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Abstract. Briefly sketched is the history of the use of experts' testimony in the courts. Specific rules of federal and state courts have recently made it easier to introduce statisticians' testimony. There are dangers in the free introduction of such testimony. Ways are suggested to assure greater reliability in experts' opinions through improvements in procedure, stronger control by the courts, pressure by outside agencies and substantive law reform.

Key words and phrases: Statistical testimony, statisticians as witnesses, statistical litigation, law and statistics, statistics in court trials, expert statistical witnesses.

As Oliver Wendell Holmes, Jr. overstated the matter in 1896: in law "the man of the future is the man of statistics and the master of economics."[1] Being neither, our problem as judges is how to supervise and control such experts to obtain maximum assistance from them while curbing abuses.

Our task is difficult. The court in *Wilkins v. University of Houston* noted:

> "The bar is reminded that sound statistical analysis is a task both complex and arduous. Indeed, obtaining sound results by these means, results that can withstand informed testing and sifting both as to method and result, is a mission of comparable difficulty to arriving at a correct diagnosis of disease.
>
> We are no more statisticians than we are physicians, and counsel who expect of us informed and consistent treatment of such proofs are well advised to proceed as do those who advance knotty medical problems for resolution. Our innate capacity in such matters extends to "the inexorable zero" and perhaps, unevenly, somewhat beyond; but the day is long past—past at least since the Supreme Court's sophisticated analysis in *Castaneda v. Partida*—when we proceed with any confidence toward broad conclusions from crude and incomplete statistics. That everyone who has eaten bread has died may tell us something about bread, but not very much" (citations omitted).[2]

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To the extent that there are any answers they tend to lie first, in the field of court procedures and, second, in the possibility of controlling experts through professional self-regulation and supervision by private associations and government.

Even more urgent than reducing the difficulties posed by the use of statisticians is the need to reconsider substantive law. Are we demanding more from statisticians than they can give? Illustrative is the broad issue of compensation for alleged toxic tort injury. An example is provided by the personal injury cases of Vietnam veterans who brought individual actions (refusing to join the class action lawsuit) against the chemical companies which manufactured Agent Orange, an herbicide used to defoliate the underbrush in portions of Vietnam. The most serious deficiency in plaintiffs' case was, the trial court found, their failure to present credible statistical evidence of a causal link between exposure to Agent Orange and the various diseases from which they were allegedly suffering.[3]

The very flexibility of the current rules regulating expert testimony requires judges to exercise more control in some cases. Intervention and activism here do not raise the same theoretical problems that have led to criticism of managerial[4] and settling[5] judges. In cases where the testimony of statisticians is critical, the jury can easily be misled because statistics often have the appearance of infallibility. In such cases, intervention and control by the judge is warranted. Yet our basic dilemma is that we must control what, almost by definition, we do not as laypersons understand.

The material which follows briefly sketches the history of the use of expert testimony in the courts. Then it describes the loosening of legal procedural rules making it easier to use expert testimony. This is

followed by a discussion of the dangers created by free introduction of such testimony. Finally, there are suggestions for assuring greater reliability in experts' opinions.

HISTORY

The use of probability and statistics in the legal process is not unique to our times. Two thousand years ago, Jewish law, as stated in the Talmud, cautioned about the use of probabilistic inference. The medieval Jewish commentator Maimonides summarized this traditional view in favor of certainty when he noted:

> "The 290th Commandment is a prohibition to carry out punishment on a high probability, even close to certainty . . . No punishment [should] be carried out except where . . . the matter is established in certainty beyond any doubt . . . ."[6]

That view, requiring certainty, is not acceptable to the courts. We deal not with the truth, but with probabilities, in criminal as well as civil cases. Probabilities, express and implied, support every factual decision and inference we make in court.

In 18th and 19th century France the legal uses of mathematical probability were discussed by Voltaire, Condorcet, Laplace, Lacroix, Poisson, Cournot, Guibert and Bienayme, These discussions, however, were largely theoretical.[7]

In England, early 19th century evidence texts began to refer to mathematical probability. Jeremy Bentham proposed that witnesses and judges numerically estimate degrees of persuasion. He envisioned a moral thermometer:

> "The scale being understood to be composed of ten degrees—in the language applied by French philosophers to thermometers, a decigrade scale—a man says, My persuasion is at ten, or nine, etc. affirmative . . . ."[8]

Responding to Bentham, Thomas Starkie wrote:

> "The notions of those who have proposed that mere moral probabilities or relations could ever be represented by numbers or space, and thus be subjected to arithmetical analysis, cannot but be regarded as visionary and chimerical."[9]

The first practical attempts to use statistics in the courtroom possibly occurred in this country. In the famous Howland will case[10] the allegation was that two signatures on different pages of a will were so similar that one must have been traced from the other. To support this claim, counsel for the defense retained a Harvard mathematician as an expert witness. The expert undertook to demonstrate by statistical means that the disputed signature was a forgery. The method he used was to contrast the similarities between the disputed signature and the unquestioned original with the lesser degree of similarity to be found in forty-two other signatures penned by Sylvia Howland.

ELIMINATING RESTRICTIONS

As technology advanced and expert testimony became more important in the resolution of increasingly complex litigation, unnecessary impediments to the use of available analytical techniques became unacceptable. Following a good deal of sensible case law and practice loosening up common law restrictions, the Federal Rules of Evidence were adopted in 1975. Substituted for the common law rules was a broadly discretionary set of guides to be discussed below. The Federal Rules have been adopted, with minor variations, by more than half the states.

Soon, however, as with many reforms, the secondary effects became apparent, leading to the question whether we had not created more difficult problems than the ones we had solved. We are reminded of Macaulay's retort to a plea for his support of parliamentary reform: "Reform, reform, don't speak to me of reform. We're in enough trouble already."

Most important of the new rules in the context of this analysis is Rule 702 of the Federal Rules of Evidence. It provides that expert testimony is admissible "[i]f scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue." The breadth of the "assistance to the trier of fact" standard has encouraged courts to adopt a balancing test in determining the admissibility of expert testimony. According to one formulation of the balancing test, Rule 702 requires that a district court

> conduct a preliminary inquiry focusing on (1) the soundness and reliability of the process or technique used in generating the evidence, (2) the possibility that admitting the evidence would overwhelm, confuse, or mislead the jury, and (3) the proffered connection between the scientific research or test result to be presented, and particular disputed factual issues in the case.[11]

By focusing not only on the reliability of the proposed evidence, but also on the jury's probable response to it, this test authorizes the admission of various types of novel expert testimony.[12]

Rule 702 has been held by the Ninth Circuit in the recent case of *Shad v. Dean Witter Reynolds*[13] to require reversal of a trial court's exclusion of expert statistical opinion concerning churning in a securities case involving the defendant brokerage house's management of plaintiff's account. The court held

that one of the components of churning is excessive trading.

> The significance of statistical measurements of account activity, such as the turnover rate, is apparent only in comparison to activity in other accounts. If an expert is not allowed to testify that given statistics evidence excessive trading, the jury is left with meaningless numbers from which they cannot judge the appropriateness of the transactions.[14]

No one can rightly object to this opening up of sources of information. As long as the balancing is sensibly done, it puts before the jury testimony that may assist it in reaching the proper result on the merits.

The Federal Rules of Evidence made a number of other important liberalizing changes. Rule 703 provides that the facts or data on which an expert bases his opinion need not be admissible if they are of a type "reasonably relied upon by experts in the particular field in forming opinions or inferences on the subject." By allowing experts to rely on hearsay and the opinions and analyses of others—provided the data is sufficiently trustworthy—Rule 703 simplifies the expert witness' task, allowing the expert to function in court in much the same way he or she does outside of court.[15]

Rule 704 abolished the old rule against expert testimony on the ultimate issue of fact.[16] In practice the abolition has had a limited impact because the courts prefer to keep the expert's opinion at least one step removed from the material proposition to be proved, leaving to the jury the final step. Rule 705 allows the expert to present his information much as he would to a client without such trappings as hypothetical questions.

Rule 706 allows the judge to appoint expert witnesses, independent of any wishes of the parties. The parties are permitted to take the deposition of a court-appointed expert as a matter of right. So as not to unduly influence the jury, the judge is granted discretion to withhold from the jury the fact that the court appointed the expert.

Other rules that do not deal directly with expert witnesses have nonetheless had the effect of increasing the utility and impact of expert testimony. If, as was formerly the case, the rule against hearsay—that is evidence of statements made outside of court and introduced for their truth—still prevented experts from relying on documents and statements not in evidence, many experts would be severely limited. Modernization of the exceptions to the rule against the introduction of hearsay evidence has resulted in the admission into evidence of much more diagnoses and treatment under Federal Rules 801(a), 803(3) and 803(4). Rules 803(6) and 803(8) provide exceptions to the hearsay rule for business records and government records and reports. Because these kinds of records often provide the raw data upon which expert opinions are based, the effect of these exceptions is to allow expert witnesses to provide the trier with the evidence that provides the basis for their opinions in those cases where its introduction may be helpful in proving the case. Rule 803(8)(C) allows introduction into evidence of "factual findings resulting from an investigation made pursuant to authority granted by law, unless sources of information or other circumstances indicate lack of trustworthiness." A number of courts have found epidemiologic studies conducted by the government sufficiently trustworthy. The Fourth Circuit, in *Ellis v. International Playtex, Inc.*,[17] recently held admissible under Rule 803(8)(C) epidemiologic studies of toxic shock syndrome conducted by the Federal Centers for Disease Control and three state health departments. The court noted that the CDC and state health departments used "uniform procedure and methods that are widely accepted by their peers" and carried out the studies in a timely and impartial manner.[18]

The learned treatise exception to the hearsay rule, Rule 803(18), and such exceptions to the hearsay rule as Rule 803(17) on market and commercial reports, are also important. They make it easier for expert witnesses to educate the trier about a body of knowledge that may be unfamiliar to the layperson. For instance, in the "Agent Orange" case there were over one hundred epidemiologic studies not conducted by government officials which may have been admissible under Rule 803(17) or under Rule 803(6) as records of regularly conducted activity.

The Rule 803(6) exception to the hearsay rule explicitly includes diagnoses and opinions, so that an expert's opinion can come in without the expert ever appearing. Of course, tactical pressures to produce the most persuasive evidence will result, in many instances, in the use of an expert's live testimony.

Rule 1006 allows summaries of voluminous data to be introduced into evidence despite the traditional "best evidence" rule which would require production of every original document or a copy thereof. This rule provides expert witnesses such as accountants and analysts with an additional convenient and understandable way to present their data.[19]

Today it is not uncommon to permit experts to read all or part of their reports into the record. Many courts will sensibly mark the reports—prepared for the litigation—in evidence, so that the jury can study the documents and any attendant tables, pictures and diagrams. Each juror may be given a copy of the report

so that he or she can follow the testimony and study the report at leisure in the jury room the way any responsible and intelligent layperson would want to.

Experts sit in court and hear all or part of the testimony. Frequently they base their reports on a summary of the facts given to them by the attorney informally by telephone or letter.

The Federal Rules of Evidence and their state counterparts have thus produced an enormous loosening up of the restrictions on the admission of expert testimony, on its basis, on its form and on the effective utilization of such testimony once admitted. This relaxation was needed to give the trier of fact convenient access to the reliable technical knowledge that is available in our modern society. As might be expected, however, the modification of the old rules has led to new difficulties.

PROBLEMS UNDER THE FEDERAL RULES

Unfortunately, we have concluded that an expert can be found to testify to the truth of almost any factual theory, no matter how frivolous, thus validating the case sufficiently to avoid summary judgment and forcing the matter to trial. At the trial itself, an expert's testimony can be used to obfuscate what would otherwise be a simple case. The most tenuous factual bases are sufficient to produce firm opinions in some experts to a high degree of "probability." Juries and judges can be, and sometimes are, misled by such experts for hire.

Rules 401 and 402 state the general standard for admissibility of all relevant evidence: If the evidence may reasonably affect the trier's evaluation of the probability of a material proposition of fact it is admissible. The probabilities are determined in the usual case in most subjective and unscientific ways according to the trier's limited experience. Precise attempts to fix probabilities in quantitative form are usually impossible because of the absence of adequate experimental data.

Some commentators believe that jurors should be made aware of the range of probabilities that exists with regard to an item of proof and should be instructed on how their assessment of the applicable probability would affect their conclusions. The dangers inherent in such an approach are illustrated by the well known—and atypical—case of *People v. Collins*.[20] In *Collins*, an eyewitness to a robbery described the perpetrators as having the following six characteristics: a man with a mustache; a Negro man with a beard; a girl with a pony tail; a girl with blond hair; an interracial couple in a car and driving a partly yellow automobile. Lack of any data concerning the incidence of each characteristic[21] in society and the independence of the factors,[22] led to an absurd multiplication by a mathematician who "found" that the chances that the defendants were not the perpetrators were one in twelve million. On appeal the conviction was, of course, reversed.

By contrast, in a recent New York Court of Appeals case, *People v. Mountain*,[23] the court joined a number of other courts in affirming the use of statistical evidence of blood types in a rape trial.

> Although blood grouping may only serve to show that the defendant and the assailant are part of a large group having that particular characteristic, it does not follow that such proof completely lacks probative value. When identity is in issue, proof that the defendant and the perpetrator share similar physical characteristics is not rendered inadmissible simply because those characteristics are also shared by large segments of the population. For instance, evidence that the person who committed the crime was white would not be excluded although that may include 80% of the population. Similarly, evidence of a person's sex, which would include roughly 50% of the general population, is routinely accepted as having some probative value with respect to identification. Proof of such common characteristics, of little value individually, may acquire great probative value when considered cumulatively.[24]

Some of the most serious problems with the use of statistics in evidence arise in mass toxic tort cases where statistics are often the major proof offered to establish causation. As the trial court indicated in the "Agent Orange" opt out cases, the plaintiffs' statistical evidence was insufficient to establish a causal relationship between exposure to "Agent Orange" and the diseases they were allegedly suffering from.[25] Therefore, summary judgment was appropriate.

Nuclear accidents such as the recent one at Chernobyl provide a striking example of this problem. Scientists estimate that an additional 25,000 to one million people who are presently alive will die of cancer because of this accident. This figure may seem high, but total cancer deaths in the affected population are expected to total in the order of 100 million.[26] If the accident had occurred in the United States, we would almost undoubtedly see a spate of lawsuits by persons claiming that their cancer was—or will be—caused by the Chernobyl incident. How would we handle such lawsuits? At trial, statistical analyses would be offered by one side to prove that the cancer was caused by the Chernobyl disaster and by the other side to prove that it was not but, rather, was caused by exposure to other harmful chemicals or from a

genetic defect inherited from some ancestor or from unknown causes.

If causation cannot be demonstrated with more than 50% probability, can we—should we—compensate the alleged victims of such a disaster? What degree of certainty should be required for recovery? Perhaps we should allow a comparative recovery similar to that in comparative negligence. Therefore, if there is a 10% chance that a plaintiff acquired the disease due to the accident at Chernobyl, he should receive an award of 10% of his damages. What are the effects of such a system for recovery? On the one hand, plaintiffs would receive something. On the other hand, such a system would increase nuisance cases and might inhibit scientific development. In situations such as this a welfare, rather than a tort, system may be more sensible.

Discretionary rules such as 403 of the Federal Rules of Evidence—permitting the court to exclude evidence where the danger of prejudice outweighs probative force—help curb the potential abuses that have appeared since adoption of the Rules. Courts are reluctant to admit evidence that has an aura of scientific infallibility, particularly where the jury may use the evidence for purposes other than that for which it was introduced. Statistics can easily become, in the words of one court, "an item of prejudicial overweight."[27] They may suggest to the jury that the probability that the ultimate fact to be proved is true can be equated with the statistical probability offered in evidence.

For example, in *United States v. Massey*,[28] a prosecution for bank robbery, the prosecutor introduced evidence that three of five hair samples on a ski mask found in a residence in which the defendant was present, and identified as similar to one worn during the robbery, matched the defendant's hair in all respects under microscopic examination. A hair analysis expert testified that the likelihood that any one individual's hair would meet all the characteristics of another's was perhaps 1 out of 1000 cases or even 1 in 4500. In summation, the prosecutor argued that the hair sample evidence alone constituted proof beyond a reasonable doubt of the defendant's guilt.[29]

The Court of Appeals reversed the conviction, finding that the expert's testimony lacked a proper foundation and was confusing. There was no evidence of the circumstances surrounding the expert's examinations, nor any foundation to establish a statistical probability from his experience or the research of others. The court found reversible error in the suggestion by the prosecutor in summation that the statistical odds showed a better than 99% chance of defendant's guilt. This statement had "infused in the minds of the jury the confusion in identifying the hair with identifying the perpetrator of the crime."[30] The court quoted with approval the following language from the Minnesota Supreme Court:

> "Our concern over this evidence is with its potentially exaggerated impact upon the trier of fact. Testimony expressing opinions or conclusions in terms of statistical probabilities can make the uncertain seem all but proven, and suggest, by quantification, satisfaction of the requirement that guilt be established beyond a reasonable doubt. Diligent cross-examination may in some cases minimize statistical manipulation and confine the scope of probability testimony. We are not convinced, however, that such rebuttal would dispel the psychological impact of the suggestion of mathematical precision and we share the concern for the substantial unfairness to a defendant which may result from ill conceived techniques with which the trier of fact is not technically equipped to cope."[31]

Nevertheless, when there is an adequate foundation for the statistical probabilities, and they are properly used and explained, their probative value may outweigh their tendency to confuse and mislead, thereby warranting their admission into evidence.[32] Such statistical data may, when used with devices such as Bayes' formula, permit combinations of anecdotal and valid statistical data to prove guilt.[33]

Although the relevancy of statistics in general is indisputable, as courts have become more familiar with the use of statistics, they have become increasingly demanding of statisticians.[34] Thus, in *Hazelwood School District v. United States*,[35] an action alleging that the defendant had engaged in a pattern or practice of racial discrimination in hiring teachers, the Supreme Court sent the case back to the district court with instructions to refine the statistics used with respect to the relevant geographic area. The Supreme Court emphasized that "statistics . . . come in infinite variety . . . [T]heir usefulness depends on all of the surrounding facts and circumstances."[36] The use of statistics requires great care, careful cooperation with experts and full pretrial procedures to agree on data bases and applicable theory. The complexities involve not only the proper source and selection of statistics, but also the manner in which they are interpreted.[37]

New discretionary controls may be needed to curb the potential abuses that have appeared since the adoption of the Rules. But how can discretion be bridled in a manner predictable and fair? How can the nonexperts control the experts?

PROCEDURAL CHANGES

Some courts have begun taking procedural steps to limit or control expert testimony. The primary actions

taken to date involve supervision of the preparation of expert testimony in the pretrial stage.

Some local practice, for example, requires each party to identify the experts that it will use at trial and to provide a summary of those experts' expected testimony.[38] A number of federal judges require that parties provide a glossary of terms that their experts will use at the trial.[39] Intended primarily to assist the reporters to take testimony accurately, the definition of terms—particularly if the experts can agree on them—can be used by the judge in preparing for the trial.[40] Although I have not yet tried it, I would be ready to order the furnishing of a list of exotic terms with definitions for each of the jurors as part of his or her notebook in a complex case.

Joint pretrial meetings between the judge and key expert witnesses are becoming more frequent.[41] The presence of each sides' experts at the other side's experiments or data is also encouraged.[42] Some courts require that each side list before trial those learned treatises admissible under Rule 803(18) and other hearsay that it intends to rely upon at trial.[43]

More might be done. Further improvements in pretrial procedure should be considered. The Special Committee on Empirical Data in Legal Decision Making of the Association of the Bar of the City of New York has made a number of useful recommendations regarding control of statistical evidence. These include proposals that a party offering data or data analyses at trial be required at each stage of discovery to provide the opposing party with all the underlying records from which the data were collected[44]; that a party offering data or data analyses at trial make available for conferences with other parties the personnel that compiled the data[45]; that parties attempt to agree on a data base well before trial[46]; and that parties be required to object to their opponent's experts' analysis before trial.[47] Data should be supplied in a form readily useable by other experts, such as compatible tapes. In a similar vein, it has been suggested that parties be compelled to reveal the names of all experts they have hired or consulted even if they will not be testifying at trial.[48]

One court recently held that Rule 26(b)(4)(B) does not prevent deposing an adversary's nontestifying expert witness, upon whom the testifying expert relied, pertaining to facts known and opinions held by the expert prior to the time he began to work for the adversary. "[T]his interpretation of the rule appears to be the only way to stop parties from hiring experts and then electing not to use them as witnesses for the sole purpose of keeping their expertise completely out of reach of their opponents."[49] Amendment of Rule 26 of the Federal Rules of Civil Procedure to regularize this practice, encouraging the taking of depositions of nontestifying experts who have conducted statistical analyses might be helpful.

Pretrial (*in limine*) rulings on conditions for admission of evidence are increasingly being utilized. They are useful because they give the parties pretrial directions.

The court can employ various techniques to enhance the capability of the fact-finder to understand the issues and the facts. For instance, a special master can be appointed pursuant to Federal Rule of Civil Procedure 53 to help the parties assimilate complex material and to present it at trial. Federal Rule of Evidence 611 states the power of control by the court of proceedings before it, which the judge can use to adjust trial procedures in ways that make statistical evidence more understandable. One simple example which is sometimes used is foregoing the traditional sequence of having one party present all of its witnesses before the other party presents its witnesses, in order to have the jury hear all expert witnesses on a particular issue sequentially. The judge may also question experts in order to simplify terms and make statistical data comprehensible to the jury.

The objective of all these suggested modifications to current procedure is to subject expert testimony to more informed scrutiny by the opposition's experts and lawyers. Ours is an adversarial system, and it is therefore quite proper for us to stress sharpening the adversaries' weapons as a means of improving the functioning of the courts. Such reforms avoid some of the hazards of unlimited discretion which lead to surprise at trial and which require overpreparing for eventualities which may not come to pass.

Minitrials and other like devices to permit a preliminary test of judge and jury reaction to proposed expert testimony may be useful in complex cases. In bench trials, I from time to time use a technique of swearing all the experts, seating them at the table together with counsel and the judge and engaging them in recorded colloquy under court direction. These discussions have sometimes produced a more reasonable attitude by the experts and considerable narrowing of disagreement among them.

The possible use of alternative dispute resolution techniques in highly technical cases needs to be explored. Arbitration by panels of technical experts—a latter-day version of the common law's special jury—is a possibility that deserves, and seems to be receiving, favorable attention.[50]

CONTROL BY OUTSIDE AGENCIES

The formulation and enforcement of ethical standards for expert witnesses might help to curb abuses. The Panel on Statistical Assessments as Evidence in

the Courts of the National Academy of Sciences[51] is considering the proposal that professional organizations develop standards for expert witnesses in legal proceedings who use statistical assessments with respect to (i) procedures required to ensure reliability in connection with frequently used statistical techniques, (ii) disclosure of methodology and (iii) disclosure of aspects that may raise ethical considerations.[52] The Panel is also considering a proposition that statistical experts who consult or testify in litigation maintain the degree of professional autonomy required by independent scientific research.[53] Precisely how these proposals could be implemented is unclear.

In addition, it may be helpful to devise some sort of professional licensing system to certify expert witnesses as being qualified to testify in a given field. An analogy would be to board certification of medical specialists. We must be careful, however, to avoid establishing such high standards for expert witnesses that we end up in some cases without any witnesses who are qualified to—or who will—testify.[54] This situation at one time existed in the medical malpractice field. The result was that people with arguably valid claims for mistreatment could not prove them.

When a state-licensed expert gives an unprofessional opinion on the stand he or she should be subject to state discipline.[55] I have had medical testimony before me that was shockingly suspect. Had a lawyer given equivalent misleading information I would have brought the matter to the attention of the disciplinary authority. What realistic threat exists against doctors? As to unlicensed economists or statisticians, the matter is now hopeless.

What at least can be expected is that learned journals criticize testimony and court opinions that do not meet professional standards. As with book reviews, this peer criticism may prove helpful in curbing future errors.

SUBSTANTIVE REFORM

In some cases the substantive law places too heavy a burden on experts.[56] Modification of that law is needed to reduce expert witness tensions. In many toxic tort damage cases, honest experts find it impossible to say that a particular claimant more probably than not was damaged by a particular chemical from a particular company.[57] We are in the process of considering changes to substantive procedural law to meet this kind of problem.

Changing burdens of proof can help to take some pressure off expert witnesses. The elimination of contributory negligence as a complete defense made expert testimony less crucial and created some room for play by eliminating the all-or-nothing effect of a plaintiff's negligence. In such cases, the burden of proof was altered in fact if not in theory. In both the worker's compensation and social security areas, whether the probability is over 50% or under 50% is similarly not critical. In the "Agent Orange" cases, it was suggested that the burden of proof could be altered by looking at the plaintiffs as a class and asking whether the class as a whole had been harmed in a statistically significant way, rather than asking whether a particular plaintiff had more likely than not been harmed by a particular defendant.[58]

In the area of medical malpractice, expert testimony might not be as critical if we relaxed the plaintiff's burden of proof, while simultaneously curtailing recoveries for pain and suffering to reduce adverse effects on doctors and malpractice insurers.[59] A full program of medical and disability benefits for all could eliminate much of this last kind of proof problem.

Shifting the emphasis in malpractice cases to full social insurance and more effective state and peer disciplining of doctors would reduce our malpractice expert problems.[60] Such proposals for substantive reform may seem like pie-in-the-sky, but workers' compensation and automobile no-fault liability statutes indicate that given the serious issue of insurability at a reasonable cost in a number of tort fields today, substantive and procedural changes are possible.

If adequate control is impossible, it may be necessary to cut back on expansion of tort liability in a variety of ways. The expansion of substantive bases of liability *plus* the ease in proof has helped create what some contend is an almost intolerable situation in fields such as manufacturers' and municipal liability, toxic torts and malpractice. It is certainly time to consider changes in the substantive law of toxic torts.[61]

EQUALIZATION OF POOR PERSONS' ACCESS TO EXPERTS

Other reform possibilities will require greater assumption of responsibility for implementing institutional changes in the courts. First, there is the problem of redressing the mismatch that results when one party has access to experts and the other party does not.[62] In *Ake v. Oklahoma*,[63] the Supreme Court held that an indigent criminal defendant is entitled to a state-provided psychiatrist to examine him and assist in the preparation of an insanity defense once a threshold showing that such assistance might be helpful is met.[64] And in another case, the Supreme Court ruled that in a paternity suit brought by the state, which is quasicriminal, the state must pay for blood tests.[65] But no such assistance is available as of right to an indigent litigant in a civil suit. Some kind of assistance for indigent litigants, either provided by

experts for no fee, similar to the bar's provision of legal representation without charging a fee, or fees paid for by the government, is needed.

The Eastern District Litigation Fund was established to help meet this last problem in my court. It provides some money for expenses incurred by attorneys appearing without charge (pro bono) for indigent litigants who need expert testimony.[66] Such funds cannot provide a complete solution. We need voluntary panels of experts such as medical doctors, statisticians and the like, to provide for the indigent and the lower middle class.

RULE 706 AND MASTERS TO ASSIST COURTS

Even when both parties can afford experts and have actually hired them, the issues in some cases may remain so muddled that the trier of fact needs more even-handed expert assistance. This problem is one that has been noted before. Judge Learned Hand wrote about it in 1901,[67] when he proposed a solution strikingly reminiscent of modern Rule 706 which allows the court to appoint its own expert witnesses.[68]

Judges have generally been reluctant to exercise their Rule 706 powers. The establishment of regional and national panels of experts in certain areas of expertise needs to be explored.[69] Perhaps if neutral experts from panels were more readily available, judges would be more likely to turn to them for help.

Use of technical masters to supervise discovery and preparation of expert testimony is also possible. We will, I believe, see an expansion of the use of special masters for this purpose.

An important distinction exists in the relative ability of trial and appellate courts to induce the production of technical evidence superior to that provided by the parties. Trial courts are able, through the means just discussed, to develop new evidence. Appellate courts, in contrast, must rule on the record developed at trial, and hence are unable, except through limited and sometimes hazardous reliance on judicial notice, to improve upon the parties' attempts to adduce technical evidence.[70]

SCIENTIFIC STUDIES FOR GOVERNMENTAL AND OTHER AGENCIES

A Rule 706 expert is incapable of conducting the expensive studies needed in much modern litigation. For example, in the swine flu, "Agent Orange," DES, toxic shock syndrome and asbestos cases, the requisite studies cost millions of dollars, and some took years to conduct. Where cases involve many plaintiffs or serious public issues, effective court control requires that studies be conducted as promptly as possible by impartial agencies.[71] In many instances such institutions as the Centers for Disease Control or the National Center for Health Statistics or the National Academy of Science will in the normal course of business produce acceptable data or analyses. Other studies will be produced by eminent scientists, such as Dr. Irving J. Selikoff of the Mount Sinai School of Medicine of the City University of New York, whose studies of carcinogenic effects of asbestos on workers proved decisive in many of the asbestos cases,[72] or by special public funding, as in the "Agent Orange" cases. Who pays for these studies is a question vital to the proper handling of these matters.

STRONGER CONTROL BY COURTS

When all else fails—when neither improved pretrial procedures nor strengthened ethical codes succeed in terminating litigation in which one party's position is grounded solely on specious expert testimony—it may be the task of the judge to do what the adversarial process and professional ethics have failed to do.[73] This is strong medicine. It impinges on our constitutional notion of the right to a jury trial. And, as I have already indicated, I share the concern with placing more power and discretion in the "unlearned" court.

SUMMARY JUDGMENT AND DIRECTED VERDICTS

The use of summary judgment in highly technical litigation may have to be expanded to prevent the enormous waste of resources caused by taking baseless or overwhelmingly strong cases to trial.[74]

Under the Federal Rules of Evidence, a judge can exclude expert testimony and thus grant summary judgment in one of two ways. First there is Rule 703, which allows an expert to base his opinion on the type of evidence reasonably relied upon by experts in his field. In some cases examination of the basis of an expert's opinion reveals that it is supported by no reliable evidence at all. In such cases exclusion of the expert's opinion under Rule 703 and a grant of summary judgment to the opposing party would be appropriate.[75] In other cases, an expert's opinion is supported by *some* credible evidence, but further investigation reveals that there is other, much more persuasive evidence available which undermines the expert's opinion and which the expert is ignoring. In these cases, the court might exclude the expert's testimony either under Rule 702, as not being helpful to the trier of fact, or under Rule 403, which allows exclusion of relevant evidence whose probative force is considerably outweighed by its possible prejudice, as being likely to mislead the jury.[76] Both the reasoning and the result are much the same regardless of which rule is used.

Judgments notwithstanding the verdict or directed verdicts may need to be used more. Obviously, summary judgment is more effective in saving time. Perhaps a form of minitrial combined with summary judgment needs to be developed.

Sanctions against attorneys and clients for pressing frivolous lawsuits may have some impact in limiting the use of frivolous expert opinions.[77] Generally I am not in favor of such punitive measures, but they will undoubtedly have some effect in reducing abusive use of experts. Would it not be proper to consider an amendment to Rule 11 of the Federal Rules of Civil Procedure, and like state provisions, permitting sanctions against attorneys and clients for frivolous actions? Should we enable the court to impose sanctions directly against the expert? There may even be inherent power in the court to deny an expert a fee for spouting nonsense. These sanction rules are probably too dangerous because they may be applied against a careful expert whose opinion may appear at the time to be frivolous to other experts and courts.

QUESTIONS AND COMMENTS BY THE JUDGE

Federal judges, and some state judges, have extensive power to comment on the evidence.[78] This power is seldom used. In the area of scientific proof and expert witnesses, the judge may need to express the court's views more forcefully to guide the jury. Alternatively, the court can provide the jury with assistance in a somewhat less heavyhanded manner by asking questions of an expert witness (or by suggesting them to counsel) where it appears to the court that counsel is doing an inadequate job of bringing out the salient facts or that the jury is missing the point. Both these alternatives imply that the court is capable of commenting or questioning intelligently.

THE ROLE OF THE JUDGE IN NONJURY TRIALS

In a nonjury trial it is desirable, to the extent practicable, for the judge to become familiar with the scientific background by reading about the issues and discussing them with the experts. There is some danger here, of course, because a half-informed layman can do more damage than one who suffers from a complete lack of knowledge but also is aware of his or her limitations. Nevertheless, some attempt at self-education and understanding is desirable—as long as the parties are made aware of the judge's efforts and can provide assistance. Thus, it would be appropriate for the judge to request the parties to provide a reading list. It would also be proper to require the parties to allow the judge to observe experiments or other relevant happenings.[79]

Passivity by the court when serious scientific questions of more than passing importance are involved is no virtue. The court owes an obligation to the parties, to society and to itself to assist in obtaining the best possible answers to the scientific questions before it.[80] That will mean forcing the parties to gather and present evidence effectively, calling upon other experts as necessary and studying to obtain the understanding needed to maintain effective control.

THE PROBLEM REMAINS UNSOLVED

It should be apparent that increasing judicial discretion in the manner that I have suggested poses serious problems. Is there not something just a little bit odd about giving judges, whose ignorance of matters scientific is well known,[81] the final word on the value of expert testimony?

Other proposals, such as those for stricter ethical standards for experts, do not raise any constitutional problems, only practical ones. How, for example, do you legislate ethics?

There is much room for reflection and debate. The bench and bar are so heavily involved in day-to-day matters that sometimes they do not fully appreciate what the problems are and how they might be solved. Moreover, a tendentious quality is added to much of the debate by those whose financial interests may be seriously affected by major substantive or procedural changes. The leadership in this area must be provided by the relatively impartial law schools and learned societies such as the National Academy of Sciences.

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NOTES

These notes have been kept to a minimum because a treatise is available for authority. See WEINSTEIN, J. and BERGER, M. (1986). *Weinstein's Evidence* and WEINSTEIN, J., MANSFIELD, J., ABRAMS, N. and BERGER, M. (1988). *Cases and Materials on Evidence*, 8th ed. Chap. 1.

[1] Panel on Statistical Assessments as Evidence in the Courts, Committee on National Statistics and Committee on Research and Law Enforcement and the Administration of Justice, Commission on Behavioral and Social Sciences and Education, National Research Council, The Evolving Role of Statistical Assessments on Evidence in the Courts at 9 (Draft Jan. 1986) [hereinafter Assessment Panel].

[2] *Wilkens v University of Houston*, 654 F.2d 388, 410 (5th Cir. 1981).

[3] See *In re "Agent Orange" Product Liability Litigation*, 611 F. Supp. 1223 (EDNY 1985) (summary judgment granted against opt out plaintiffs); 611 F. Supp. 1267 (EDNY 1985) (Lilley opinion), *aff'd*, 818 F.2d 187 (2d Cir. 1987). See also "Lack of Military Data Halts Agent Orange Study." *The New York Times* **136** Sept. 1,

1987, at A1, col. 3 (impossible to do research because of difficulty of measuring exposure).

[4] See, e.g., Symposium on Litigation Management (1986). *Univ. Chicago Law Rev.* **53** 306; RESNIK, J. (1982). Managerial Judges, *Harvard Law Rev.* **96** 374, 424–426; ELLIOTT, E. (1986) Managerial judging and the evolution of procedure. *Univ. Chicago Law Rev.* **53** 306. But see MCGOVERN, F. (1986). Toward a functional approach for managing complex litigation. *Univ. Chicago Law Rev.* **53** 440.

[5] See id.; see also FISS, O. (1984). Against settlement *Yale Law J.* **93** 1073; SAROKIN, H. L. (1986). Justice rushed is justice denied. Unpublished. But cf., e.g., PECKHAM, R. (1985). A judicial response to the cost of litigation: Case management, two-stage discovery planning and alternative dispute resolution. *Rutgers Law Rev.* **37** 253.

[6] RABINOVITCH, N. (1973). *Probability and Statistical Inference in Ancient and Medieval Jewish Literature* 111. Univ. Toronto Press, as cited in Assessment Panel, note 1 at p. 312.

[7] Assessment Panel, note 1, at p. 310.

[8] BENTHAM, J. (1827). *Rationale of Judicial Evidence, Specifically Applied to English Practice* (J. S. Mill, ed.), as cited in Assessment Panel, note 1 at p. 311.

[9] STARKIE, T. (1833). *A Practical Treatise of the Law of Evidence*, 2d ed., 225, as cited in Assessment Panel, note 1 at p. 311.

[10] *Robinson v Mandell*, 20 F. Cas. 1027 (CCD Mass. 1868) (No. 111,959). See Assessment Panel, note 1, for discussion on statistical analysis used by this court.

[11] *United States v Downing*, 753 F.2d 1224, 1237 (3d Cir. 1985). See also *United States v Williams*, 583 F.2d 1194 (2d Cir. 1978), *cert. denied*, 439 U.S. 1117 (1979). See the extensive and very valuable discussion by evidence scholars in the series of symposia reported in 99 FRD 187 (1983); 101 FRD 599 (1984) and 115 FRD 79 (1987).

[12] See, e.g., *United States v Sebetich*, 19 Fed R Evid Serv 384 (3d Cir. 1986) (testimony on eyewitness identification); *Sprynczynatyk v General Motors Corp.*, 771 F.2d 1112 (8th Cir. 1985), *cert. denied*, 106 S. Ct. 1263 (1986) (hypnotically enhanced testimony); *United States v Ferri*, 778 F.2d 985 (3d Cir. 1985) (comparison of impressions inside defendant's shoes with footprints at scene of crime); *United States v Metzger*, 778 F.2d 1195 (6th Cir. 1985) (thin-layer chromatography used to prove presence of explosive); *Reardon v Manson*, No. 85-2312, slip op. (2d Cir. Nov. 20, 1986) (testimony of supervisor of toxicology lab, under whom analysis was performed, sufficient to introduce evidence); see also ABNEY (1986). Expert testimony and eyewitness identification *Case Comment* Mar–Apr 26; DEPAUL (1985). The rape trauma syndrome: New weapon for prosecutors. *Natl. Law J.* Oct. 28, 1; PRICE (1985). Battered-woman syndrome: A defense begins to emerge. *New York Law J.* Dec. 2, 3; MARTIN (1986). Expert opinion on eyewitness testimony. *New York Law J.* Feb. 2, 1.

[13] *Shad v Dean Witter Reynolds, Inc.*, 799 F.2d 525 (9th Cir. 1986).

[14] Id. at 530.

[15] In *Delaware v Fensterer*, 474 U.S. 15, 106 S. Ct. 292, 88 L.Ed.2d 15 (1985) the Supreme Court held that admission of a prosecution expert's testimony despite his inability to recall the basis for his opinion did not violate defendant's sixth amendment confrontation rights. But see Carlson, R. (1986). Policing the bases of modern expert testimony. *Vanderbilt Law Rev.* **39** 577.

[16] See, e.g., *Shaffter v Ward*, 17 Ohio St. 2d 79, 477 N.E.2d 1116 (1985) (trial court's verdict reversed because the court improperly excluded testimony of plaintiff's mechanical engineer regarding the point of impact in two-car collision); but see *United States v Arenal*, 768 F.2d 263 (8th Cir. 1985) (police officer's testimony that all the cocaine at issue probably had a common source because it was all cut with the same agent excluded under Rule 702 as unhelpful because within the knowledge of the jury); *United States v Affleck*, 776 F.2d 1451 (10th Cir. 1985) (testimony of "memory expert" excluded on similar grounds). In contrast to the issue of usurpation of the role of the jury is the issue of usurpation of the role of the judge, which arises in accounting and tax cases (among others) in which lawyers provide testimony combining law and fact. See WEINSTEIN, J. and BERGER, M. (1987). *Weinstein's Evidence* **3** 704[02] at 704-15 and n.13.

[17] 745 F.2d 292 (4th Cir. 1984).

[18] Id. at 301.

[19] For a discussion of the interplay of Rules 803(6), 803(8) and 1006, see *Manual for Complex Litigation*, Second, §21.466 at 61 n.80.

[20] 68 Cal.2d 318, 66 Cal. Rptr. 497, 438 P.2d 33 (1968).

[21] Id. at 325, 66 Cal. Rptr. at 500, 438 P.2d at 36.

[22] Id.

[23] 486 N.E.2d 803, 495 N.Y.S. 2d 944, 66 N.Y.2d 197 (1985).

[24] 486 N.E.2d at 805, 495 N.Y.S. 2d at 947–48 (citations omitted).

[25] In re "Agent Orange" product liability litigation, 611 F. Supp. 1267 (EDNY 1985) (Lilley opinion), *aff'd on other grounds*, 818 F.2d 187 (2d Cir. 1987).

[26] See, e.g., "Chernobyl's Toll in Future At Issue," *The New York Times* **135** Aug. 29, 1986.

[27] *Marx & Co., Inc. v Diners' Club, Inc.*, 550 F.2d 505, 511 (2d Cir.), *cert. denied*, 434 U.S. 861, 98 S. Ct. 188, 54 L.Ed.2d 134 (1977) (securities fraud case; statistic regarding the median time in which registration statements filed with the Securities and Exchange Commission become effective was misused as "if it were akin to a statute of limitations"; jury based damage award on apparent conclusion that registration statement actually became effective on date established by statistical probability).

[28] 594 F.2d 676 (8th Cir. 1979).

[29] Id. at 681.

[30] Id.

[31] Id., quoting from *State v Carlson*, 267 N.W.2d 170, 176 (Minn. 1978).

[32] See, e.g., *United States ex rel. DiGiacomo v Franzen*, 680 F.2d 515, 518–19 (7th Cir. 1982) (on habeas corpus challenge to state rape conviction, court held that, despite fact that some jurors may have been confused about significance of hair expert's testimony that chance was one in 4500 that hair found in victim's car belonged to someone other than defendant, no error of constitutional dimension in admission of testimony).

[33] See WEINSTEIN, J., MANSFIELD, J., ABRAMS, N. and BERGER, M. (1983). *Cases and Materials on Evidence*, 7th ed., 46–47.

[34] See, e.g., *New York City Transit Authority v Beazer*, 440 U.S. 568, 99 S. Ct. 1355, 59 L.Ed.2d 587 (1979) (in action alleging that transit authority's policy of not hiring persons employed in methadone treatment programs was racially discriminatory, the population basis used by plaintiffs—New York City area population enrolled in methadone treatment programs and metropolitan area labor force—did not accurately reflect actual applicant pool and persons qualified for jobs).

[35] *Hazelwood School District v United States*, 433 U.S. 299, 97 S. Ct. 2736, 53 L.Ed.2d 768 (1977).

[36] 433 U.S. at 312.

[37] See *Moultrie v Martin*, 690 F.2d 1078, 1082 (4th Cir. 1982) (held that "in all cases involving racial discrimination, the courts of this circuit must apply a standard deviation analysis such as that approved by the Supreme Court in *Hazelwood* before drawing conclusions from statistical comparisons"); FISHER (1980). Multiple regression in legal proceedings. *Columbia Law Rev.* **80** 702.

[38] See *Symposium on Science and the Rules of Legal Procedure*, 101 F.R.D. 599, 603–604 (1984); see also Assessment Panel, note 1 at 347 setting this forth as a recommendation.

[39] See *Manual for Complex Litigation*, Second, §22.31 (1985).

[40] In most instances terminology in the field is sufficiently standard that agreement as to the definition of terms can be obtained,

and the trier will be able to more readily follow the testimony. In those occasional instances where agreement cannot be reached, a separate glossary by each side is possible.

[41] This is the practice in my court and discussion of the issue with other judges indicates that other judges do this as well.

[42] See *Hall v General Motors Corp.*, 647 F.2d 175 (D.C. Cir. 1980); see also JAFFEE (1985). Of probativity and probability: Statistics, scientific evidence, and the calculus of chance at trial *Univ. Pittsburgh Law Rev.* **46** 925, 1077, n.202.

[43] See, e.g., the standard civil pretrial order, at paragraph 4, and the standard criminal pretrial order, at paragraph 11, used in my court.

[44] See Assessment Panel, note 1 at 360; see also *Manual for Complex Litigation*, Second, §21.481 at 83-84.

[45] See Assessment Panel, note 1, at 360.

[46] See id. at 351; *Manual For Complex Litigation*, Second, §33.12 at 289 (1985).

[47] See Assessment Panel, note 1, at 364.

[48] See id. at 241; see also In re *"Agent Orange" Product Liability Litigation*, 105 F.R.D. 577 (EDNY 1985), *aff'd on other grounds*, 818 F.2d 145 (2d Cir. 1987).

[49] *Eliasen v Hamilton*, 111 F.R.D. 396, 403 (N.D. Ill. 1986).

[50] See WESSEL (1986). Alternative dispute resolution for the socioscientific dispute. *Harvard J. Law Tech.* Spring; NYHART and HEATON (1982). Proceedings of the task force workshop on disputes involving science and technology. *Corp Dispute Management* 389; see also LUNEBURG and NORDENBERG (1981). Specially qualified juries and expert nonjury tribunals: Alternatives for coping with the complexities of modern civil litigation. *Univ. Virginia Law Rev.* **67** 887.

[51] See Assessment Panel, note 1.

[52] Id. at 233.

[53] Id. at 235.

[54] Cf. *Dawsey v Olin Corp.*, 782 F.2d 1254 (5th Cir. 1986) (expert biochemist may testify regarding effects of phosgene on humans, even though not a medical doctor).

[55] Efforts are currently underway in Florida and New York to pass new medical malpractice laws providing for disciplining doctors who give unprofessional testimony. See Tainted testimony. *Amer. Lawyer* April 1986, at 115.

[56] A related problem is the tendency of judges in certain types of cases to place too much reliance on expert testimony instead of relying on their own common sense. This may be occurring in child custody cases. See OKPAKU (1976). Psychology: Impediment or aid in child custody cases *Rutgers Law Rev.* **29** 1117.

[57] See ROSENBERG, D. (1984). The causal connection in mass exposure cases: A "public law" vision of the tort system. *Harvard Law Rev.* **97** 849; WEINSTEIN, J. (1986). Preliminary reflections on the law's reaction to disasters. *Columbia J. Environ. Law* **11** 1 [hereinafter Law's Reaction to Disasters]; WEINSTEIN, J. (1985). The role of the court in toxic tort litigation. *Georgetown Law J.* **73** 1389 [hereinafter Role of the court]. See generally GOUGH, M. (1986). *Dioxin, Agent Orange: The Facts* 21-24 (discussing the difficulties inherent in attempting to scientifically determine whether a particular substance affects humans). But see the criticism of the use of statistics in the "Agent Orange" cases in SHERMAN, P. (1986). Agent orange and the problem of the indeterminate plaintiff. *Brooklyn Law Rev.* **52** 369, 385-387.

[58] See In re *"Agent Orange" Product Liability Litigation*, 597 F. Supp. 740, 816-43 (EDNY 1984), *aff'd on other grounds*, 818 F.2d 145 (2d Cir. 1987); The Institute.for Health Policy Analysis, Causation and Financial Compensation (1986) [hereinafter The Institute for Health Policy Analysis]; WEINSTEIN, Law's reaction to disasters and Role of the courts, note 57.

[59] A bill introduced by Senator Danforth, S. 1999, 99th Cong., 1st Sess. §205(d)(2) (1985), follows this approach, allowing a plaintiff to recover limited damages if he can prove that the defendant's actions caused the incidence of injury to increase by 30% over the injury rate that would otherwise be expected.

[60] See WEINSTEIN, Law's reaction to disasters, note 57, at 33-36. But see Law Scope, Bitter Medicine, A.B.A.J., Apr. 1, 1986 at 20 (ABA House of Delegates rejects call for modification of traditional tort system in medical malpractice cases).

[61] See The Institute for Health Policy Analysis, note 58.

[62] See Assessment Panel, note 1 at 240-43.

[63] *Ake v Oklahoma*, 470 U.S. 68, 105 S. Ct. 1087, 84 L.Ed.2d 53 (1985). On retrial, Ake was again found guilty; however, the jury in the second trial sentenced him to life imprisonment, unlike the first jury, which sentenced him to death. *The New York Times* Feb. 14, 1986, at A1, col. 1.

[64] 105 S. Ct. at 1097; cf. *SEC v Whitman*, 613 F. Supp. 48, 49-50 (D.D.C. 1985) (witness testifying at an SEC investigative proceeding has a right under the Administrative Procedure Act to the assistance of an expert accountant in addition to the assistance of counsel).

[65] *Little v Streater*, 452 U.S. 1, 101 S. Ct. 2202, 68 L.Ed.2d 627 (1981). But see *United States v Brewer*, 783 F.2d 841 (9th Cir. 1986) (18 USC §3006(A)(e)(1), which requires court to authorize necessary defense services for indigent defendants, does not require courts to appoint experts on defects in eyewitness identification).

[66] A number of federal courts use their attorney admission fees to fund such programs and pay the attorney's expenses.

[67] HAND (1901). Historical and practical considerations regarding expert witnesses. *Harvard Law Rev.* **15** 40.

[68] See WILLGING, T. (1986). Court-appointed experts. Federal Judicial Center; The Institute for Health Policy Analysis, note 58 at 10 (1986); Jaffee, note 42 at 1056 and n.174.

[69] S. 1999, 99th Cong., 1st Sess. (1985) introduced by Senator Danforth, provides for creation of a "National Toxic Health Effects Panel" to conduct scientific inquiries to resolve issues of causation. See also TRUBATCH (1985). Informed judicial decision making: A suggestion for a judicial office for understanding science and technology. *Columbia J. Environ. Law* **10** 255. The Alabama Supreme Court has created a special panel of experts to assist the court in deciding appeals of public utility rate-making cases from the public utility commission. See WEINSTEIN, J. (1986). Warning: Alternative dispute resolution may be dangerous to your health. *Litigation* Spring 5.

[70] On the difficulties produced by appellate review of scientifically-based administrative decisions, see DAVIS, K. (1985). The "shotgun wedding" of science and law: Risk assessment and judicial review. *Columbia J. Environ. Law* **10** 67.

[71] See note 69. Speed is of the essence because it may be necessary to delay the start of trial until the studies are completed.

[72] See, e.g., SELIKOFF, I. J. (1981). Disability compensation for asbestos-associated disease in the United States. Environmental Sciences Laboratory, Mount Sinai School of Medicine at the City University of New York; SELIKOFF, I. J., CHURG, J. and HAMMOND, E. C. (1965). The occurrence of asbestosis among insulation workers in the United States. *Ann. New York Acad. Sci.* **132** 139-155; SELIKOFF, I. J., HAMMOND, E. C. and CHUNG, J. (1964). Asbestos exposure and neoplasia. *J. Amer. Med. Assoc.* **188** 22-26; SELIKOFF, I. J. and DOUGLAS, H. K. L. (1978). *Asbestos and Disease*. Academic, New York.

[73] See Institute for Health Policy Analysis, note 58, at 26 (endorsing "[r]obust judicial management of scientific factfinding").

[74] See, e.g., In re *"Agent Orange" Product Liability Litigation*, 611 F. Supp. 1223 (EDNY 1985); 611 F. Supp. 1267 (EDNY 1985), *aff'd on other grounds*, 818 F.2d 187 (2d Cir. 1987). See also CARLSON, R. (1986). Policing the bases of modern expert testimony. *Vanderbilt Law Rev.* **39** 577.

[75] See, e.g., *Fontenot v Upjohn Co.*, 780 F.2d 1190 (5th Cir. 1986) (summary judgment granted for defendant where no evidence was introduced to prove that progesterone manufactured by defendant could cause birth defects); *American Key Corp. v Cole National*

Corp., 762 F.2d 1569 (11th Cir. 1985) (exclusion of witness and grant of summary judgment in antitrust case); *KN Energy, Inc. v Great Western Sugar Co.*, 698 P.2d 769 (Colo.), *cert. denied*, 105 S. Ct. 3489 (1985) (exclusion of witness and grant of partial summary judgment in breach of contract claim). But see *Bulthuis v Rexall Corp.*, 777 F.2d 1353, *as amended*, 789 F.2d 1315 (9th Cir. 1985) (expert opinion not accompanied by underlying facts may defeat a summary judgment motion).

[76] See, e.g., In re *"Agent Orange" Product Liability Litigation*, 611 F. Supp. 1223, 1250, 1255–56 (EDNY 1985); 611 F. Supp. 1267, 1281–83 (EDNY 1985), *aff'd on other grounds*, 818 F.2d 187 (2d Cir. 1987). Cf. CAIRNS (1985). The treatment of diseases and the war against cancer. *Sci. Amer.* Nov. 51, 58 (explaining why positive-looking statistics on the effects of chemotherapy are misleading). It should be noted, however, that in *Zenith Radio Corp. v Matsushita Elec. Indus. Co.*, 723 F.2d 238, 284 (3d Cir. 1983), *rev'd on other grounds*, —U.S.—, 106 S. Ct. 1348, 89 L.Ed.2d 538 (1986), the Third Circuit reversed the trial court on the precise point of exclusion of expert testimony. Because antitrust cases have a higher public policy content than generally do tort cases, it may be that the court was more ready to require an expert's affidavit than it would be in other cases. See 106 S. Ct. 1360 n.19 ("the expert opinion evidence ... has little probative value in comparison with the economic factors"). The Supreme Court did not directly address the admissibility issue, but instead minimized its probative value. Id.

[77] Cf. Fed. R. Civ. P. 11 (sanctions on attorneys for frivolous litigation); *Oliveri v Thompson*, 803 F.2d 1265 (2d Cir. 1986); *Eastway Construction Corporation v City of New York*, 637 F. Supp. 558, 570–76 (EDNY 1986), *as modified*, 821 F.2d 121 (2d Cir. 1987).

[78] See WEINSTEIN, J. and BERGER, M. (1986). *Weinstein's Evidence* **1** 107-1 et seq.

[79] Judges must be careful, however, to remain neutral. See generally Book Note, Lord's justice: One judge's battle to expose the deadly Dalkon shield IUD. *Harvard Law Rev.* **99** 875.

[80] This should be contrasted to the rules *against* the jury doing independent research. See *United States v Duncan*, 598 F.2d 839, 866 (4th Cir.), *cert. denied*, 444 U.S. 871 (1979) (juror reference to dictionary definitions of "motive" and "intent" was improper).

[81] Cf. KOSHLAND (1985). The basic concepts of science elude the decision-makers. *Newsday* December 12, 94 ("Judges and legislators with little or no scientific training are making sweeping decisions on risks to the environment and from nuclear war and industrial accidents").