when viewed holistically with Article VII and the other evidence rules.

Three reasons *require* a reconsideration of the role of Rule 403 in the admissibility of scientific evidence. First, Rule 403 has already been the focus of much discussion dealing with the problems of scientific evidence which recognizes the potential of Rule 403 to exclude unreliable scientific evidence. There has been, however, a failure to realize that promise. Second, that promise *can* be realized by redefining the inquiry to be undertaken when examining an offer of scientific evidence under Rule 403. This redefinition must reflect that *the concerns underlying Rule 403 parallel those of Article VII.* Third, absent this analysis, Rule 403 may continue to be an impediment to careful scrutiny of offers of scientific evidence rather than a tool used in conjunction with Article VII to ensure reliable and comprehensible evidence. When used in an isolated context, the language and structure of Rule 403, and its sister rule, Rule 402, have resulted in an overly liberal approach to admissibility.

1. The Conventional Wisdom: How Rule 403 Allows Exclusion of Unreliable and/or Incomprehensible Evidence.

Rule 403 allows the court to exclude otherwise relevant evidence where the court determines that the probative value of the evidence is substantially outweighed by one or more of a list of "considerations" and "dangers."[179] It is customary to divide these concerns of Rule 403 into three clusters: unfairly prejudicial evidence, evidence which confuses the issues or misleads the jury, and evidence which is a waste of time.[180]

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178. *See supra* text accompanying notes 42-65.

179. FED. R. EVID. 403. "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." *Id.*

180. R. CARLSON, *supra* note 151, at 262-64 .

The first two clusters are concerned with achieving accuracy in the factfinding process. The most widely discussed cluster is the undue prejudice factor.[181] The advisory committee defines the term as follows: "'Unfair prejudice' within its context means an *undue tendency* to suggest decision *on an improper basis*, commonly, though not necessarily, an emotional one."[182]

Although the unfair prejudice jurisprudence usually focuses on the possibility of a trier's negative emotional reaction to the evidence,[183] both the advisory committee and the commentators recognize that unfair prejudice is not limited to emotional reactions.[184] The traditional focus on emotional reaction has been criticized for failing to recognize that appeals to *faulty logic* are as dangerous to accurate factfinding as improper emotional appeals.[185] It is the former that are at stake with scientific evidence. Whether the proper focus be improper bias or illogic, the advisory committee's note underscores the common ground of each — "the undue tendency to suggest a decision on an improper basis." When the evidence would interfere with rational factfinding, evidence should be excluded under the unfair prejudice consideration. Because *unreliable* or *incomprehensible* evidence will tend "to suggest a decision on an improper basis," these concerns are comprehended by the Rule.

Similarly, the second cluster also addresses the reliability and comprehensibility concerns. The second cluster — "misleading to the jury" and "confusion of the issues" — are the criteria most commonly used for exclusion of scientific evidence.[186] Commentators note the potential of scientific evidence (and experts) to lure the jury into overvaluing the evidence.[187] This conventional outlook, although based upon an erroneous view of the jury, does seem appropriate when there is insufficient evidence of reliability, or when the trier is denied adequate testimony to evaluate the evidence properly. The "confusion of the issues" factor may coalesce with the misleading factor. The danger which the confusion counterfactor addresses is that a clash over the evidence may create a side issue which will unduly distract the jury from the main issues and/or create confusion which obscures the kernel of the controversy.[188]

The third cluster also comprehends these concerns. This "waste of time" cluster includes the three counterfactors, undue delay, waste of time, and needless presentation of cumulative evidence.[189] This waste of time cluster is "a concession to the shortness of life," and is concerned with efficiency in factfinding. The basic question is whether an unsuitable amount of time will be

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181. There is a tendency to subsume discussion of the other two clusters within the cluster of undue prejudice. C. WRIGHT & K. GRAHAM, *supra* note 41, § 5215, at 273-74.

182. FED. R. EVID. 403 advisory committee's note (emphasis added).

183. The concept is reflected in the rules governing the admissibility of character evidence; *i.e.* the rules governing the admissibility of evidence of prior crimes. FED. R. EVID. 404.

184. C. WRIGHT & K. GRAHAM, *supra* note 41, § 5215, at 275.

185. R. CARLSON, *supra* note 151, at 262; C. WRIGHT & K. GRAHAM, *supra* note 41, § 5215, at 275.

186. *See, e.g.*, WEINSTEIN'S EVIDENCE *supra* note 42, ¶ 403[04], at 403-65.

187. M. GRAHAM, HANDBOOK OF FEDERAL EVIDENCE § 403.1, at 185 (2d ed. 1986); C. WRIGHT & K. GRAHAM, *supra* note 41, § 5217, at 293.

188. M. GRAHAM, *supra* note 187, § 403.01, at 184-85.

189. FED. R. EVID. 403.

consumed by the evidence in light of the importance of the issue, the availability of other evidence, and the probative value of the offer.

There may be cases where, without court control, lengthy and/or poor presentations of opposing expert testimony will cancel each other out, and leave no rational basis for deciding the credibility of the respective versions. In this situation, there is overlap between the efficiency "considerations" and the misleading/confusion cluster of "dangers."[190] Although the standard for excluding probative evidence on the basis of administrative efficiency should seemingly be higher than for exclusion of evidence on grounds which distort rather than merely delay the process,[191] the court may choose the more easily definable delay or waste of time considerations.[192]

2. The Relationship Between Rule 403 and Article VII: An Approach To Accurate Factfinding

There are three substantial obstacles to the traditional approach to utilizing Rule 403 as the standard for the admissibility of scientific evidence — the lack of definition of the basic concepts used in the Rule, the *apparent* directive to "balance" incomparables, and the *apparent* conflict between the need to utilize Rule 403 to exclude certain unreliable or otherwise "legally irrelevant" evidence and the preference for admissibility in Rules 401-03. These problems have resulted in underutilization of the Rule to protect against unreliable evidence. When the Rule is invoked the courts have typically merely excluded the evidence rather than analyzed why the dangers outweigh the probative value. The underuse and misuse of the Rule reflects the definitional inadequacy and the difficulties of balancing incomparables more than a conscious non-effort to balance the apparent tension between the preference for admissibility and the need to preclude use of unreliable evidence.[193]

This typical approach to Rule 403 in the scientific evidence context is deficient *primarily* because it fails to consider the 403 analysis in the context of the other related rules. This myopia not only results in the underuse and misuse of the Rule but it also limits the strategy available to deal with unreliable and/or incomprehensible evidence to the exclusionary sanction. This focus on the exclusionary sanction fosters underutilization of the Rule because outright exclusion has such a draconian effect on the proponent's case.

There is a more coherent way to approach the Rule 403 analysis which obviates these problems, and which additionally suggests an "enhancement of the evidence" strategy rather than an exclusionary one. This strategy resolves what is only an *apparent* conflict between the admissibility and safeguarding policies and eliminates the need to balance incomparables. The remainder of

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190. WEINSTEIN'S EVIDENCE, *supra* note 42, ¶ 403(04), at 403-79 to 403-80.

191. The structure of the original proposed rule which would have posed a higher standard to exclude evidence based on the "considerations" and the current terminology which categorizes this cluster as "considerations" rather than "dangers," suggests that this third cluster is a less weighty one than the other two. *See* Lewis, *supra* note 47, at 320 n.114.

192. *But see, e.g.*, WEINSTEIN'S EVIDENCE, *supra* note 42, ¶ 403[04], at 403-79.

193. The combination of these factors also helps to explain the reluctance of those concerned with reliability of the evidence in criminal cases to move away from what may appear to be a more meaningful and easier to apply trump card — the *Frye* doctrine.

this part is devoted to describing the approach and laying the groundwork for the "enhancement" strategy.

It is important to put the general preference for admitting evidence into its proper perspective. Traditionally the preference for admissibility has operated in conjunction with the more important principles of reliability of the evidence and accurate factfinding. Some potentially relevant evidence has always been excludable *per se* by the rules because its unreliability might not be perceived by the trier of fact. Rules 801 and 802[194] reflect a judgment that certain kinds of hearsay evidence are not sufficiently reliable or susceptible to adversarial challenge to advance accurate factfinding. The non-specific formulation of many of the rules demonstrate the drafters' mandate that discretion to exclude *must* be accorded the judge because of the diversity of potential situations to which the rules must be applied.[195] Rule 702 is a prime example:[196] not all specialized knowledge is sufficiently reliable to form the basis of accurate factfinding nor can such specialized knowledge always be presented in a manner which assists the trier. The drafters intended that Rule 403 be a meta-rule allowing the judge broad discretion to exclude evidence which otherwise passes muster under the minimal relevance requirements of the Rules.[197] These specific mandates for discretion contained in individual rules,

194. FED. R. EVID. 801, 802.
195. Mengler, *supra* note 66, at 447.
196. *Id.* at 447-48.
197. Although the commentators recognize the broad discretion, courts and commentators sometimes point to the "substantially outweigh" language of Rule 403 as a limit on the discretion. The "substantially outweigh" language is an enigma. Discussions of the power to exclude otherwise relevant evidence indicate that the power pre-dated modern attempts to formulate rules of evidence. *See, e.g.*, Dolan, *Rule 403: The Prejudice Rule in Evidence*, 49 S. CAL. L. REV. 220, 222-23 n.5 (1976). *See also* WEINSTEIN'S EVIDENCE, *supra* note 42, at ¶ 403[01].

The initial attempt to formulate a set of model rules omitted the "substantially" language. MODEL CODE OF EVIDENCE Rule 303 (1942). "That provision served as the lightning rod for a large part of the abuse which the Model Code drew, ultimately contributing to the legislative defeat the code suffered in every jurisdiction." Dolan, *supra*, at 221-22. The Federal Rules advisory committee's note, however, does not explain why the "substantially" language was utilized. *See* WEINSTEIN'S EVIDENCE, *supra* note 42, ¶ 403[01], at 403-07. Judge Weinstein and Professor Berger refer to the language of Rule 403 as "ambiguous," but indicate "the broad power of the judge to characterize proffered evidence in light of the special circumstances of each trial." *Id.* at 403-07. Several contemporary state rules utilized the language, and some case law adopted functionally equivalent language. *See, e.g.*, CAL. EVID. CODE § 352 (West 1966). *See also* Dolan, *supra*, at 235 n.55. A review of the cases decided as of the effective date of the adoption of the Federal Rule concluded that the difference between the Model Code and Federal Rule formulation was not of great practical importance; both versions reflect the general modern bias in favor of admitting relevant evidence, but the Federal version suggests a somewhat more tightfisted use of the rule. Dolan, *supra*, at 236. Undoubtedly, the drafters were aware of the poor reception accorded the unbridled discretion of the Model Code [and the initial version of the Uniform Rules which was based largely upon the Model Code]. The Uniform Rules of Evidence, promulgated by the National Conference of Commissioners on Uniform State Laws incorporated the Model Code of Evidence Rule 303 as Rule 45. HANDBOOK OF THE NATIONAL CONFERENCE OF COMMISSIONERS ON UNIFORM STATE LAWS 189 (1953). The Uniform Rules met with only slightly more success than the Model Code, serving as the basis for state evidentiary rules only in a handful of jurisdictions. Probably the drafters of the Federal Rules also felt that insertion of "substantially" would contribute to a more careful exercise of discretion to exclude. In any event, Rule 403 was accepted by the Supreme Court as proposed and received virtually no notice by Congress. Dolan, *supra*, at 221; WEINSTEIN'S EVIDENCE, *supra* note 42, at ¶ 403[01].

as well as the broader discretion mandated under Rule 403 and the underlying concern for reliable evidence and accurate factfinding, are negated if the preference for admitting relevant evidence is overemphasized.

It is extremely critical to view this preference for admissibility from the perspective of the rules as a whole. This general preference cannot be read as negating the more specific considerations of Article VII. Rather, the *primary* focus should be on the Article VII preference for reliable, comprehensible evidence and *then* on the discretionary mechanisms afforded the judge by Article VII, Rule 403, and the structure of the rules — mechanisms which *call on the judge to effectuate the larger goals of the rules.* Viewed in this light, the ambiguity of Rule 403 largely disappears, and the congruence of Article VII and Rule 403 becomes manifest. The tension between the preference for admissibility and the discretion to exclude evidence which does not contribute to accurate factfinding can be resolved in favor of a strategy of *enhancing* scientific evidence — a strategy that fosters *both* admissibility of helpful evidence and safeguarding the trier from unreliable evidence.

A starting point in resolving the tension and the ambiguity of Rule 403 is to recognize that the vague and rarely explicitly used balancing analysis is not a necessary or appropriate strategy for offers of scientific evidence. Balancing dissimilar dangers against probative value seems to be the appropriate strategy only in cases where the trier is likely to "infer more than one fact from the evidence, at least one of which is logical and at least one of which is illogical, or otherwise improper."[198]

The two problems with scientific evidence which do not require balancing, are (1) that an offer is made to cause the trier to believe the inference to an illogical degree[199] or (2) that the offer may encourage the trier to draw an inference which does not logically flow from the evidence.[200] The former occurs when the offer is unreliable, especially so when the evidence is not adequately challenged by the opponent. The latter occurs when the offer is made in a manner which is incomplete or incomprehensible, so that the jury cannot understand, evaluate and apply the evidence. If the court exercises its discretion to exclude the evidence in either of these cases, it should be because the proponent has, knowingly or willingly, offered evidence which does not assist the trier in fulfilling its role of accurate factfinding.

This interpretation of Rule 403 is supported by the work of Victor Gold. Gold recognized the relatively small role that the balancing analysis actually plays in applying Rule 403 and analyzed the Rule in a way that avoids the unnecessary and nearly impossible task of balancing probative value and counterfactors.[201] Gold used the goals of Rule 403 and of the Rules in general to explain the relationship between probative value and the counterfactors.[202]

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198. Where this danger is present, it is frequently dealt with a under Federal Rule of Evidence 105 by a limiting instruction, but it is also subject to the judge's discretion under Rule 403 to exclude the evidence where the trier is likely to make the improper inference regardless of any instruction. Gold, *supra* note 46, at 90.

199. *Id.* at 89.

200. *Id.* at 88.

201. *Id.* at 87-91.

202. Gold was concerned with the ad hoc approach to Rule 403 balancing and the underlying definitional problems described in Part I. The analysis in this section relies heavily

He demonstrated that the concept of probative value and the dangers listed in Rule 403 are concerned with accuracy or reliability of procedurally fair factfinding.[203] Gold found that the ultimate goal underlying the "dangers" of Rule 403 was not clear on from the face of the Rule.

> Rule 102, which defines the general principles underlying all the Federal Rules, is constructed similarly. Administrative concerns such as "unjustifiable expense and delay" are identified. Like Rule 403, Rule 102 implies that such concerns are inferior to a more basic goal. However, unlike Rule 403, Rule 102 identifies that goal: the ascertainment of truth in a context of procedural fairness.
>
> The nature of the dangers specified in Rule 403 suggests that the unstated primary goal of the rule is also securing truth through procedural fairness. Obviously, confusion of the issues or misleading the jury jeopardizes accurate factfinding. While the precise meaning of unfair prejudice is unclear, it is apparent that fairness is compromised by evidence that is "unfairly" prejudicial. Unfair prejudice also presents an obstacle to accurate factfinding . . . . . Emotion is therefore dangerous since it may lead to inaccuracy.[204]

Gold views Rule 403 as a manifestation of the principle that concern for truth or fairness may properly override a more specific rule of admissibility.[205] He sees probative value and the dangers as opposite sides of the same coin: "[i]f probative value refers to the capacity of evidence to produce a judgment based on accurate factfinding, the unfair prejudice must refer to the capacity of evidence to subvert that objective."[206] In Gold's view, the primary focus of Rule 403 is whether the trier can use the evidence in a way that will "add to rather than detract from accurate factfinding."[207]

This focus on accurate factfinding provides a more coherent way to approach an offer of scientific evidence — it *requires* the judge to inquire whether or not the offer is made to improve the trier's ability to accurately determine an issue of consequence. This focus is consistent with the *abilities* of both the judge and the jury. In contrast to the erroneous concern of protecting the parties from an irrational fact finder, the judge is asked to protect the presumptively competent trier "from actions attributable to understandable

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on Gold's insightful attempt to provide a principled approach for the vast majority of Rule 403 problems because his approach is particularly helpful with scientific evidence. (I do, however, take issue with Gold's position that the judge can and should predict the inferential process that the jury will utilize in response to the offer. *See infra* note 208). *See also* Mengler, *supra* note 66, at 438-39, for a discussion of the concept of discretion in the Rules, and for authority for resorting to Rule 102 to clarify the analysis of the goals of Rule 403.

203. Gold, *supra* note 46, at 64-73.
204. *Id.* at 65-66.
205. *Id.* at 66.
206. *Id.* at 79.
207. *Id.*

biases or weaknesses of parties, their witnesses, and of course, their lawyers."[208]

Dale Nance builds on this argument by pointing out that the vast majority of inadmissible offers involve evidence that is (often knowingly) incomplete or less valuable than alternative forms within the control of the proponent,[209] and thus will not enhance the trier's ability to accurately find facts. The judge has a much fuller appreciation than the lay trier of lack of attorney preparation, tactical maneuvering, resource constraints, and the economics of litigation in general — factors which affect the way evidence is adduced[210] and which may deprive the trier of necessary tools.

Focusing on the capacity of evidence to advance accurate factfinding suggests that the judge must look beyond the purely logical connection between the offer of scientific evidence and the fact to be proved. The capacity to produce an accurate view of the facts cannot be reliably measured simply by reference to the inferences logically deducible from the evidence,[211] especially with respect to scientific evidence where experience and common sense do not provide an adequate basis to evaluate the evidence. "[T]he value of evidence to the jury is a function not of its intrinsic worth, but of its usefulness in the context within which it is offered."[212]

The context in which the court determines the potential to enhance or detract from accurate factfinding should include the other evidence offered by the parties as well as the alternative evidence reasonably accessible to the proponent. The "ability" of an offer to enhance factfinding is a function both of related evidence to be presented by the parties which may enable the trier to comprehend and evaluate the offer, and of other possibly more reliable evidence that may be reasonably available. The analysis of the offer's ability to enhance accurate factfinding requires that the judge consider whether the presentation will be coherent[213] and whether the evidence will be selectively presented. The ability to further the truth-finding goal is also a function of the opponent's ability to oppose the evidentiary offer. If the court fails to take context into account in making its assessment of probative value, the court will base its assessment on "some theoretical maximum with no connection to

208. Nance, *supra* note 74, at 291. While Gold would attempt to predict the impact of the evidence on the jury by anticipating the inferential process the jury will likely employ when evaluating the evidence, Nance is highly critical of this suggestion and points to indications that judges are not able to make such a prediction. *Id. Compare with* Gold, *supra* note 46, at 68. Although Gold builds from the work of Kalven and Zeisel and sees jury lapses as rare and occurring primarily when the meaning of the evidence or the proper inferences to be drawn from the evidence are unclear, Nance seems to have the better of the argument. *See* Gold, *supra* note 46, at 89.

209. Nance, *supra* note 74, at 286.

210. *Id.* at 291.

211. *Id.* at 274. The logical relevance is a function of the number of intermediate inferences which must be drawn between the offer of evidence, the "fact that is of consequence to the determination of the action," and the relative strength of these inferences. *See also* FED. R. EVID. 401.

212. Gold, *supra* note 46, at 174.

213. *Id.* at 76.

reality", and the weighing process will be improperly distorted in favor of admissibility.[214]

The suggested approach allows the judge to focus the Rule 403 analysis on a single question. But more importantly the Rule 403 analysis parallels and reinforces the "will assist" inquiry of Rule 702: the court is asked to consider the offer in a broad context and inquire whether the offer is made in a manner which will assist the trier in performing its role. By examining the offer in context rather than solely with a view to logical probative value the judge can identify those factors which might make the offer *unlikely* to assist the trier to understand the other evidence or accurately determine a fact in issue. When these factors are identified, the judge can then communicate these problems to the attorneys and work *with* the attorneys to alleviate at least some of them. The judge may then effectuate the goals of Rule 702 and the Rules in general — to facilitate the admission of scientific evidence which assists the trier. The judicial strategy thus can and should be changed from a passive choice between admissibility and exclusion to an active enhancement one. This approach promotes admission of reliable and comprehensible evidence. The preference for admissibility can thus be fostered by the enhancement strategy without sacrificing the larger goals of the Rules. Under this approach, the exclusionary sanction would not disappear but would be utilized only when the enhancement strategy fails to produce an offer which meets the larger goals of the Rules.

In summary, the Rules provide a coherent mode of analysis and strategy for dealing with controversial offers of scientific evidence.[215] It remains to be demonstrated, however, that the enhancement approach can be practically implemented in a manner which meets the needs of the trier and is consistent with the role of the judge in our procedural system.

V. THE SUGGESTED ROLE FOR THE JUDGE: ENHANCEMENT OF ATTORNEY OFFERS WHICH ARE NOT RELIABLE AND/OR COMPREHENSIBLE

As Part I demonstrated, the existing approaches to admissibility — grounded on the little used exclusionary sanction — have often led to the

214. *Id.* at 77.

215. While this paper has not discussed the second meta-goal of the Federal Rules of Evidence — "fairness of the procedure" — the foregoing suggestions seem likely to advance that goal as well. Part I indicated that the concerns for admitting unreliable evidence were particularly acute with respect to criminal cases where discovery is typically inadequate and the disparity of forensic resources is great. If courts look to the "fairness of procedure" goal and examine the offer in a broad context, many of the fairness concerns which are not typically raised in invoking *Frye* might surface for more explicit discussion. A contextual analysis requires that Rule 403 be interpreted consistently with the sixth amendment right of effective assistance of counsel and right to confront witnesses to enable litigants to expose defects in the evidence that may mislead a jury. The focus on the fairness of the procedure is consistent with due process concerns. For example, if the defendant is unable to secure an expert to assist in opposing arguably unreliable evidence, the trier will be deprived of evidence necessary to evaluate the offer and the defendant will be deprived of a fundamentally fair procedure. Thus, the judge ought be more solicitous of the defendant in a criminal case where constitutional requirements merge with fairness goals than in civil litigation under similar circumstances. Nonetheless, the contextual factors implicate fair procedure in civil cases as well. *See, e.g.*, FED. R. CIV. P. 1, 26(b)(1)(iii).

admission of unreliable evidence. Part II demonstrated that the jury can understand, evaluate and apply scientific evidence, but that the jury requires comprehensible and reliable evidence to perform its role. Part III demonstrated that attorneys frequently do not provide the reliable and comprehensible evidence needed by the trier. This failure is due to attorneys' lack of familiarity with scientific methodology and lack of resources, and/or adversarial pressures to utilize evidence that will win the case rather than reliable and comprehensible evidence.[216]

A major theme of these first three parts was that resolution of a scientific question is qualitatively different from resolution of an historical fact question. Unlike the scientific question, the lay trier has an adequate experiential basis to critically evaluate the evidence in historical fact questions. Part IV demonstrated that the rules governing admissibility must be read to reflect the reality that scientific evidence is different. These rules, when read as a whole, require that scientific evidence be reliable and comprehensible to meet the "will assist" threshold and the goal of accurate factfinding.

The necessary conclusion is that we need an approach to admissibility of scientific evidence that proceeds from the core concern of accurate lay factfinding. This requires moving beyond a deceptively simple but elusive test for scientific evidence and the exclusive reliance on the little used exclusionary sanction. This approach *must* utilize *all* the Rules *as well as* available procedural tools to ensure that the lay trier is provided with comprehensible and reliable scientific evidence. This approach requires a more active, thoughtful and flexible role for the judge that actively "enhances" the evidentiary offer rather than passively focusing on the admission decision. The judge must utilize the tools available to provide incentives for the attorneys to supply reliable and comprehensible evidence. When such incentives and efforts fail to result in reliable and comprehensible offers, the judge must be prepared to utilize the special resources available to her via the procedural and evidentiary rules to secure that evidence.

A. The Great Irony: Modern Underutilization of Traditional and More Recent Judicial Tools

Early in the history of the judicial system, courts recognized the need for skilled witnesses to assist the trier in deciding matters beyond the trier's common experience.[217] For several centuries, the court called these witnesses,

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216. Judge Higginbotham made several important observations which point out the interrelationship between the actors in the justice system. First, when a judge or a jury tries a case involving complex evidence, the case "must, as a practical matter, be presented through the mouths of experts whose function it is to organize the mass of information into a comprehensible form." Higginbotham, *supra* note 117, at 53. Second, "[t]he success of a jury trial depends upon counsel understanding their case and presenting it innovatively." *Id.* at 54. Third, "[t]he court must sufficiently understand the legal issues involved to be capable of stating them in clear, comprehensible terms to the jury." *Id.* Successful use of juries requires the trial judge to run the court efficiently. Judge Higginbotham points out that failure of judge or counsel to discharge their duties should not be blamed on jury inefficiency. *Id.* at 54-55.

217. Basten, *The Court Expert in Civil Trials—A Comparative Appraisal*, 40 MOD. L. REV. 174, 175 (1977). *See also* 7 J. WIGMORE, WIGMORE ON EVIDENCE § 1917, at 3 (J. Chadbourn ed. 1978) (noting that the practice of using skilled witnesses dates back to the fourteenth century).

and continued to exercise its prerogative to call expert witnesses long after the jury was transformed from a body chosen because of its familiarity with the dispute to one which heard witnesses called before it.[218] The jury received the expert information only indirectly via the judge.[219] Thus the judge had considerable authority to regulate the evidence and ensure that it was presented so that the jury could comprehend it. Only during the last two hundred years can one find case references to experts called by the advocates themselves rather than by the court.[220]

Discussions earlier in this century concerning the use of experts emphasized the historical and then-current use of a variety of tools, such as specially qualified juries, masters, assessors, advisory jurors, and court-appointed experts to assist the lay trier.[221] Although these non-adversarial techniques are still available to the courts, their use appears to have become infrequent.[222] Thus, as knowledge became increasingly specialized and the use of experts became increasingly necessary, the responsibility for providing and controlling this critical form of evidence passed into the hands of the parties. Given the complexities of modern litigation, this failure to utilize the courts' prerogatives with respect to expert evidence seems surprising and helps explain the problems with scientific evidence.

The Article VII rules set a higher threshold requirement for scientific evidence (to *assist* the trier rather than to merely demonstrate minimal probative value)[223] and, with Rule 611,[224] specifically give the judge the power to enhance that evidence through control of the form of the testimony and the ability to call her own witnesses. Modern procedure not only carries forward older devices such as masters[225] to help provide necessary expertise, but also provides additional devices such as the pretrial conference[226] and motions *in limine*[227] so that evidence may be screened prior to trial. The court may

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218. Basten, *supra* note 217, at 175-76.

219. 7 WIGMORE ON EVIDENCE, *supra* note 217, § 1917, at 3.

220. Basten, *supra* note 217, at 176; 7 WIGMORE ON EVIDENCE, *supra* note 217, § 1917, at 4 (noting that the expert had ceased to be a helper of the court and had taken "his place with others as a mere witness to the jury" by the latter part of the 1700's).

221. Hand, *Historical and Practical Considerations Regarding Expert Testimony*, 15 HARV. L. REV. 40 (1901); Beuscher, *The Use of Experts by the Courts*, 54 HARV. L. REV. 1105 (1941).

222. Basten, *supra* note 217, at 176-78. It is ironic that many commentators have pointed, often critically, to the greater discretion available to and the purported larger role of the modern judge, while the less frequent use of these devices has been largely ignored. (The use of masters in institutional litigation is certainly an exception.) *See, e.g.*, Subrin, *How Equity Conquered Common Law: The Federal Rules of Civil Procedure in Historical Perspective*, 135 U. PA. L. REV. 909 (1987); Resnick, *Failing Faith: Adjudicatory Procedure in Decline*, 53 U. CHI. L. REV. 494 (1986).

223. *See* FED. R. EVID. 702 and discussion of these rules generally at Part IV(B), *supra*.

224. FED. R. EVID. 611(b). *See* discussion of this rule at Part IV(A), *supra*.

225. FED. R. CIV. P. 53.

226. FED. R. CIV. P. 16.

227. Motions *in limine* are not recognized explicitly by either the Federal Rules of Civil or Criminal Procedure but are widely utilized as a method to raise objections prior to trial. *See, e.g.*, R. CARLSON, *supra* note 151, at 101. The term is typically used to refer to a motion to exclude evidence which is not based on constitutional grounds. Motions to exclude evidence which *are* based on constitutional grounds are termed "motions to suppress," and are specifically

enhance the quality of the evidentiary offer and thereby increase the likelihood of accurate factfinding.

B. The Enhancement Role

Thoughtful analysis of the history of scientific evidence, contemporary procedure, and the rules of evidence must conclude that our justice system posits accurate factfinding as its goal. The system provides the judge with the tools to ensure that scientific evidence will assist the lay trier in meeting this goal.

There are four functional guidelines that will facilitate the judge's performance of an enhancement role that seeks to elevate an evidentiary offer to a reliable and comprehensible form. First, the judge should require the parties to identify the scientific evidence they will offer and establish the basis for that evidence well in advance of trial. Second, the judge should acquire early familiarity with the problems posed by the offers. Third, the full range of incentives should be utilized in motivating the parties to provide reliable and comprehensible evidence. Fourth, when the parties are unable or unwilling to adequately "assist" the trier, the judge herself must utilize techniques to enhance the reliability and comprehensibility of the evidence.

A major difficulty with the current treatments of scientific evidence is that the judge becomes involved with scientific evidentiary issues close to the beginning of the trial, or at trial. She is thus limited to the option of exclusion or admission. For most inadequate offers, this limited option does not serve to advance the goal of accurate factfinding. Blanket admission, with the attendant possibility of unreliable and/or incomprehensible evidence being presented, hinders this goal. Unnecessary exclusion, however, may also frustrate accurate factfinding. Exclusion hinders a party's effort to prove its case and may cause the party to lose that case. Appointment of the court's own expert at this late stage may result in unacceptable delay.[228] Thus, a critical component of enhancement is to identify cases in which controversial scientific evidence will be offered sufficiently *in advance of trial* so that the judge, or her surrogate such as a master or magistrate, can take steps to enhance the quality of evidence without significantly prolonging the case.

The first step is to require the parties to identify the scientific evidence they will offer, and the basis upon which that evidence rests, in advance of trial. Modern pretrial rules, particularly the recently amended Federal Rule of Civil Procedure, Rule 16, provide a vehicle for obtaining this information.[229] The

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recognized by rule. Like motions *in limine*, motions to suppress are raised prior to trial. *See* FED. R. CRIM. P. 12(b)(3).

228. The delay problem, especially relevant in civil jury trials, hardly needs documentation. *See* FED. R. EVID. 706 (Rule provides for consultation by the judge with the parties with respect to the appointment of an expert, directions to the expert as to her duties, preparation of findings by the expert, and deposition of the expert by the parties).

229. Federal Rule of Civil Procedure Rule 16, governing pretrial conferences, was amended in 1983 to expand the focus of the rule to encompass all aspects of case management to meet the needs of modern litigation. The use of a single conference late in the pretrial process frequently led to under-management of complex cases. The rule contemplates earlier pretrial conferences to, *inter alia*, consider evidentiary issues which will improve the quality of the trial. FED. R. CIV. P. 16 advisory committee's note, 1983 Amendment to Rule 16. *See also*

court can establish a date well in advance of trial by which the parties must indicate the issues upon which they will submit scientific evidence, and by which they must submit a report from each expert who will testify. Such report should set forth the essence of the proposed testimony, the factual and scientific basis for the testimony, and a demonstration that the proffered evidence is reliable.[230] The court can then allow a reasonable time for objections to the adequacy of the reports and/or to the testimony. The judge will then have a basis to undertake the second step — acquiring early familiarity with the problems posed by the offer.

The court now has a basis to work with the parties to try to mediate their differences and to enhance the reliability and comprehensibility of the evidence. Where the differences are sharp, the court might call for a conference of the parties to try to get the experts to agree on a common factual basis. The court can also appoint its own expert to assist in evaluating the positions of the parties and/or to assist in mediating the positions.[231] In very complicated cases, the court could resort to a master who is familiar with the scientific area to hear evidence and to prepare a report.[232] When a party will not work with the court or its surrogate, the court has a number of options to enhance the evidence: use of its own expert to testify,[233] use of a master's report, requirement of a

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MANUAL FOR COMPLEX LITIGATION, SECOND § 21.64 (1985) (use of pretrial conference to expedite offers of evidence).

230. E. Donald Elliot has noted the ineffectiveness of the exclusionary approach, and suggests the use of expert reports as the incentive needed to enhance the quality of scientific evidence. He would, however, not require the report until much later in the pretrial process than this author suggests. Elliot, *Toward Incentive Based Procedure: Three Approaches For Regulating Scientific Evidence*, 69 B.U.L. REV. 487, 493-511 (1989). Elliot's suggestion would curtail the judge's options to employ other incentives. Elliot's suggestion would, however, avoid committing precious judicial resources for cases that had no likelihood of being tried. The court must strike a balance between acting too early or too late to be effective.

Peter Huber applauds the suggestion that reports be required. He points out that the complexity of science requires that the scientific findings be reduced to writing to ensure comprehension. Huber, *supra* note 72, at 515.

Expert reports are utilized extensively in English civil cases, frequently as a substitute for live expert testimony. *See* R.S.C., Ord. 38 rr. 35-44. *See also* R. CROSS, CROSS ON EVIDENCE 443 (6th ed. 1985); P. MURPHY, A PRACTICAL APPROACH TO EVIDENCE 231-234 (1980). While the English use of reports can be instructive, the fact that the civil jury has been largely abolished limits the usefulness of the English experience. Yet the goal of the English practice certainly applies here — to save time and costs, and to identify points of agreement at an early stage so that "evidence can be shortened and attention concentrated on the areas of disagreement." P. MURPHY, *supra*, at 231.

231. *See* FED. R. EVID. 706. The use of the rule does not appear extensive from a survey of reported cases and the literature. However, there are indications that some judges utilize the practice frequently. *See, e.g.*, WEINSTEIN'S EVIDENCE, *supra* note 42, ¶706[01], at 706-13 to 706-14; M. SAKS & R. VAN DUIZEND, *supra* note 104, at 65-66; Lambros, *The Summary Jury Trial and Other Alternative Methods of Dispute Resolution*, 103 F.R.D. 461, 466.

232. *See* FED. R. CIV. P. 53. The rule provides that references shall not be routine. "A reference to a master shall be the exception and not the rule. In actions to be tried by a jury, a reference shall be made only when the issues are complicated." *Id.* at 53(b). "The master's findings . . . are admissible as evidence of the matters found. . . ." *Id.* at 53(e)(3). The Supreme Court has noted the usefulness of a master to assist the jury in complicated cases but has also noted that use of a master's report to the jury can represent an inroad on the right to jury trial. Masters should thus be utilized only when unusual circumstances exist. Dairy Queen, Inc. v. Wood, 369 U.S. 469, 478 (1963).

233. FED. R. EVID. 706(a) ("[T]he witness may be called to testify by the court or any party.").

specific form of the testimony,[234] preclusion of an opinion utilizing unreliable bases,[235] and finally a partial or total exclusion of the evidence. At this point, a threat to use the exclusionary sanction is both justifiable and credible because of the court's familiarity with the evidence and its attempts to moderate adversarial excesses.

Becoming familiar with the proposed evidence of the parties ordinarily allows the court to analyze possible trade-offs between the reliability and comprehensibility concerns. The greater the extent to which the court can ensure that the evidence will be comprehensibly presented by the proponent and subjected to effective opposition by the opponent, the less the court need be concerned with the threshold reliability requirement. In this circumstance, the reliability question will be effectively presented to the trier who may accurately make its own determination.

It must be noted that even in the desirable circumstance where the adversaries present comprehensible versions of the evidence so that the trier may accurately evaluate reliability, the trier may be left with versions of the evidence which largely cancel each other out. But by acquiring familiarity with the evidentiary problems well in advance of trial, the judge has the option to exclude such sharply conflicting data, to attempt to mediate the positions, and/or to enhance the information through a court-appointed expert.

In criminal cases, it is especially important that the courts require early and *full* reports of scientific tests.[236] The court should also use its power to appoint experts for indigent criminal defendants.[237] Because of speedy trial problems in criminal cases, the court must also expedite the discovery process and the appointment of experts.

When the parties submit the information called for, the court can intelligently pass on admissibility of the evidence at a pretrial conference well in advance of trial. The court can then indicate what additional conditions, if any, must be satisfied prior to admission at trial. This may require exposition of underlying facts or data to help ensure comprehension and evaluation by the trier.[238] The court can also decide, without delaying the trial, whether or not to utilize its own expert or a master's report. Additionally, when pretrial measures do not suffice, the court can anticipate and plan for the use of other facilitating mechanisms at the trial itself. The court could interrogate witnesses

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234. For a discussion of Rules 705 and 611, see Part IV(A), *supra*.

235. For a discussion of Rule 703, see Part IV(A), *supra*.

236. Paul Giannelli indicates that laboratory reports typically fail to disclose critical information such as the bases for the conclusion reached. *The Reliability of Scientific Proof*, *supra* note 1, at 692-93. A major theme at *Symposium I* was the inadequacy of criminal discovery. *See supra* note 12. Giannelli has suggested an amendment to Federal Rule of Evidence 702 which would require notice of the intent to utilize expert testimony and provide substantial information about the proposed evidence. Giannelli, *Scientific Evidence: A Proposed Amendment to Federal Rule 702*, 26 JURIMETRICS J. 260 (1986) [hereinafter *Observations on Discovery of Scientific Evidence*].

237. *See, e.g.*, 18 U.S.C. 3006A(e) (1988) (providing that a judge may appoint an expert to assist the defense). *See also supra* note 131 and accompanying text indicating that this power is underutilized.

238. Federal Rule of Evidence 705 provides for considerable discretion with respect to the manner in which underlying data will be presented to the trier. *See supra* text accompanying notes 166-71.

under Rule 614 and/or allow the jurors to pose questions through the judge when they do not understand the presentations.[239]

The priority must be on working with the parties to provide the type of evidence required by the trier by utilizing the full range of incentives available to achieve this purpose.[240] Nonetheless, the judge should not shrink from utilizing techniques to enhance the evidence when the parties are unwilling or unable to adequately assist the trier in spite of these incentives.

C. Confronting the Reluctance to Enhance the Reliability and Comprehensibility of Scientific Evidence

In spite of recognition by the architects of our trial system that accuracy of factfinding and procedural fairness are the ultimate goals, and in spite of the large number of procedural tools to promote these goals, why do we persist with approaches to scientific evidence which denigrate these goals? There are several problems that underlie our reluctance to utilize procedural tools to support accurate scientific factfinding, and to adopt active enhancement strategy for judges.

One basic problem seems to be an adherence to an oversimplified conception of the adversary system. This conception emphasizes the adversarial clash of proofs.[241] The difficulty arises when we forget that the adversarial process is not the *goal* of our legal system but a *means* by which we seek to achieve accurate factfinding and fairness. The procedural system has historically resorted to other techniques or processes to meet these goals. This resort has often been undertaken to moderate the dysfunctional effect of the adversary system, and to steer the procedural system toward meeting the goals.[242] Those who tend to view the adversary system as the end of the court

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239. A number of writers have recently noted the apparently beneficial effects of allowing jurors to increase comprehension in this manner. A balanced discussion can be found in IMPROVING JURY COMPREHENSION IN COMPLEX LITIGATION 21-24 (Report of the Committee on Federal Courts, N.Y. St. B.A., July 12, 1988). *See also* Weinstein, *Improving Expert Testimony*, 20 U. RICH. L. REV. 473 (1986) for a rich source of ideas to improve expert testimony.

240. The author is suggesting a proactive stance with respect to bringing expertise to bear in a helpful fashion, as suggested by Judge Weinstein, *supra* note 239, at 484, not bureaucratization of the judiciary which has recently been criticized by several scholars. *See, e.g.*, Resnick, *Managerial Judges*, 96 HARV. L. REV. 376 (1982); Fiss, *The Bureaucratization of the Judiciary*, 92 YALE L.J. 1442 (1983). My concern is simply to utilize the full role of the judge to ensure that reliable scientific evidence is presented in a comprehensible manner.

241. S. LANDSMAN, READINGS ON ADVERSARIAL JUSTICE: THE AMERICAN APPROACH TO ADJUDICATION 2 (1988). Landsman notes the difficulty of capturing "important principles and practices inherent in adversary methodology" but ignores the notion that the adversary methodology must be viewed in the larger context of the procedural system. *Id.* He later notes that: "In summary, although the predominant means of resolving disputes in American courts is the adversary system, a variety of nonadversarial mechanisms have been incorporated into the judicial process. In recent years a steadily increasing number of nonadversarial techniques have been adopted in all sorts of cases." *Id.* at 24. But the discussion suggests that inroads should be judged against the standards of the adversarial system rather than against any larger system goals.

242. With respect to the tendency to confuse the goals of the procedural system with the adversary system as means to these goals, and the substantial inroads upon the adversary system, see, *e.g.*, Sword, *Values, Ideology, and the Evolution of the Adversary System*, 64 IND. L.J. 301 (1989). Sword concludes that "non-adversarial elements in modern litigation exist

system by which judicial techniques should be measured rather than as a important means to larger goals will disparage and fail to adopt non-adversarial techniques to enhance scientific information.

Nowhere is this myopia more harmful than in passing upon the admissibility and form of scientific evidence. The adversary system is particularly suitable for determination of historical fact, such as whether X assented to a key contract term or whether X struck Y. A question such as whether a semen sample left at the scene of a sexual assault is the defendant's semen is a very different question. It is a question which taxes the lay trier's ability under the best of conditions because it requires a determination, *inter alia*, of the underlying reliability of the technique — a determination which is largely a "scientific question."[243] Whatever the merits of the adversary system in determining historical facts, a thoughtful analysis of the nature of expert evidence must conclude that a lay trier cannot make accurate scientific or quasi-scientific determinations based upon the bones tossed to it by an uncontrolled, adversarial procedure.

Commentators such as Judge Weinstein point out that it is proper to work with adversaries in presenting evidence as a means of improving the function of the courts.[244] And even those who are wary of expanding the discretion of the trial judge will concede that it is proper for the judge to assist the advocates in making a coherent presentation of the case.[245]

A second problem underlying the reluctance to adopt active enhancement by the judge rests with the conditioning of the trial judge. At a practical level, the typical trial judge must overcome many years of laboring as a trial lawyer in the adversary system — years when she believed that maintaining control over the course of "her" case was essential. To adopt the enhancement role, she

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because adversarial investigation and presentation of evidence is not well-suited to fact finding," especially as "the factual basis of disputes has grown more complicated." *Id.* at 355.

243. I am painfully aware of this term's lack of precision. However, some imprecision is necessary for two reasons. First, as Part VI demonstrates, there are no clear criteria which establish when a scientific theory or technique has been proven. As Thomas Kuhn demonstrated, disconfirming evidence mounts until an existing paradigm of scientific explanation is displaced by a newer paradigm which better explains the evidence. T. KUHN, THE STRUCTURE OF SCIENTIFIC REVOLUTION (2d ed. 1970).

Second, legal and scientific systems have quite different goals. The scientific system pursues the elusive concept of demonstrable truth and sets very high standards for what is deemed to be proven; many philosophers of science argue that theories can't be proven, that we can only assess whether a theory is more or less probably true. *See, e.g.*, SCIENTIFIC KNOWLEDGE: BASIC ISSUES IN THE PHILOSOPHY OF SCIENCE chs. 3-4 (J. Kourany ed. 1987). The legal system cannot afford to stand by waiting for science to declare a theory to be proven before admitting relevant evidence; the court must decide cases based upon evidence available at the time. The court must attempt to balance the need for relevant evidence with the possibility that the evidence is unreliable or incomprehensible. If the evidence is unreliable or incomprehensible, it undercuts the goals of the rules of evidence and the goals of the larger procedural system — to accurately determine facts rather than just dispose of the case. Inaccurate determination undermines the very legitimacy of the system.

These differences in goals of the two systems, as well as expression of doubt whether the legal system's treatment of scientific evidence is consistent with a search for truth, are succinctly expressed by Peter Huber. *See* Huber, *supra* note 72.

244. Weinstein, *supra* note 239, at 495.

245. Saltzburg, *The Unnecessarily Expanding Role of the American Trial Judge*, 64 VA. L. REV. 1 (1978). Saltzburg, however, draws a very fine line as to what constitutes permissible judicial intervention.

must now confront the hostility of many trial lawyers with these same beliefs when she requires them to draw upon reliable sources and to present their case fairly and comprehensibly.[246]

The judge must also find time in a busy schedule[247] to send out pre-trial questionnaires, evaluate information, and conduct the follow up to identify and solve problems relating to scientific evidence. Experimentation will be necessary to identify the kinds of cases in which these pre-trial efforts are time-effective, but failure to utilize the tools to promote reliable and comprehensible evidence may result in fewer settlements, poorly tried cases, and inaccurate factfinding.[248]

A third basic problem underlying a reluctance to adopt an enhancement role by the judge is grounded in our schizoid attitude toward the jury.[249] While many commentators denigrate the abilities of the jury, others protest that the judge will usurp the role of jury as a fact finder if she acts to enhance the evidence.[250] This other objection ignores the roles and relative abilities of the judge and trier in the context of scientific evidence. Rather than denigrate or attempt to diminish the role of the jury, the enhancement role suggested herein is based upon a full appreciation of the trier's ability. This role seeks to *provide* the tools for the trier to utilize in accurate factfinding. The judge's role in enhancing or ultimately excluding an offer of scientific evidence is similar to utilizing the best evidence rule[251] or the hearsay rule[252] to ensure reliable evidence.[253] Whether the offer of scientific evidence requires

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246. Arthur Miller believes that judges are willing to assume the role of managers and "to experiment with procedures designed to enhance their effectiveness in that role. . . ." Miller, *The Adversary System: Dinosaur or Phoenix*, 69 MINN. L. REV. 1, 21 (1984). He also opines that, because of their frustration with adversarial shortcomings, "the bar may not be a major obstacle to more aggressive management and enforcement of the rules, even at the expense of a measure of its independence and autonomy." *Id.* at 21-22. Perhaps my estimate of the impact of the socialization process of lawyers and judges is too great, and the full intended impact of revised Federal Rule of Civil Procedure 16 will be realized.

247. *See* 28 U.S.C. § 636(b) (1988); FED. R. CIV. P. 72.

248. The strongest argument for pretrial proceedings is that pretrial efforts *do* improve the quality of those cases that are subsequently tried. Such proceedings will not be effective in all cases. C. WRIGHT, LAW OF FEDERAL COURTS 602 (4th ed. 1983). The problem seems to be identifying criteria which allow the court to make a timely identification of those cases in which intervention will be time-efficient. For a discussion of the problem of over and underutilization of pretrial proceedings see FED. R. CIV. P. 16 advisory committee's note (1983 Amendment).

249. For a more general discussion of this attitude, see *supra* text accompanying notes 73-77.

250. A recent statement of this position can be found in Schwartz, *There Is No Archbishop of Science — A Comment on Elliot's Toward Incentive Based Procedure: Three Approaches for Regulating Scientific Evidence*, 69 B.U.L. REV. 517, 521-23 (1989). For an argument that Rules 104(b) (governing conditional relevance) and 90(b)(9) (governing authentication of a process) suggest that the judge should play a minimal screening role, see Imwinkelried, *supra* note 37, at 577.

251. FED. R. EVID. 1001-04.

252. FED. R. EVID. 801-05.

253. However, the rules governing the admissibility of scientific evidence arguably accord the judge more discretion to control the evidence to meet the underlying policy objectives of these rules because they are not susceptible to formulation via a bright-line rule. *See supra* notes 195-97.

enhancement or exclusion, like other important questions of evidence policy, is one for the judge.[254]

The enhancement approach makes much more sense practically than the liberal admissibility approach. The judge has a much better understanding than the jury of attorney resource and training limitations, as well as the attorney motivation to offer less then reliable or comprehensible evidence.[255] The judge has the unique ability to require the attorneys to enhance the evidence, or to enhance the evidence herself. The jury's role, albeit critically important, is a passive one; it can only attempt to play with the hand dealt to it by the attorneys and the court. The enhancement role seeks to strike an appropriate balance between the abilities and the needs of a lay trier of fact. It attempts to create an effective partnership between the judge, attorneys, and jury which promotes the goals of Rule 702 and the goals of the Rules in general.

Related to the schizoid attitude about the jury's abilities is another concern underlying reticence towards a larger role for the judge. Some who resist this role believe that the judge lacks the requisite abilities to make those threshold determinations of reliability and comprehensibility that are required to decide whether or not the enhancement strategy is appropriate in a given case. There is some truth to this argument, but it ignores the judge's superior experience and resources. The judge's extensive experience, attempting to utilize scientific evidence as a trier and presiding over juries which struggle

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254. The most comprehensive discussion reluctantly concludes, contrary to the prevalent point of view, that the question of reliability of scientific evidence is a question for the jury under Rules 104(b) and 901(b)(9). Imwinkelried, *supra* note 37, at 616. Imwinkelried concedes that the line between what is a preliminary question of fact to be decided by the judge under the usual admissibility approach of Rule 104(a) and what is one to be decided under the lesser threshold standard of Rule 104(b) is a murky one. *Id.* at 606-07. He also acknowledges that Rule 901(b)(9) is not clearly applicable to scientific evidence. He calls for a clarification of these Rules to allow the judge to make preliminary findings of validity. *Id.* at 607.

His analysis, however, fails to take the language of Article VII into account, and largely ignores Rule 403. Article VII and Rule 403 are the critical rules governing admissibility of scientific evidence. *See* Part IV, *supra*. Imwinkelried's view contradicts the position of other commentators who seem to assume that Rule 702 questions are to be decided under Rule 104(a). *See, e.g.*, D. LOUISELL & C. MUELLER, *supra* note 50, at 167 & Supp. 1990, at 106-10; WEINSTEIN'S EVIDENCE, *supra* note 42, ¶ 104[01], at 104-10 (explicitly discusses only questions of qualification but logic appears to extend to other determinations under Rule 702). *See also Downing*, 753 F.2d at 1240-41 & n.21 (rejecting the Rule 901 approach). The United States Supreme Court may have muddied what had appeared to be fairly clear water in United States v. Huddleston, 458 U.S. 681 (1988) in which the court treated the admissibility of prior bad acts under rule 104(b). The decision has been heavily criticized. *See, e.g.*, Ordover, *Balancing the Presumptions of Guilt and Innocence: Rules 404(b), 608(b), and 609(a)*, 38 EMORY L.J. 135 (1989) (amend 104(a) to modify *Huddleston*). *Compare* Bourjaily v. United States, 481 U.S. 171 (1987) (admissibility of co-conspirator's statement treated under Rule 104 (a)).

Imwinkelried's treatment pays little attention to recent criticism of the "conditional relevance" approach to admissibility. The post-rules reexamination has been initiated by Vaughn Ball. Ball, *The Myth of Conditional Relevancy*, 14 GA. L. REV. 435 (1980). The most recent treatment suggests that the criticism is wide-spread and well-known, at least among academicians. Nance, *Conditional Relevance Reinterpreted*, 70 B.U.L. REV. 447 (1990).

Imwinkelried also pays inadequate attention to the policy underlying the allocation of preliminary factfinding to the judge. *See* Kaplan, *Of Mabrus and Zorgs - An Essay in Honor of David Louisell*, 66 CAL. L. REV. 987, 990 (1978). Kaplan points out that questions like the reliability of scientific evidence involve important questions of evidentiary policy which the jury is insufficiently experienced to decide. *Id.*

with inadequate scientific evidence, provides a basis for understanding what she requires to function effectively when dealing with new and complex information. The judge can also supplement her experience by resort to a considerable body of literature devoted to how people comprehend and apply information.[256]

The argument that the judge has inadequate knowledge to understand the scientific information being offered confuses the role of the trier with the role of the judge. The former role is to determine whether or not to ultimately credit the evidence, while the appropriate and necessary role for the judge is to assure that the evidence in fact assists the trier. The judge need not master the intricacies of each subject matter involved in an offer of scientific evidence. Rather the judge ensures that the offer will assist the trier. The judge can appropriately ask the proponent to demonstrate that the evidence meets threshold reliability and comprehensibility concerns. Although the judge may be no better than the jury in weighing the credibility of material admitted into evidence, one of the judge's strengths is asking questions which relate to whether an adequate foundation has been established. This strength can be augmented by studying the questions which should be asked with respect to scientific evidence.[257] The strength can be further supplemented by utilization of tools such as fairly detailed reports from experts, use of advisors, and conferences between the experts.

Those commentators encouraging more effective use of science in the court room indicate that judges *can* become sufficiently familiar with the basics of sound scientific methodology to screen unreliable evidence.[258] A substantial number of decisions during the past ten years demonstrate that judges are capable of evaluating whether an offer of evidence is sufficiently reliable to merit serious consideration.[259] These decisions demonstrate a working familiarity with, *inter alia*, basic research design, the science peer review process, and the concept of statistical significance. The task of helping the judges become scientifically literate seems manageable. The remaining Part attempts to provide a framework for this task.

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255. *See supra* text accompanying note 210.

256. Cognitive psychologists suggest that the trier requires sufficient background information to make up for lack of knowledge in an area; understanding and the ability to critically evaluate are a function of context. Note, *The Frye Doctrine and Relevance Approach Controversy: An Empirical Evaluation*, 74 GEO. L.J. 1769, 1785-87 (1986). The psychological literature also suggests that the jury should receive a coherent and complete initial exposition of the evidence. Many lawyers will appreciate the importance of these principles and will not require judicial prodding, but for those unaware of the principles or incapable of educating the jury, the judge has a number of tools to help ensure comprehensibility.

257. Part VI, *infra*, discusses the concerns which should be addressed by the judge.

258. *See, e.g.*, Monahan & Walker, *Social Authority: Obtaining, Evaluating and Establishing Social Science in Law*, 134 U. PA. L. REV. 477, 508-12 (1986) [hereinafter *Social Authority*]; *A Unified Theory of Scientific Evidence*, *supra* note 27, at 682.

259. A number of these opinions are cited in Part I, *supra*, as exemplary of thoughtful applications of the reliability requirement in conjunction with the *Frye* and relevancy tests for admissibility. *See, e.g.*, *supra* notes 38, 70.

VI. EVALUATING RELIABILITY OF SCIENTIFIC EVIDENCE

Key to the judge's more active, enhancement role is the concept of reliability. "Reliability" asks whether the evidence is worthy of serious consideration in the particular context in which it is offered, when measured against standards that a neutral highly qualified scientist would apply. Reliability builds on probative value — the tendency to make a material proposition more or less likely than it would be without the evidence. Reliability defines and strengthens the concept of probative value because of the practical requirements of a lay trier which are reflected in Rule 702 and 403.

The focus of this Part is on how reliability can be "operationalized," *i.e.*, how the insights of science can be incorporated into an analysis that judges can perform to meet the accurate factfinding goal.[260] It is an attempt to meet the concern for reliability expressed throughout this discussion, and the concern that judges cannot make intelligent assessments of reliability. This Part sets forth a comprehensive approach[261] to evaluating the reliability of scientific evidence. In organizing discussion of the standards applied by a neutral scientist to ascertain reliability, this part utilizes the three levels of scientific application in the court: scientific theory, scientific technique, and application of the technique.[262] But first, an explanation of how scientific knowledge is acquired and subjected to peer review must be undertaken.

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260. Bert Black makes the most serious effort to examine the interplay between the need for the law to establish a threshold of reliability and the scientific concepts upon which the law should draw in making that determination. *See A Unified Theory of Scientific Evidence*, *supra* note 27. His discussion of the current view of science is particularly helpful. He argues, as do I, that the decision to admit must be based upon a view of how science operates. However, Black's approach is limited because he focuses on science theory. While Black presents an enormously sophisticated discussion, his analysis largely ignores the other two levels of scientific use, and therefore provides an incomplete set of tools for the judge or lawyer to analyze an offer of scientific evidence.

261. Most notable are the efforts of Judge McCormick, *supra* note 28, at 911; WEINSTEIN'S EVIDENCE, *supra* note 42, at ¶ 702[03]. McCord summarizes and criticizes these efforts as being too oriented toward a technique involving hard scientific evidence and as being unsuitable for application to "nontraditional psychological evidence." McCord, *supra* note 58, at 90-94. He goes on to provide what he considers to be a more flexible and comprehensive framework utilizing four factors: necessity, reliability, understandability, and importance.

My effort proceeds from the premise that one must evaluate the offer of evidence by considering the evidence in terms of the validity of the underlying basic scientific theory and the technique of application, as well as how that technique was applied. This approach is intended to provide a comprehensive perspective applicable to any offer of scientific evidence by enumerating the basic concerns that apply to each of these three levels of science. The McCormick and Weinstein-Berger efforts at cataloguing important considerations do not provide a comprehensive approach to the problem of reliability, nor are their concerns exhaustive. Nevertheless, the efforts of these authors are very helpful and are reflected in the following discussion.

262. *See supra* notes 17-21 and accompanying text. In the discussion of how science operates at three levels of inquiry, I draw upon examples from both social and natural sciences. There is merit to the observation that the social science inquiry may be rendered more complex than that of the natural sciences because of the unique nature of human behavior. I have deliberately intermingled the examples to demonstrate factors common to all types of scientific evidence, and to use examples familiar to most readers.

A. Establishing Scientific "Knowledge"

In the modern scientific world, there is no single method of establishing scientific knowledge that fits the common denominator - "scientific method."[263] Advances in physics, cognitive psychology and philosophy during the last hundred years dispel notions that scientific knowledge can be positively ascertained and be ultimately *certain* in its validity. Scientific knowledge has only a provisional validity rather than a certainty. Correspondingly, this realization diminishes agreement on the appropriate canons of an ideal scientific method. This provisional validity is a function, *inter alia*, of the perspective of the investigator, the terminology chosen, the issues defined, the variables examined, and the methodology used to investigate the relationship among these variables. While provisional validity precludes defining explicit criteria for "scientific truth" or agreeing on appropriate scientific methodology, we *can* comprehend the basic values which underlie scientific inquiry. These values indicate how a competent scientist would proceed, and how a knowledgeable scientist would evaluate the work of a fellow scientist.

The primary criterion of the neutral scientist is a commitment to objectivity.[264] In pursuing this objectivity, the scientist evaluates ideas against

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263. Black traces the development of the changing views of science in *A Unified Theory of Scientific Evidence*, *supra* note 27, at 613-27. An excellent discussion of the evolution of "science" in terms of causality is Brennan, *Causal Chains and Statistical Links: The Role of Scientific Uncertainty in Hazardous-Substance Litigation*, 73 CORNELL L. REV. 469, 478-491 (1988). *See also* Loevinger, *Law And Science As Rival Systems*, 19 U. FLA. L. REV. 530, 534 (1966).

The most cynical view of whether a scientific methodology can be (or should be) articulated is expressed by Paul Feyerabend. P. FEYERABEND, AGAINST METHOD (1975). He sees empiricism as an adaptable method of rationalizing our already held ideas. While empiricism has increasingly come under attack as a vague collection of rules, all of which are violated at some time, there are helpful general concepts which would be utilized to evaluate assertions based upon the practice of science. I attempt to distill these concepts and apply them practically to typical scientific evidence. These concepts are based on empiricism, which, although not the sole paradigm, is nevertheless the clearly predominant one.

264. *See, e.g.*, *A Unified Theory of Scientific Evidence*, *supra* note 27, at 622. One of my colleagues reminds me of the maleness of equating the search for truth with objectivity. Carol Gilligan and others have identified the problem with viewing the world from a single highly rationalistic perspective. C. GILLIGAN, IN A DIFFERENT VOICE (1982); MAPPING THE MORAL DOMAIN (C. Gilligan, J. Ward & J. Taylor eds. 1988). Eisenstein notes that a radical feminist renounces "rationality and clarity as fundamentally male[,] and therefore [a] flawed [perspective]." H. EISENSTEIN, CONTEMPORARY FEMINIST THOUGHT xii (1983).

Evelyn Keller has attempted to define a constructive role for the feminist critique of science, one that does not fall prey to the nihilist dangers of the radical cultural relativism critique. She would extend the feminist critique to the very foundations of science by attempting to "reconceptualize objectivity as a dialectical process so as to allow for the possibility of distinguishing the objective effort from the objectivist illusion." Keller would not abandon the effort to understand the world in rational or "scientific" terms but would add the process of critical self-reflection. Keller, *Feminism and Science*, in FEMINIST THEORY: A CRITIQUE OF IDEOLOGY 118 (N. Keohane, M. Rosaldo & B. Gelpi eds. 1982). *See also* E. KELLER, REFLECTIONS ON GENDER AND SCIENCE (1985).

Students of science other than feminists are also skeptical of the claim to objectivity. In a study of science fraud, William Broad and Nicholas Wade argue that dogma, career pressure, prejudice and the inadequacy of the supposed safeguards destroy the perfect objectivity which is said to constitute the essence of science. W. BROAD & N. WADE, BETRAYERS OF THE TRUTH ch. 11 (1983). For an attempt to define what makes the *choice* to support a theory "objective," see Kuhn, *Objectivity, Value Judgment and Theory*, in INTRODUCTORY READINGS IN THE

criteria that involve testability, impartiality, and confidence in the connection between evidence and reason.[265] The remaining portion of this subpart is a simple model of the empirical process as utilized by a neutral scientist, followed by a discussion of the public inquiry by which scientists demonstrate a commitment to objectivity. Also included is a discussion of basic methodological concerns which are important indicators of reliability.

A simplified model of the empirical process depends fundamentally on the methodical collection of data through observation in a manner that can be repeated and verified by others. The method looks something like the following:

> 1) Out of practical experience, observation, intuition, as a result of drawing implications from previously established theory, or a combination thereof, the scientist forms a hypothesis. Typically, this hypothesis posits a relationship — often causal — between two or more variables;[266] *e.g.*, cigarette smoke is a cause of cancer.
>
> 2) The scientist next plans an experimental or other research design, such as a regimen of systematic observation, to test the hypothesis. The good experiment or research design will contain a mechanism to control for rival hypotheses or influences.[267]
>
> 3) The experiment, or other research design, is then begun. In this phase, "sound practice require[s] sufficient documentation of the apparatus, the technique, and the environment so that any other trained person could exactly reproduce the experiment."[268]
>
> 4) The experiment or study must consider enough subjects to eliminate the possibility that the result occurred by chance. Tests of statistical significance are typically used to eliminate the pos-

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PHILOSOPHY OF SCIENCE (E. Klemke, R. Hollinger & D. Kline rev. ed. 1988). In brief, objectivity is a goal and a difficult one to define.

265. *A Unified Theory of Scientific Evidence*, *supra* note 27, at 622.

266. The scientist would typically like to predict *when* the event being studied will occur to have the ability to control *whether* the event occurs, and to understand what *causes* the event to occur. J. MONAHAN & L. WALKER, SOCIAL SCIENCE IN LAW 36 (1985) [hereinafter SOCIAL SCIENCE IN LAW]. Frequently not all of these goals are attainable.

267. A number of research designs are available. The basic systematic designs are experimental or quasi-experimental. A proper experimental design would manipulate the subjects, *e.g.*, give one group an aspirin and the control group a placebo. But this design is often impractical or unethical. Rather than expose the subject group to a carcinogen we study a group who was exposed to the carcinogen and compare it to a group who was not. Much research is of the latter, quasi-experimental variety. *See* D. CAMPBELL & J. STANLEY, EXPERIMENTAL AND QUASI-EXPERIMENTAL DESIGNS FOR RESEARCH 34 (1966).

The key is a design which eliminates, to the greatest extent possible, other influences which might impact the object of the study. Lung cancer can be caused by a number of carcinogens. A study of the effect of cigarette smoking which failed to account for the effect of other possible carcinogens that subjects were exposed to would be suspect.

268. Haun, *Some Thoughts on Science and Scientists in the 1980's*, in J. NYHART & N. CARROW, LAW AND SCIENCE IN COLLABORATION: RESOLVING REGULATORY ISSUES OF SCIENCE AND TECHNOLOGY 47 (1983).

sibility of random error;[269] *i.e.*, error beyond control of the research design.

5) Ultimately, the hypothesis may be confirmed or the study may result in an unexpected outcome such as the discovery that cigarette smoking causes some disease other than the hypothesized cancer.[270] It should be noted that failure of the experiment or study to confirm the hypothesis does not necessarily mandate the conclusion that the hypothesis is false.[271] To so conclude, the scientist would have to make the "subjective evaluation that in light of the hypothesis, its parameters, the experimental technique, and the treatment of the resulting data, the experiment would have detected [the carcinogenic activity if cigarette smoke were truly a carcinogen]."[272]

In any particular situation, the temporal sequence above may or may not be followed.[273] Informed observation may precede the explicit hypothesis and general problem formulation or rudimentary hypothesis. The experimentation or other research design must be viewed as a part of an evolutionary process. The single "crucial" experiment supporting a broad theory is very unlikely.[274]

The empirical process applies both to the formulation of scientific theory (*e.g.*, liars tend to demonstrate certain physiological symptoms), and to the development of a scientific technique (*e.g.*, the X polygraph accurately determines whether the subject is lying). Typically, techniques are developed only after a general theory or a strong hypothesis has been established. There may be situations, however, where an accurate technique will be developed even when the underlying theory is not completely understood.[275]

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269. Large & Michie, *Proving that the Strength of the British Navy Depends on the Number of Old Maids in England: A Comparison of Scientific with Legal Proof*, 11 ENVTL. L. REV. 557, 573 (1981). The statistical tests do not prove what caused the result under observation. By reducing the probability of a chance relationship between non-observed events and the outcome, statistics aid the inference of a relationship between observed events and the outcome. D. BARNES, STATISTICS AS PROOF 31 (1983). A faulty research design can, however, negate the statistical inference. This research design error is often called systematic error (v. random error). *See infra* note 293 for a brief discussion of random error.

270. Haun, *supra* note 268, at 47.

271. Large & Michie, *supra* note 269, at 567.

272. *Id.*

273. Attempts to set out the sequence of events that the empirical investigator undertakes reveals differences in sequence and terminology. But the efforts are often prescriptive rather than descriptive. *See, e.g.*, R. ACKOFF, SCIENTIFIC METHOD: OPTIMIZING APPLIED RESEARCH DECISIONS (1962); 1-2 M. BUNGE, SCIENTIFIC RESEARCH, THE SEARCH FOR SYSTEM (1967); J. FEIBLEMAN, SCIENTIFIC METHOD: THE HYPOTHETICO-EXPERIMENTAL LABORATORY PROCEDURE OF THE PHYSICAL SCIENCES (1972).

274. *See* D. CAMPBELL & J. STANLEY, *supra* note 267, at 3. Some philosophers of science maintain that the theory can never be proven. *See, e.g.*, SCIENTIFIC KNOWLEDGE: BASIC ISSUES IN THE PHILOSOPHY OF SCIENCE ch. 3 (J. Kourany ed. 1987). *See also supra* note 243.

275. A model can either be a "formal representation of a theory about, or empirical observation of, a defined set of facts or system." Case, *Problems in Judicial Review Arising from Use of Computer Models and Other Quantitative Methodologies in Environmental Decisionmaking*, 10 B.C. ENVTL. AFFAIRS L. REV. 251, 254 (1982). Another example is the use of many drugs which have been empirically established to be an effective treatment for a condition without more than a rudimentary understanding of why the drug works.

B. Three Basic Concerns of the Scientific Community

The scientific researcher is a part of the larger scientific community. Even when the scientist who performs a study concludes that her data confirms the hypothesis, fellow scientists may be skeptical. The scientific community has three general concerns regarding another scientist's work: internal validity, external validity, and consistency.[276]

Internal validity "considers the research on its own terms and looks to whether the methods and analyses employed were sound enough to justify the inferences drawn by the researcher[s]."[277] It asks whether the study was properly designed and executed so that the study accurately tests the hypothesis. Key to this first concern are the control mechanisms which must be included in the study to eliminate other possible causes of the effect. The researcher attempting to demonstrate a relationship between smoking and lung cancer must use a research design which controls or accounts for the effect of other possible carcinogens, such as air pollution or workplace chemicals and substances. The critical scientist will look to the literature on research design or methodology. Because there is no one correct research design, other scientists will often fault at least some aspect of the design. The key question in determining internal validity is whether the design eliminated as many plausible rival explanations as possible, such as intervening causes, impact of the testing on the subject, and/or the manner of selection of the subjects. Only after the skeptical evaluator has assessed the adequacy of the research design should the statistical analysis of the data collected be considered.[278]

Internal validity must also ask whether the statistical analyses of the data were appropriate for the hypothesis and research design. There is considerable debate about the appropriateness of various statistical techniques for different types of data, but, as with research design, the literature indicates whether the

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276. This concept is intended to capture the inquiry whether another scientist applying the protocol or technique which is utilized in a validity study would obtain the same result. The term "reliability" in a technical, non-legal sense is often used to capture this idea. Sometimes the term "replicability" is used. I chose not to use the term "reliability" in its technical sense to avoid confusion with the legal use of scientific reliability.

277. SOCIAL SCIENCE IN LAW, *supra* note 266, at 45.

278.

> With few exceptions, the relevant legal literature largely ignores the methodological aspects of how data are gathered for statistical analysis. Yet the more basic question of whether the data being analyzed have been validly collected or if the data are even relevant to the issues in the litigation should logically precede statistical analysis. As a practical matter methodological issues are at least as important, if not more so, than are questions about the appropriateness of the statistical analysis used in litigation.

Miller, *Facts, Expert Facts and Statistics: Descriptive and Experimental Research Methods in Litigation*, 40 RUTGERS L. REV. 101, 107 (1987). *See also supra* note 269.

technique falls within an acceptance range.[279] The critical question is whether the analysis of the statistical data was sound.[280]

External validity, by contrast, refers to the extent to which a research finding can be generalized to different situations, settings, persons, or times.[281] A particular problem in the legal setting is the extent to which research findings can be generalized to the real world.[282] There is a trade-off between internal and external validity.[283] The experimenter can exercise considerable control in the research design and thus avoid confounding variables thereby increasing internal validity. This simplification, however, results in increased artificiality, thereby decreasing external validity.[284] Thus social scientists studying mock juries might use videotaped testimony to ensure presentation of identical subject matter to different juries. Although the use of this "canned" testimony may accurately test the variable of jury size to predict outcome, the use of edited videotape testimony makes generalization to the real courtroom problematic.[285]

As with theories originating in particular settings, the lawyer or judge must be keenly aware of differences which might make the validation of a technique inapplicable to the dissimilar circumstances at issue. For example, polygraph tests may have considerable validity in determining truth or falsity when administered by neutral, highly trained personnel.[286] The results, however, may not apply in a courtroom where the technique is performed by poorly trained, partisan operators who are insensitive to all the possible variables which might affect the subject's response and their own subjective evaluation thereof.[287] In such case, the controls of the original setting are not present.

The third concept of importance is consistency. Consistency (reliability in its *technical* sense) refers to whether the same result is obtained each time the

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279. Material dealing with statistical techniques is accessible to lawyers. General treatments, like D. BARNES, STATISTICS AS PROOF (1983), explain and illustrate the use of common statistical techniques. Texts and teaching materials in areas such as employment discrimination also discuss appropriate statistical methodologies. M. ZIMMER, C. SULLIVAN & R. RICHARDS, EMPLOYMENT DISCRIMINATION 117-34 (2d ed. 1988). A plethora of more specialized or detailed treatments are available in the law reviews and books.

280. Since there are no laws governing the legitimacy of inductive inferences and the many approaches to analysis, there can be considerable debate about nonstatistical aspects of the analysis as well. Black suggests that the question of validity depends on "accepted scientific practice . . . and cogency of the entire pattern of reasoning leading to the expert's conclusion." *A Unified Theory of Scientific Evidence*, *supra* note 27, at 600.

281. SOCIAL SCIENCE IN LAW, *supra* note 266, at 50.

282. R. HASTIE, S. PENROD & N. PENNINGTON, JUDGING THE JURY 38 (1983) [hereinafter JUDGING THE JURY]. The process of determining external validity is similar to analogical legal reasoning, determining factual similarity. *See Social Authority*, *supra* note 258, at 505-07. An example of external validity is the extent to which a study of mega-doses of tobacco tar and resultant cancer in mice can be utilized to demonstrate that cigarette smoking causes cancer in humans. *See infra* note 297.

283. JUDGING THE JURY, *supra* note 282, at 38. SOCIAL SCIENCE IN LAW, *supra* note 266, at 52.

284. SOCIAL SCIENCE IN LAW, *supra* note 266, at 52.

285. *See supra* note 80, discussing jury study methodology.

286. A. MOENSSENS, F. INBAU & J. STARRS, SCIENTIFIC EVIDENCE IN CRIMINAL CASES § 14.09 (3d ed. 1986) [hereinafter SCIENTIFIC EVIDENCE IN CRIMINAL CASES].

287. *Id.* at § 14.04; Skolnick, *Scientific Theory and Scientific Evidence: An Analysis of Lie Detection*, 70 YALE L.J. 694, 707, 711 (1961).

test is performed on the same subject.[288] A technique is consistent to the extent a series of measurements or applications yield similar results. The question of yielding consistent results is related to sufficient documentation of an experiment so that others can repeat it. The scientific community will be skeptical of conclusions based on a single study or even multiple studies solely by the proponent of the hypothesis. The community will also be properly skeptical when procedures are not carefully documented. Consistency is to a large extent a function of carefully articulated standards or procedures for conducting the test and evaluating the data so that others may in fact conduct the same test. Only in this manner may subjectivity in evaluation be minimized.

C. The Process of Challenge and Defense of a Theory

Whether the conclusion drawn by the proponent of the hypothesis is provisionally accepted and advanced to the level of theory is not a decision for the proponent. Scientific work must be subjected to the rigors of challenge and defense by other scientists. William Haun described the process as follows:

> The classic way to do this was the presentation of the thesis in an open meeting, followed by discussion, question and answer, and leaving to each participant the resolution of the issue. There are no judges. As the numbers of scientists have grown, the process has become institutionalized in the refereed journal. Such a journal accepts a responsibility to ensure that articles submitted for publication are significant, reporting some significant information that may be of value to other scientists, and that the quality of work and conclusions are suitable to be relied upon by others.
>
> The referees are authoritative, accepted workers who have agreed to review, comment upon, and advise the editor on the value of the work reported for publication. Most recognized journals guard this process with great care, and it is an excruciating one for the aspiring author.
>
> The idea is that every published article meets at least minimum standards of quality and reliability. Many articles are rejected.[289]

While appearance in a recognized refereed journal does not guarantee the accuracy of the conclusions, it does ensure that qualified experts have indicated the work has substantial merit and that the work is exposed to others in the field who can react to it.[290] The lawyer or judge should be concerned with whether the underlying study has been exposed to the process of challenge through scientific meetings, refereed journals and recognized treatises. Even when the particular studies have not been subjected to this ideal crucible the related literature on the topic would be used by a scientist to determine how the result of the study relates to the mainstream of scientific opinion. The literature should also reflect the methodological concerns — internal and external validity and consistency — for the topic of the study.

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288. SOCIAL SCIENCE IN LAW, *supra* note 266, at 44. *See also supra* note 276.
289. Haun, *supra* note 268, at 48.
290. *Social Authority*, *supra* note 258, at 500.

The relationship between admissibility, probative value, and reliability is difficult to define. The legal system cannot wait for "scientific certainty" to illuminate the issue in light of the "provisionality" of most scientific knowledge.[291] Yet the courts ought not blunder ahead without considering the dangers to accurate factfinding posed by unreliable evidence.

The courts and others are put into a particularly difficult position when they attempt to evaluate a novel scientific theory or technique without resort to scientific criteria. While one side will push the theory or technique too far or attempt to draw more from the results of the study than can be supported, the opponent will be reluctant to accept even valid innovation. Because a theory or technique rejected initially by mainstream science may ultimately be proved correct, the court cannot reject innovation out of hand. But the limits of the adversary system suggest that the court adopt a conservative stance unless the evidence can be adequately contested and presented in a comprehensible manner. And, even when the evidence can be presented in a comprehensible manner so that dangers to accurate factfinding are minimized, the court may ultimately decide that the efficiency concerns of Rule 403 mandate exclusion of unreliable evidence because of the time required.

D. Evaluation of the Three Levels of Scientific Evidence

Even though the concept of reliability as defined herein is a relative one, the court must consider scientific criteria in determining whether the evidence will assist the trier in factfinding. A number of courts and commentators list factors, many of which relate to the criteria described above that scientists use, which need to be considered in any admissibility decision. A number of these and other factors suggested by the foregoing discussion can be organized in terms of the three levels of scientific evidence.[292]

1. Scientific Theory

Frequently a scientific study is offered as evidence.[293] Consider the toxic tort case: a party offers an epidemiologic[294] study to prove or disprove the

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291. The legal decision-maker must frequently make decisions in the absence of generally accepted scientific knowledge, *i.e.*, under conditions of scientific uncertainty. Although "science" does not accommodate the legal need for information, certain scientific practitioners can be found who venture an "opinion." For a discussion of the "over-extension" of actual scientific knowledge, see, *e.g.*, Wasyliw, Cavenaugh & Rogers, *supra* note 133.

292. McCord summarizes the efforts by Judge McCormick and Weinstein and Berger to catalog the factors articulated by the courts. McCord, *supra* note 58, at 93-94.

293. A considerable body of the literature disputes the propriety of admitting the statistical evidence of a valid study to prove the litigated fact. One aspect of validating a study is a demonstration that the result could not have been achieved as a result of chance. A scientist would not reject the null hypothesis without both a sound research design and a statistically significant result. Typically, the scientist will reject the null hypothesis only if the results of the study could have occurred by chance in five or less of 100 cases ($p. \leq .05$). *See* SOCIAL SCIENCE IN LAW, *supra* note 266, at 79. The authors present a very understandable treatment of statistical inference. *See id.* at 75-81.

A study which is explicitly probabilistic does not prove that an individual case in a comparable setting fits within the theory. The evidence, however, is highly probative that an individual case conforms to the theory, given the conservative nature of the convention. The probative value seems particularly high in class claims — situations in which the inference sought to be proven is an aggregated one. Thus, statistical evidence alone may establish requisite intent in discrimination class actions, but such evidence is only one factor in determining whether dis-

carcinogenicity of a substance, such as agent orange, asbestos, tobacco, etc.,[295] manufactured by the defendant. The proponent of the evidence suggests that the conclusion, the substance's inherent carcinogenicity or non-carcinogenicity, and the supporting data and reasoning are probative of whether the substance caused plaintiff's injury. The focus will be on the scientific study and its transferability to the particular circumstance at issue; problems of technique and proper application of the technique are not present. The questions of validity may be relatively minor when, for example, the suspected carcinogens are "specific" in nature and cause a cancer which is rare and closely associated with the chemical.[296] The more common carcinogen, however, entails extremely difficult questions of internal validity; *i.e.*, the ability of the research design to eliminate other possible causes of the cancer when the cancer may be caused by several carcinogens singly or in combination.

By contrast, animal studies typically raise the problem of external validity. To what extent is it appropriate to generalize from high dosage studies on lower species to humans?[297] Fortunately, lawyers have experience dealing with offers of evidence that raise problems analogous to the concept of external validity. Lawyers must frequently consider the similarity of the circumstances between the offer and the litigated event and other accidents, experiments

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crimination against an individual took place. *Compare* Hazelwood School District v. United States, 433 U.S. 299 (1977) *with* Furnco Construction Co. v. Waters, 438 U.S. 567 (1978).

The literature is concerned with the possibility that the jury will be "overawed" by the apparent precision of mathematical proof. The other expressed concern is a fear that probabilistic evidence may detract from legitimacy of the legal system which depends upon individualized determinations. *See supra* note 72.

294. Epidemiology is a science which deals with the incidence, distribution, and control of disease within the population. Epidemiologists have evolved a quite specialized methodology for study of disease that has recently been the subject of a number of law review treatments. *See, e.g.*, Black & Lillienfeld, *Epidemiologic Proof in Toxic Tort Litigation*, 52 FORDHAM L. REV. 732 (1984).

295. The toxic tort case and the question of whether the government ought to act to prevent activity such as smoking or use of a chemical compound raise the difficult question of how the legal system copes with scientific uncertainty. For a number of reasons discussed earlier, the scientist is reluctant to conclude, *even when* there are epidemiologic studies, that the agent in question definitely caused the cancer. Frequently, the epidemiologic studies are non-existent. The scientist can thus typically neither conclude that the variable causes the condition nor does not cause the condition, but he can possibly draw limited inferences about the strength of the relationship. The tenuousness of inference under such circumstances makes the analysis of probative value very difficult. The solution is beyond the scope of this paper but is fortunately the subject of a vast literature. *See, e.g.*, Brennan, *supra* note 263; Rosenberg, *The Causal Connection in Mass Exposure Cases: A "Public Law" Vision of the Tort System*, 97 HARV. L. REV. 849, 855 (1984).

296. For a discussion of this problem, see G. NORTHSTEIN, TOXIC TORTS § 1602 (1984); M. DORE, LAW OF TOXIC TORTS ch. 24 (1987).

297. Such a question may be "trans-scientific," a question which is cast in scientific terms, but is not practically amenable to scientific resolution. Although nearly all known human carcinogens also cause cancer in animals and many scientists are willing to make a leap of faith, questions such as dosage extrapolation still persist. Brennan, *supra* note 263, at 509-10. The federal courts are divided on the question of whether an expert should be permitted to testify as to the cause of human illness based upon animal studies. *In re* Paoli Railroad Yard PCB Litigation, 706 F. Supp. 358, 367 (E.D. Pa. 1988). A brief, recent treatment of the underlying scientific controversy with respect to the megadose problem, one of the most serious with the use of animal studies, is Begley, *These Rats Die for Our Sins: New Attacks on the Relevance of Animal Testing*, Newsweek, Oct. 22, 1990, at 68. While the neutral scientist could not defini-

and/or demonstrations.[298] The proponent bears a heavy burden in demonstrating that a study undertaken in such an alien environment has sufficient external validity in the instant context to meet the reliability threshold.

2. Scientific Technique

Most of the reported cases in the scientific evidence area involve the second level of scientific evidence — scientific techniques based upon underlying scientific theory. The degree to which the technique follows a sound basic theory provides some corroboration for the soundness of the technique. We can be more confident, for example, of a DNA technique when basic research indicates that the unknown sample of material under consideration does contain the genetic information that the technique purports to isolate and compare with a known sample. But even where the underlying basic theory is reliable, the technique may fail to reliably extract the genetic material from the unknown sample or fail to provide a reliable procedure for comparing the known and unknown bands of genetic material.

The three basic criteria by which a neutral scientist determines the reliability of a study — internal and external validity and consistency — are also applicable to studies that a proponent may use in supporting the admission of a technique. At this level, we are most concerned with whether the technique accurately measures or indicates what it purports to measure or indicate.

We must be concerned with whether data exists to support claims of validity. Proponents of particular techniques often have a vested interest in acceptance and have been known to make largely unsupported statements claiming a high accuracy rate for their technique even though validating studies have not been conducted.[299] Yet even where such data does exist, validity studies often fail to control for other possible causes of the observed effect. Adherents, purportedly validating what is called the "dermal nitrate" analysis offered as proof that the subject had recently fired a gun, failed to account for the fact that the residue can also occur naturally at levels similar to gun-shot residues.[300] Accordingly, it is important that the court scrutinize both the

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tively answer the question, she could suggest the considerations which inform an intelligent decision as to the "trans-scientific" question of admissibility.

298. *See* MCCORMICK ON EVIDENCE *supra* note 140, at §§ 196-202 for a discussion of "Similar Happenings and Transactions" and "Pretrial Experiments," illustrating areas in which lawyers must apply Rule 403 and analogical reasoning to determine the admissibility of evidence of similar situations.

299. The DNA example illustrates claims of accuracy without disclosure of validation studies. *See infra* note 303. Kersta, the proponent of voice spectrograms, claimed accuracy without making public the techniques he used in his comparison. SCIENTIFIC EVIDENCE IN CRIMINAL CASES, *supra* note 286, at § 12.06. Two authors who discuss the need to explore the data base are Imwinkelried, *New Era in the Evolution of Scientific Evidence—A Primer on Evaluating the Weight of Scientific Evidence*, 23 WM. & MARY L. REV. 261 (1981), and George, *Statistical Problems Relating to Scientific Evidence*, SCIENTIFIC AND EXPERT EVIDENCE 105 (E. Imwinkelried ed. 1981). George cites several examples of exaggerated claims.

300. The test — also called the "diphenylamine paraffin test" — presents one of the sadder cases of the courts' failure to examine reliability. Initial acceptance of the test came shortly after the test was promulgated. It was twenty-six years before a serious challenge was made. Yet, even after the test was totally discredited, several courts admitted evidence based upon the tests. SCIENTIFIC EVIDENCE IN CRIMINAL CASES, *supra* note 286, at §§ 4.12, 4.25.

adequacy of background data and the research design to determine whether other variables have been eliminated.

Assuming an internally valid study and actual statistical data, the lawyer or judge should ask: "What is the potential error rate of the technique?" The proponents may claim that the technique is ninety-five percent accurate. While this high degree of accuracy may seem to call for admissibility, contextual reliability may be a far different matter. One must also look at the technique in the context of its application, and ask "What is the rate of error for this particular application of the technique?" A "conditional probability analysis" will often yield very different results.[301]

A brief example illustrates this point. Suppose the proponent's expert testified that the results of polygraph testing are ninety-five percent accurate. And suppose that 25 out of every 1000 employees are actually embezzlers. All employees are given a polygraph test to identify the embezzlers, with the following results:[302]

Polygraph Results	Found "Innocent"	Found "Guilty"
95% right	926 /(.95 x 975)	24/(.95 x 25)
5% wrong	1 (.05 x. 25)	49 (.05 x 975)
Total:	927	73
	Actually Innocent	Actually Guilty
Compared to Fact:	975	25

The polygraph examination would indicate that 73 (24 + 49) are guilty whereas only 24 of those identified are actually guilty and would miss one of the truly guilty parties. The examination was only *33%* (24 of 73) accurate in identifying guilty employees rather than the claimed 95% accuracy. The test, however, over-identified embezzlers by 292%, an unacceptable level of false positives by any standard. "Conditional probability analysis" thus indicates a far lower rate of accuracy and reliability than the claimed rate.

Another important consideration is what the data from the technique actually demonstrates. A reliable technique does not necessarily guarantee significant probative value.[303] A great number of tests using chemicals, spectrographic analysis, and nuclear energy, if correctly utilized, permit highly reliable identification of the chemical elements present in a sample. These techniques, however, only establish whether or not the unknown sample is indistinguishable from the known sample. Consider a cigarette found at the crime scene where the brand is the same as the brand smoked by the defen-

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For an excellent discussion of why courts should use base-rate data to provide a basis for evaluating the probative value of forensic evidence, see Saks, *Enhancing and Restraining Accuracy in Adjudication*, 51 LAW & CONTEMP. PROBS. 243, 256 (1988).

301. Skolnick, *supra* note 287, at 714-21.

302. The example is based upon a discussion by John Reed. Reed, *Practical Pitfalls in Handling Scientific Evidence*, in SCIENTIFIC AND EXPERT EVIDENCE IN CRIMINAL ADVOCACY 24-26 (J. Cedarbaum & S. Arnold eds. 1975).

303. George, *The Use and Misuse of Scientific Evidence*, in SCIENTIFIC AND EXPERT EVIDENCE IN CRIMINAL ADVOCACY 10-11 (J. Cedarbaum & S. Arnold eds. 1975). George cites a number of examples.

dant.[304] If the defendant smoked a custom-made brand used by only a dozen people in the metropolitan area, the probative value is high. If he used a brand smoked by thirty percent of the smoking population, the probative value is low. Only by resort to "background" data in addition to the test results can we estimate how likely it is that the specimen was left by the defendant.

Also important is the question of consistency; *i.e.*, the ability to replicate the findings. A major factor in whether other users can replicate a finding is the extent of documentation of the standards for the use of the technique. The more explicit the standards, the greater the ability will be of operators to achieve the same result with the same subject on a different occasion. Where detailed standards for use exist the court can be more confident that the result is not dependent upon the person utilizing the technique. Subsequent replication of the original study itself allows increased confidence in soundness of the technique. Absent public standards which facilitate replicating the study, the original data and scientific conclusions cannot be confirmed. The court must be highly skeptical of the proponent who cannot or will not enumerate detailed standards for replication of the technique.[305]

Related to the question of the existence of appropriate standards is the extent to which the technique involves subjective interpretation of data or requires broad inferences to be drawn from the data. The more the witness must rely on subjective interpretation, the lower the likelihood that different persons applying the technique will reach the same conclusion. Thus, a much greater degree of caution should be exercised in admission of evidence based upon inferences unguided by objective standards.

Many diagnoses rely on soft data and broad inferences from the data. A diagnosis of Post Traumatic Stress Syndrome in the courtroom requires that the interpreter be able to tell whether the subject was in fact exposed to the stressor as claimed, and whether the stressor caused the symptoms.[306] Careful standards

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304. A more sophisticated discussion utilizing neutron activation analysis is Comment, *The Evidentiary Use of Neutron Activation Analysis*, 59 CAL. L. REV. 997 (1971). *See also supra* note 300 for a discussion of "background" data.

305. Recall the 1989 "cold fusion" fiasco. The sponsors of the technique jumped the usual step of publication. Subsequently, many attempts to replicate the experiment were unsuccessful because of the inadequate description of the procedure. Those who claimed to replicate the experiment generally failed to duplicate the results. However, subsequent experiments produced some interesting results — apparently enough to justify additional research. Leary, *Recent Tests Said to Justify More Cold Fusion Research*, N.Y. Times, Oct. 19, 1989, at A20, cols. 1-2. Consider also the much-discussed recent DNA developments. A leading private DNA-testing laboratory revealed its procedures only when required by a court order pursuant to discovery, and did so only under the condition that the disclosure would not go beyond the particular case. Because of competitive fears, the technique was not subject to peer review. Thompson & Scott, *DNA Typing: Acceptance and Weight of the New Genetic Typing Tests*, 75 VA. L. REV. 45, 59-60 (1989). *See also supra* note 20.

306. AMERICAN PSYCHIATRIC ASSOCIATION, DIAGNOSTIC AND STATISTICAL MANUAL OF MENTAL DISORDERS § 309.89, at 247-51 (3d. rev. ed. 1987) [hereinafter MANUAL OF MENTAL DISORDERS]. The problem occurs when applying Diagnostic Criteria A, "existence of a recognizable stressor . . . in a forensic context to demonstrate that a particular stressor occurred." *See, e.g.*, People v. Bledsoe, 36 Cal. 3d 236, 681 P.2d 291, 203 Cal. Rptr. 450 (1984) (court held that it was error to utilize a counsellor's rape trauma testimony to prove the complainant was raped). *See* Massaro, *Experts, Psychology, Credibility and Rape: The Rape Trauma Syndrome Issue and Its Implication for Expert Psychological Testimony*, 69 MINN. L. REV. 395 (1985).

directing the gathering of information, analyzing it, and eliminating rival hypotheses reduce the subjective element. In this regard, the American Psychiatric Association has attempted to establish specific diagnostic criteria to increase the reliability of diagnosis of mental disorders.[307]

The proponents of some identification techniques purport not to make an identification unless certain criteria are satisfied. For example, fingerprint identification rests on establishing a number of common characteristics so that the likelihood of subjective interpretation and resulting expert disagreement is decreased.[308] When generally accepted conservative criteria are required, reliability is high. When the standards are not set at levels intended to minimize false positives and are not generally accepted, the court must carefully consider whether the standards are adequate to ensure reliability.

The court can utilize the margin of error concept to impose safeguards. When the margin of error is identifiable (and the court should be skeptical when it is not), the court can use safeguards to ensure that a properly administered technique results in reliable evidence. Thus, if radar is accurate to plus or minus seven miles per hour at the speed limit, the evidence could be rejected unless the clocked speed exceeded the speed limit by seven miles per hour.

Techniques involving extrapolation of data, such as relating the alcohol content level at the time of the test to the time of driving, often involve simplifications or assumptions[309] which are also amenable to the margin of error analysis. The court can consider the extent to which such assumptions vary in individual cases. If variability in the elimination rate of alcohol from the blood stream was plus or minus twenty-five percent, the court could demand a result twenty-five percent greater than the rate normally accepted as indicative of intoxication. This would preclude error caused by the simplifying assumption. By using the margin of error concept, courts can not only increase probative value but also decrease the contentiousness of expert witnesses.

The extent to which the technique is accepted by scientists in the relevant field also indicates the soundness of the technique.[310] But in this regard, the court must be skeptical of partisan experts as the sole guarantees of general acceptance.[311] The court should consider whether support for the technique has been published in refereed journals and, if not, the extent to which the findings have been otherwise disseminated. Has this dissemination led to confirmation by others, or were the replications non-conforming with resulting critical comment? What is the strength of the confirming or opposing views? What is the expertise, standing, and perceived degree of neutrality of the persons who express them? A scientist would be particularly skeptical when acceptance

307. *See* MANUAL OF MENTAL DISORDERS, *supra* note 306, at 436; Bower, *The Diagnostic Dilemma*, 135 SCI. NEWS 120 (1989). However, many of these criteria require a subjective judgment.

308. SCIENTIFIC EVIDENCE IN CRIMINAL CASES, *supra* note 286, § 7.08, at 436.

309. Fitzgerald & Hume, *The Single Chemical Test for Intoxification: A Challenge to Admissibility*, 66 MASS. L. REV. 23 (1981); Imwinkelried, *supra* note 299, at 276.

310. McCormick, *supra* note 28, at 912. Black discusses the relationship between general acceptance and reliability. *See A Unified Theory of Scientific Evidence*, *supra* note 27, at 627-38.

311. *See Questions Affecting the Admissibility of Scientific Evidence*, *supra* note 22, at 9.

comes only from proponents who are practitioners of the technique.[312] She would also be concerned with the time lag between the initial development of the technique and the offer of the technique: "Has the appropriate scientific community had the opportunity to carefully scrutinize the proposal, to attempt to replicate the technique, and to publish opposing viewpoints?"[313]

While the technique's reception in other courts *may* indicate reliability, it is possible that favorable reception may have no bearing at all. Wariness of other judicial treatment is appropriate. First, the primary consideration is the thoroughness and sophistication with which the pertinent concerns were considered by the precedent court. Second, admissibility of scientific evidence should be a context-specific decision. The expert in a prior case may have adopted different standards for the use of the technique which renders the current technique similar in name only.[314] The probative value of the technique depends upon the care with which the technique was applied in the circumstances at issue, and on the ability of the interpreter. Use of precedent can thus obscure, more than illuminate, the appropriate inquiry.

An even more dangerous judicial practice is resort to the admission of other "analogous" scientific techniques."[315] Techniques, their reliability, and the soundness with which the techniques were applied may vary greatly. Resort to analogous cases, however, does seem helpful to ascertain whether important reliability considerations are being overlooked in passing on a particular technique.

In summary, the court must determine whether studies actually validate the technique in question and whether the technique can be accurately replicated, and then ascertain reliability in context by resort to error rate and relevant background data. The court can also use concepts such as margin of error to build in safeguards which compensate for potential error and thereby increase reliability.

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312. For an instructive discussion of voice print identification (spectrographs), see SCIENTIFIC EVIDENCE IN CRIMINAL CASES, *supra* note 286, at §§ 12.06-07. The initial support by proponents resulted in acceptance by the courts, only subsequently to have the procedure severely criticized by neutral scientists. *See also* the discussion of the rush to initial acceptance of DNA finger-printing, *supra* notes 20, 305.

313. For a classic example of instant judicial recognition, see Coppolino v. State, 223 So. 2d 68 (Fla. Dist. Ct. App. 1968), *appeal dismissed without opinion*, 234 So. 2d 120 (Fla. 1969), *cert. denied*, 399 U.S. 927 (1970). Contrast the importance placed by courts recently on the peer review process. *Richardson*, 857 F.2d at 831; Brock v. Merrell Dow Pharmaceuticals, Inc., 874 F.2d 307, 313 (5th Cir. 1989).

314. The DNA controversy is instructive. Of the three commercial laboratories doing DNA testing, two utilize somewhat similar techniques, while the third uses a very different methodology. Schmeck, *supra* note 1, at B1, col. 1. The FBI recently announced that it will utilize yet another technique which is purportedly more reliable than the commercial ones. Malcolm, *supra* note 20, at A1, col. 1. Thus, while four laboratories proceed from the same basic genetics/molecular biology, their techniques for DNA testing cannot be treated similarly for admissibility purposes.

315. The criterion was identified by the Second Circuit in upholding the admissibility of voice spectrographs. United States v. Williams, 583 F.2d 1194, 1199 (2d Cir. 1978), *cert. denied*, 439 U.S. 1117 (1979). The notion was picked up by Judge McCormick in his "Proposal for a New Model of Relevance Analysis" as one of the eleven factors. *See supra* note 28, at 911-13. Neither the court nor McCormick shed significant light on how the factor should be applied.

3. Application of the Technique on This Occasion

The probative value of the evidence may be nil on a specific occasion, even when the underlying theory and technique is sound or even flawless. A recent study of forensic laboratories indicates deplorably high error rates for commonly used techniques.[316] A number of factors appear to be responsible. Before examining these problems, it is important to note the inadequate attention by legal actors to the particular application of the scientific technique. More attention must be paid to this crucial level of scientific evidence.

The extent to which the designers of the technique promulgate standards for the technique must be brought to bear on this phase of the analysis.[317] Assuming that the technique imposes standards which minimize error in data collection, processing and interpretation, are those standards correctly applied in this particular case? When the standards are marginally adequate, what, if any, additional safeguards were imposed to enhance the reliability of the evidence.[318] Given the adversarial nature of forensic proof, does the expert's reasoning indicate a commitment to scientific objectivity, eliminating the possible dangers of subjective interpretation or rival explanations?[319]

Related to the question of standards application is the question of transferability of the techniques — the appropriateness of the technique in the current context. In what context was the technique designed and validated?[320] To what extent do the conditions of the current situation match the conditions for which the technique was designed and tested? Are they essentially similar so that the studies originally validating the conclusion apply? Or, are they so dissimilar that the court should require validation under the current conditions? When the court doubts the transferability of the technique, it should require a foundational witness who is well versed in the relevant studies, and should additionally consider the resources of the opponent to oppose admission and rebut the evidence if admitted.

Reliability must also be assessed relative to other available techniques which could have been used in the circumstance at issue.[321] Some roughly

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316. *See supra* note 1.

317. *See supra* note 305 and accompanying text.

318. *See supra* note 309 and accompanying text for a discussion of "margin of error."

319. One of the working groups at Symposium I suggested that the judge consider "[w]hether the expert is prepared to discuss uncertainties in the techniques used to prepare the evidence and in the conclusions." *Symposium I, supra* note 12, at 231 (remarks of Margaret Berger). *See also* Judge Weinstein's discussion of the failure to consider the epidemiologic evidence in forming the opinion as a bases for exclusion in *In re Agent Orange*, 611 F. Supp. at 1250.

320. The post traumatic stress syndrome, *see supra* note 306, poses a good example. Rape trauma syndrome was designed to help clinicians diagnose and treat victims of sexual assault. California and other courts have refused to admit evidence of the syndrome to prove that the defendant was sexually attacked. *See, e.g.*, People v. Bledsoe, 36 Cal. 3d 236, 681 P.2d 291, 203 Cal. Rptr. 450 (1984). Linda Carter suggests that the evidence would be inadmissible for the non-designed purpose under either *Kelly-Frye* (the California version of *Frye*) or the enhanced Rule 702 analysis. Carter, *Admissibility of Expert Testimony in Child Sexual Abuse Cases in California: Retire Kelly-Frye and Return to a Traditional Analysis*, 22 LOY. L.A.L. REV. 1103, 1151-53 (1989).

321. For example, a Marquis' reagent test will show a positive purple reaction to morphine, metopon, and heroin. An infrared spectrophotometer can distinguish between the three

similar tests provide more general results than others and therefore have a greater error rate than more specific tests. When the error rate is significant, especially when resources are not equal, the court should consider the availability of other techniques and why the more specific ones were not utilized. A marginal utility analysis can be undertaken. For example, would an alternative technique, available to the proponent, yield a substantially more reliable result for a similar cost?[322]

Courts must consider that the application of a technique typically involves two or more persons. Frequently a technician performs the more mechanical function of preparation for and application of the technique while another more highly trained person interprets the results. Others may be involved in collecting the sample and transporting and/or storing the sample or data. Utilization of standards and/or safeguards must be approached at all levels of data collection, storage, manipulation, and interpretation. For example, when the person preparing the sample contaminates it by placing it in a beaker which contains a residue that will also test positive, the aphorism "garbage-in, garbage-out" applies.[323] The court must also be concerned with the question of sample deterioration prior to actual testing or evaluation.[324]

The qualifications of persons employing the technique, typically lab technicians, are important. What relevant general training has she obtained? What specific training and experience has she had with the technique? Is her work supervised and checked for accuracy? Similarly, the qualifications of the person interpreting the results merit scrutiny. Did she work with the technician to insure that the results were accurate?[325]

The court must also be mindful of the equipment and materials utilized in performing the test. Were the instruments calibrated according to manufac-

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drugs. A laboratory can even determine the percentages of the drug of interest in a sample by use of other tests. SCIENTIFIC EVIDENCE IN CRIMINAL CASES, *supra* note 286, § 6.24, at 373-74.

322. This idea of requiring the "better evidence" under a crude cost-benefit analysis was recently developed by Dale Nance. Nance's argument is that a party owes an obligation to the trier of fact to present evidence which enhances accurate factfinding when the cost is not disproportionate, and when the party reasonably ascertains that the evidence will not be produced by her opponent. The attorney's obligation is a derivative one; *i.e.*, is based upon the client's obligation. Given the difficulties of the lay trier understanding and evaluating specialized evidence, Nance's notion seems particularly applicable to scientific evidence. Nance, *supra* note 74, at 240-43.

323. *See, e.g.*, SCIENTIFIC EVIDENCE IN CRIMINAL CASES, *supra* note 286, at § 2.09 (discussing contamination in chemical tests of intoxication).

324. A scientist-lawyer colleague related the story of closing the Guilford, Conn. beaches for coliform pollution. A water sample was mailed to the lab, allowing time for the bacteria to multiply beyond the level which existed in the sample as originally taken. Similar questions of degradation of the sample abound with respect to techniques like DNA testing which examine human blood or other organic material highly subject to deterioration or contamination. *See, e.g.*, Neufeld & Colman, *supra* note 20, at 51-52.

325. Giannelli and other commentators point out that more complete information is necessary to preclude admission of unreliable expert testimony. Giannelli proposes to amend Rule 702 to require advance written notice of some specificity before such evidence can be used. *Observations on Discovery of Scientific Evidence*, *supra* note 236. The procedures used should be made available far in advance of the admissibility decision. *See supra* note 227 and accompanying text.

turer's specifications and sound forensic practice? Were the storage and handling procedures followed adequate for the instruments involved?[326]

Frequently the offering witness will not be the interpretive analyst or the one who can testify personally to what procedures were followed. The court should require clear evidence that the protocol was followed. It can properly require that persons with particular knowledge be required to complete the foundation with respect to whether standards and safeguards were utilized in this case.[327]

When there is doubt about the adequacy of the foundation and the probable error rate is high because of interpreter subjectivity, concern with whether the data is available for retesting or evaluation by the opponent is appropriate.[328] When the proponent should have substantial doubts about the accuracy of the results, performing or failing to perform a blind repetition utilizing different personnel for crucial evidence would be probative.

A related consideration is the reputation and standing of the foundational witness and the extent to which the expert maintains an impartial scientific posture.[329] Is the expert qualified and respected in the particular field?[330] Does she tend to maintain the scientist's role or is the expert a partisan co-opted by the adversary system?[331] Is the expert willing to candidly discuss

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326. For example, commonly used devices for analyzing breath samples for blood alcohol content may be used in an environment where radio frequency interference leads to distorted readings; the placement of the machine is thus crucial. SCIENTIFIC EVIDENCE IN CRIMINAL CASES, *supra* note 286, § 2.05, at 87.

327. An illustration of the problem is contained in United States v. Oates, 560 F.2d 45 (2d Cir. 1977), dealing with admissibility of documents purporting to be the official report and worksheet of a Customs Service chemist who analyzed the alleged heroin under the business records and government report exceptions to the hearsay rule. A second chemist who had never worked with the author of the documents unsuccessfully attempted to lay the foundation.

A thorough discussion of the report problem is contained in *The Reliability of Scientific Proof*, *supra* note 1.

328. *But see* Arizona v. Youngblood, 488 U.S. 51 (1988), rejecting a challenge to failure to preserve evidence potentially useful to a criminal defendant absent bad faith. It should be noted that a larger sample can be obtained, that techniques can be utilized which do not destroy or use the entire sample amount, and that chemical techniques exist to easily create additional sample material. With respect to the latter, see, *e.g.*, Mullis, *The Unusual Origin of the Polymerase Chain Reaction*, 262 SCI. AM. 56 (April 1990). A DNA fingerprinting technique developed by Cetus Corp. utilizes this P.C.R. or DNA amplification technique. *Id.* The technique has been used forensically although not as extensively as the restrictive fragment length polymorphism (RFLP) technique utilized by Cellmark in *Castro*. Schmeck, *DNA Findings Are Disputed by Scientists*, N.Y. Times, May 25, 1989, at B1, col. 1.

329. *Symposium I*, *supra* note 12, at 231 (report of a working group by Margaret Berger).

330. The problem here is the loose standard applied under Rules 702 and 403 which fails to require sufficient expertise to ensure that the expert can provide a reliable opinion which "assists" the trier. *See, e.g.*, State v. Bubar, 146 Vt. 398, 505 A.2d 1197 (1985) concerning a "counsellor" with no professional certification but who assisted four rape victims over a period of more than four years, attended several training sessions concerning, *inter alia*, problems of rape victims, and who read about victims' problems. The Vermont Supreme Court sustained the trial court's exercise of discretion in finding the witness qualified to testify as to post-attack symptoms on the ultimate issue of whether the rape had occurred. *See supra* notes 306, 320.

331. This requires the judge to think beyond the conventional wisdom of allowing any marginally "qualified" expert to testify and leave it to the trier to sort it out. The minimalist approach ignores the "will assist" language of Rule 702. While the question may initially seem to be a "credibility" question, failure to consider all available evidence, deliberately choosing an

uncertainties in the techniques used to prepare evidence, and in its evaluation, and her conclusion?[332] This consideration is particularly important when a resource imbalance exists and/or discovery is inadequate.

The standing in the forensic community of the laboratory or body providing the analysis is also relevant.[333] Was the laboratory itself formally evaluated, by whom, and with what results? What quality control procedures has the laboratory instituted, especially for this technique? Does the laboratory receive training and back-up services from other highly regarded laboratories or experts? The orientation of the laboratory may affect its analysis. Does the lab only work for a police department? The court must attempt to control institutional bias.[334]

All the foregoing should be considered in determining not only reliability, but also the larger concern of probative value. While these factors are far from exhaustive, hopefully they illustrate that lawyers and the court must go beyond the abstract concerns of theory and technique to focus on questions relevant to application of the theory or technique. One casualty of inadequate attention to application may be the tradition of offering a single foundational witness who may not have employed the technique or interpreted the results. While efficient, the practice should give way when there are reasons to suspect the absence of sound standards and procedures, retention of less than highly qualified technicians, inadequate supervision of personnel, and/or lack of adequate quality control. *If* opposing lawyers are more perspicacious, have better access to expertise, and have adequate discovery in criminal cases, they will be better able to challenge an inadequate basis for the scientific evidence. *If* the courts are more demanding and attorneys become increasingly able to mount a challenge, laboratories will institute better controls rather than squander resources in increased court-time laying a foundation for admissibility. Adequate standards, supplemented by a checklist which ensures actual conformity to the standards, and adequate quality control mechanisms could be used to minimize the need for more than one foundation witness in most cases.

In sum, the court should maintain a *skeptical* posture and should require that the proponent address reliability concerns. With a basic understanding of how a neutral scientist might approach the question and an appreciation of problems which arise at the three levels of scientific evidence, a lawyer or judge can move toward ensuring that the evidence is reliable.

In the short run, adopting a regime in which the court requires the proponent to demonstrate reliability and probative value in context will be costly. The proponent will have to lay a more thorough foundation, laboratories will have to tighten up procedures, and some evidence will be excluded even after a significant outlay of cost. Adequate discovery and court-appointed experts for indigent defendants must be provided in criminal cases if the courts are serious

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unsound mode of collecting data, or ignoring widely available and generally accepted literature make the opinion unhelpful and invite the trier to inaccurately decide the case.

332. *See* the typology of experts developed by Wasyliw, Cavenaugh & Rogers, *supra* note 133.

333. *Observations on Discovery of Scientific Evidence*, *supra* note 236, at 688-91.

about ensuring reliability. But if the courts are willing to maintain a skeptical attitude of "show me that the evidence is reliable and probative in this context," proponents should catch on and eschew much of the marginal evidence. Much of the battle of the experts should be eliminated.[335] Furthermore, by consideration of the above discussion and standards, the courts can clearly help enhance the reliability of the evidence, resulting in greater admissibility — not as a consequence of an arbitrary preference, but rather as a result of standards being met which truly facilitate the accurate factfinding process.

CONCLUSION

The primary purpose of the rules of evidence governing admissibility of scientific evidence is to facilitate provision of evidence which will truly assist a lay trier to achieve the larger goal of the rules and our procedural system of accurate factfinding in the context of fair procedure. The prevalent approach to scientific evidence has tended to focus on the expansive aspect of Rules 401-403 and 702, and has lost sight of other important rules and the larger goal of the rules. In doing so, the courts and commentators have frequently failed to recognize the different quality of scientific evidence and the prerequisites for a lay trier to be able to utilize the evidence to perform its task of accurate factfinding. Furthermore, the virtually exclusive reliance on the exclusionary sanction to meet the purpose of the rules has not been effective: the sanction is little used because it is basically inconsistent with the expansive focus and therefore provides an inadequate incentive for counsel to produce truly helpful evidence.

This paper constitutes a plea to reexamine the approach to admission of scientific evidence to achieve an approach which will better realize the potential of such evidence. Such a reexamination requires that we explicitly address a number of basic issues such as the inherent unfamiliarity of scientific evidence to lay triers, the capacity of and requirements of a lay trier to utilize such evidence, the limitations of counsel and disincentives which tend to produce offers of scientific evidence which fail to meet the requirements, and the tools available to the judge and her ability to utilize them to facilitate admission of evidence which meets the lay trier's requirements. The reexamination requires that an offer of scientific evidence is both reliable in the particular context and comprehensible to the trier of fact, concepts which underlie the relevant rules and larger goals of the evidence rules. The procedural tools exist to implement these concepts.

Continued reliance on a simplistic rule to determine admissibility and the exclusionary sanction as *the* procedural tool will result in continued admission of less-than-helpful evidence. The result will be increased dissatisfaction with

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334. *See* Miller, *Procedural Bias in Forensic Science Examinations of Human Hair*, 11 LAW & HUM. BEHAV. 157, 161 (1987).

335. The recent DNA "finger-printing" episode in New York is illuminating in this regard. Where the defense had adequate expertise and where defense experts met with plaintiff's experts, the experts (other than the testing laboratory) were apparently able to reach a consensus that the procedure utilized lacked the appropriate controls. The judge excluded the evidence but noted that he was confining his ruling to this particular DNA evidence. It seems highly unlikely that Lifecodes, the laboratory involved, will utilize this ad hoc procedure in the future. For a discussion of the DNA/Lifecodes case, see *supra* note 1.

the accuracy of factfinding based upon scientific evidence, greater cynicism as the use of scientific evidence increases, and concomitant pressure to manipulate rules such as Rule 703 to limit the expansive focus of the current inadequate approach.