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## Legal Alchemy: The Use and Misuse of Science in the Law<sup>†</sup>

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### I. INTRODUCTION

<sup>§1</sup> Whenever I tell people that I am involved in the area of law and science, they become perplexed. They ask, "What does science have to do with law? Where is there any science in the legal field?" I want to emphasize the fact that science is everywhere. There is no aspect of the law today, whether civil or criminal law, where an education in basic scientific methods would not greatly improve the effectiveness of legal advocacy and policymaking.

<sup>§2</sup> I have three objectives for my talk today. First, I will outline the various uses of science in the law. Second, I will try to describe some of the fundamental challenges at the intersection of law and science. Specifically, I want to address the question of whether law and science as institutions or disciplines are simply too far apart intellectually to be integrated. Third, I want to present some solutions to give you a sense of why and how the law can integrate science to some extent into its decisionmaking.

### II. USES OF SCIENCE IN THE LAW

<sup>§3</sup> Complex scientific issues arise regularly in the context of litigation, legislative debates, and administrative agencies. These questions have forced judges, legislators, and policymakers to reexamine the relationship between science and their work in the legal arena.

#### A. Civil Cases

<sup>§4</sup> Starting with civil cases, there have been three U.S. Supreme Court decisions since 1993 involving expert testimony and the admissibility of scientific or technical evidence. The first case was *Daubert v. Merrell Dow Pharmaceuticals*,<sup>1</sup> decided in 1993. The case involved Bendectin, a drug manufactured by Merrell Dow Pharmaceuticals and used for severe morning sickness. The plaintiff claimed that Bendectin was associated with birth defects. The litigation went forward and one of the results was that Merrell Dow ended up pulling Bendectin from the market. Yet there had been almost no toxicological research and only extremely weak epidemiological research into whether there was any connection whatsoever between Bendectin and birth defects.

<sup>§5</sup> The Supreme Court revised the standards for the admissibility of expert evidence in *Daubert*, holding that judges must serve as gatekeepers by evaluating the basis for scientific evidence before admitting it into the courtroom. The standard for admissibility of expert testimony before *Daubert* was the "general acceptance" test from *Frye v. U.S.*<sup>2</sup> Essentially, the general acceptance test required a judge to determine whether the scientific technique used to produce the evidence was generally accepted in the pertinent field. Thus, all the judge had to do was to go out, find the pertinent field, and inquire as to its general acceptance. If the field was polygraphs, for instance, she would locate a lot of people who did polygraphs and ask them if polygraphs are generally accepted. The problem

with *Frye* then becomes obvious: it is similar to asking tea leaf readers, "Is tea leaf reading generally accepted?" Of course the answer will be that tea leaf reading is generally accepted. If you ask polygraphers whether the polygraph techniques are generally accepted, the answer undoubtedly will be yes. If you ask experimental psychologists if polygraphs are generally accepted, the answer will be no. *Frye* was problematic because it depended on the self-assessment of a group on whether that group's own activities are valid.

<sup>56</sup> Without rejecting the *Frye* test, the *Daubert* Court held that the general acceptance test was not incorporated into the Federal Rules of Evidence.<sup>3</sup> Instead of simply determining whether a scientific technique is generally accepted, judges now are expected to understand the science themselves. *Daubert* was revolutionary because it put an end to judges' abdication of their responsibility to assess the reliability of proffered scientific evidence. Now, judges themselves are expected to understand the scientific method well enough to decide whether a particular technique is valid and reliable as evidence. This ruling has had dramatic implications for the judiciary. In fact, since 1993, the Federal Judicial Center and various state agencies have been holding seminars to help judges get up to speed on scientific evidence.

<sup>57</sup> The problem is that courts have been inundated by civil cases involving scientific evidence. The volume of mass toxic tort litigation has been overwhelming. There are claims involving asbestos, agent orange, trichloroethylene, Bendectin, silicone implants, lead, tobacco smoke, Fen-Phen, and latex gloves, and the list goes on and on. Surgical implants alone account for tens of thousands of cases. Over 500,000 silicone implant cases have been filed in the United States. These civil cases have driven a lot of the reforms in the trial courts.

## B. Criminal Cases

<sup>58</sup> While science was creating havoc in civil cases, DNA profiling came on the scene on the criminal side. Although DNA profiling turned out to be the most publicly debated topic, there are many other kinds of so-called scientific evidence that come into the criminal court. There are handwriting identification, bitemark analysis, ballistics, hair analysis, carpet fiber analysis, footprint analysis, and blood splatter analysis, all based ostensibly on some sort of empirical analysis. For a long time, many forensic scientists who dealt with these phenomena were able to get into court without having to produce any data whatsoever to prove the reliability of their investigative techniques. Now, however, trial courts are looking at this information more skeptically, as they did with DNA profiling. Courts are increasingly scrutinizing techniques and asking forensic scientists for data to support their work before admitting their testimony.

<sup>59</sup> Just a few months ago, the Massachusetts federal court excluded handwriting analysis on the question of identity. The forensic expert could not testify that the defendant matched the handwriting sample left by the perpetrator of a crime. The judge in the Oklahoma City bombing case also was inclined to keep handwriting identification out after he asked if the experts had data to support their handwriting analysis techniques. What is fascinating is that if you start probing into what we consider as basic science, such as ballistics tests, you will find very little data to support widely-accepted investigative techniques. Forensic scientists now are running into problems because the courts are starting to ask more sophisticated and probing questions.

## C. Constitutional Cases

<sup>510</sup> In my new book, *Legal Alchemy: The Use and Misuse of Science in the Law*, I also discuss the Supreme Court's use of scientific evidence in constitutional cases. We tend not to think of constitutional cases as raising empirical questions, but such questions are everywhere. For example, empirical issues are involved in cases claiming that capital punishment is racially biased. In *Kansas v. Hendricks*,<sup>4</sup> the Supreme Court recently allowed states to involuntarily commit sexual predators on the theory that they will perpetrate more crimes. The Court, however, never even asked what

error rate is associated with these predictions of violence. It never even considered the question. The Court's opinion was just shocking in its ignorance of the scientific method. In addition, cases that involve scientific advancements will have constitutional ramifications. Frozen embryos, genetic screening, and genetic manipulation are some technologies that will raise constitutional questions.

#### *D. Congressional Uses of Science*

§11 In addition to looking at how the courts grapple with scientific evidence in civil, criminal, and constitutional cases, I was also interested in looking outside the judiciary. I wrote the book in part because I was curious to see how Congress and administrative agencies deal with science. The basic question that I was trying to answer in the book is, how do you bring empirical scientific research into normative, moral, policy-based analysis? I was shocked to discover how poorly Congress regards scientific evidence and how readily it ignores science. I have divided congressional use of science into three main categories in the book.

##### *1. Big-ticket Science*

§12 One category is what I call big-ticket science. I examine two examples of the big-ticket science phenomenon. The first is the huge project involving the construction of a superconducting super collider. The ultimate goal of the project was to identify fundamental, physical laws of the universe with the help of the super collider. Congress spent \$2 billion to build a 14-mile hole in Texas, but then killed the project. The main reason they killed the project appears to be a lack of support for it within Congress. The reason they did not have enough support was that they did not spread the money around. Texas and Louisiana were the big winners, and every Senator and Representative who opposed the project complained because they were not getting any money for their own constituent states. One of the basic rules about Congress is that if you want big-ticket science to be done, make sure that every single state gets a piece of it. Otherwise, it will not get accomplished.

§13 A good example of this principle is the space station. The space station project continues, at the cost of over \$100 billion, because Congress distributed the money to numerous groups and no one state was favored. The human genome project is another example of big-ticket science. Congress pays attention, not so much to the science, but to the amount of money being spent and who is getting the money.

##### *2. Setting Moral Boundaries on Science*

§14 The second area that I looked at in terms of congressional use of science is Congress' role in setting the moral boundaries on science. When legislators see a significant technology emerging, they will want to impose their views on how the technology can be used morally and what uses of it would be immoral. Some of the examples I examine in the book are cloning, fetal tissue research, and human subjects research. These are areas where Congress likes to wax poetic about the immorality of whatever the science might be, cloning being a recent favorite.

##### *3. Oversight of Administrative Agencies' Use of Science*

§15 The third area of congressional use is really the biggest as far as Congress is concerned, although it involves Congress indirectly. This area is congressional oversight of administrative agencies, especially those agencies that deal with clean air and water. Here, I focus on the recent rules regarding particulate matter and ground ozone that the Environmental Protection Agency (EPA) adopted two years ago. This past May, after the book was done and had gone through its last edit, a mini-crisis hit. I was just relaxing one Saturday morning and reading the New York Times when I glanced on the front page of the New York Times, "DC Circuit overturns EPA's rules on particulate matter and ground ozone." Immediately I called my editor and said, "Stop the presses," and I ended up having to rewrite the entire section dealing with the EPA's regulations. It was an

author's nightmare. Interestingly enough, the D.C. Circuit struck down the ruling on the non-delegation doctrine, holding that Congress had delegated too much authority to the EPA to set standards and to do a cost-benefit analysis.

#### *E. Uses by Administrative Agencies*

§16 I also examine directly how administrative agencies themselves use science. One of the subjects I discuss is the reintroduction of the gray wolf into Yellowstone National Park. There was a lot of conflicting biological theories about what exactly the wolf would do when it got back to Yellowstone. Opponents of reintroduction, namely the ranchers and the hunters, argued that it was going to wipe out the cows and the deer, and eat everybody's cats and dogs. Not surprisingly, proponents of bringing the wolf back talked about the beauty and the wonder of such a magnificent creature.

§17 One of the things I get out of this discussion is the interaction between the administrative agencies and Congress. Congress uses committee hearings to beat administrators over the head to try to bring them into line. In this case, the gray wolf was protected by the Endangered Species Act of the 1970s, and the Act required that the federal government reintroduce the wolf into its natural habitat. The Department of the Interior had control of that, and so long as it was controlled by the Republicans, they sat on it. They sat on it throughout the Reagan and Bush presidencies, during which time Congress tried to instigate action by requiring the relevant agencies to file an environmental impact statement. After Clinton assumed office and the Republicans took over Congress, the Interior Department became interested in bringing the wolf back while Congress became an opponent. The story ended when Bruce Babbitt took over and, seeing that the Republicans now had control of the House of Representatives, immediately let the wolves go in Yellowstone, knowing that it would be virtually impossible for Congress to get them back. The dynamics and power shifts between Congress and the Department of the Interior were intriguing.

### III. CHALLENGES IN THE INTERSECTION OF LAW AND SCIENCE

§18 All of this is just to give some sense of how different entities—trial courts, both civil and criminal; the Supreme Court; the legislature; and administrative agencies—are dealing with scientific research and the integration of science into the law. In my book, I tried to get a sense of what the real obstacles are, and I identified four basic challenges that confront the legal system in its efforts to integrate science and the law.

#### *A. Unavailable Data*

§19 One problem is what I refer to as unavailable data. Part of the problem with unavailable data is that there are very different timetables for law and for science. For example, legal liability for silicone implants had already been imposed before the first major epidemiological research on silicone implants had been conducted. Because of the time lag, the question is, what happens if science later determines that silicone implants are perfectly harmless? How do we turn back time in the law?

§20 Another example is global warming. We have to make decisions about global warming today, even before we are quite sure about what all the costs and benefits of each policy choice are. Legislators and policymakers have to make decisions under extraordinary conditions of uncertainty, decisions which must be made knowing that circumstances might change over time.

§21 Trial courts, in particular, have difficulty making these types of decisions. In the 1980s, people were convicted based on DNA profiling with three loci matches. That is, if a defendant's genetic material matched the DNA left by the perpetrator of a crime at three locations on the genetic material, then the prosecutor urged that the defendant had left the DNA at the crime scene. Today,

the Federal Bureau of Investigation (FBI) recommends thirteen matches between the defendant's DNA and the perpetrator's DNA as proof that the defendant is the perpetrator. The question now becomes whether a person who had been convicted on the basis of a three-loci match now should be able to file a habeas petition to challenge his conviction because the FBI now requires thirteen matches. Do we go back on our legal decisions when science provides us with new information?

§22 Another problem with the unavailable data issue is that the law and science very often have different outcome measures. For example, post-traumatic stress disorder, rape trauma syndrome, and battered women syndrome are all diagnoses that were formulated as therapeutic diagnoses to help in treatment. For most of these, there is virtually no research. The little research that has been done has been treatment-oriented research. The law, however, focuses on forensics, not on therapies. Therefore, acceptance of a diagnosis for a therapeutic purpose does not mean that it is also generally accepted for a forensic purpose. Post-traumatic stress syndrome is generally accepted by clinical psychologists, but not by forensic scientists. Nevertheless, the law often conflates these two, and courts fail to realize that they need to ask questions relating to the use of the science in the legal context, not in the clinical context.

§23 Similarly, what do we do with toxicological research involving animals? Is animal research generalizable to humans? Epidemiological research is also an issue. Epidemiological research looks to see whether the exposed population—those who took the drug, ate the food, or had the silicone implant—has an increased incidence of an illness. If the answer is yes, for example, that the incidence of disease is two times greater in the exposed population than in a non-exposed population, then the answer tells us something about the population. This, however, tells us little about any one particular plaintiff. Knowing that a community served by a contaminated water supply has a higher incidence of leukemia does not tell us whether a particular leukemia victim got leukemia because he drank toxic chemicals dumped into the water supply by the defendant or whether his leukemia had some other cause.

§24 Differential diagnosis is another subject that often confuses the boundaries between science and law. Medical doctors use differential diagnosis to rule out certain causes of disease, thereby permitting them to identify the disease. Lawyers, on the other hand, attempt to use differential diagnosis to identify the cause of the disease. It might very well be that doctors appropriately use differential diagnosis to identify a disease, but that does not mean that differential diagnosis can identify what caused the disease. In *Heller v. Shaw Industries*,<sup>5</sup> Judge Becker made just that mistake. He reasoned, wrongly, that since doctors rely on differential diagnosis, the courts certainly should rely on it as well. The fact of the matter, however, is that physicians and lawyers rely on different techniques and data.

### B. *Understanding the Science*

§25 Another problem with integrating law and science is understanding the science. We have judges and legislators making decisions based on virtually no experience and no education in math and science. Laypersons in the legal system, such as jurors, have the same problem. How does a lawyer explain complex science to them? The adversarial method further complicates the understanding and use of science because it tends to polarize science. A litigator does not present middle-of-the-road scientific evidence; instead, he will present the expert at the end of the spectrum that best supports his arguments. He will put on the witness stand the physician who is sure beyond medical certainty that he is right. The result is that jurors and judges are given only the polarized views of the science.

### C. *Integrating Science and Policy*

§26 The third fundamental challenge is that the issue of integrating science and policy just may be too big for the human mind. Maybe we are simply not smart enough to integrate science and policy.

§27 Think about the difficulty of integrating complex science into complex policy. The example I use is a case that came out of my clerkship. The Corps of Engineers wanted to build a reservoir outside Houston, Texas. The argument was that a reservoir would prevent drought and the problem of dislocation, and enhance navigation, recreation, fish and wildlife. The reservoir, however, would also harm some wildlife—it would replace certain birds with other kinds of birds and certain fish with other kinds of fish. Furthermore, as the Sierra Club argued, the reservoir would basically wipe out the oyster and shrimp populations in the Gulf of Mexico because the salinity levels would change in their breeding areas and this would allow fish and other predators to prey on them. In order to decide whether or not to permit construction of the reservoir, the Corps had to integrate the information about the likelihood of drought, the empirical effects of drought, and the economic effects of the reservoir on the area. There were also questions about the comparative values of certain species of birds, oysters, and fish. There are questions about the error rates associated with all of these empirical predictions. How should a court or legislator factor all these variables to come up with the right answer?

#### D. *Cultural Conflicts*

§28 Finally, there are inherent cultural conflicts between the law and science. Obviously, among these issues are free will versus determinism, adversarial processes versus cooperative processes (science being a little bit more cooperative), and the law's reliance on precedent versus science's willingness to throw away precedent and move toward progress. These are some basic cultural conflicts.

### IV. SOME ANSWERS TO THE QUESTIONS ABOUT INTEGRATING SCIENCE AND THE LAW

#### A. *Science Cannot Prescribe Policy*

§29 What do we do about all this? I try to offer some answers that may facilitate and streamline the use of science in the law. First of all, scientists should not be allowed to prescribe policy. Ultimately, legislators and policymakers need to understand the science well enough so that when scientists come to them with their agendas, they can separate the science from the ideology and make the proper policy decision. When, for instance, advocates of battered women syndrome lobby to protect women who kill their abusers in self-defense, the legislator is the one who must make the policy judgment regarding the law of self-defense. The judgment is up to the legislators to make, so they need to understand how reliable the science is.

§30 One of the examples I use is Edward O. Wilson, one of my heroes, who is a biologist at Harvard. He frequently testifies before Congress on biodiversity and the environment. He is very honest and states at the beginning of his testimony that he intends to describe the effects of extinction on the environment, but that the legislators need to understand that his goal is to avoid extinction if possible. That goal is a value judgment because extinction is not inherently negative. It is an outcome that we, as interested citizens, invest with value judgments that have nothing specifically to do with science. Unfortunately, most scientists do not state their normative policy preferences as plainly as Wilson.

#### B. *Error Rates are Matters of Policy*

§31 Another basic principle is that the error rates associated with science are themselves a matter of policy. That is, we tend not to know anything with 100% certainty and that is almost always true in the science policymaking area. All applied sciences have huge error rates associated with them. Let us return to *Daubert* and Bendectin. If courts permit the litigation to go forward, Merrell Dow removes the drug from the market. If science later determines that Bendectin does not cause birth defects, then we have lost a valuable drug and society suffers harm. On the other hand, if we get rid of the litigation and it turns out that Bendectin does cause birth defects, then we have not allowed

the plaintiffs to recover and all those people who have suffered because of the defendant's drug will have no recourse. Answers to whether or not Bendectin causes harm have an error rate associated with them.

§32 The other example is global warming. How should we react to global warming when there is a huge error rate associated with global warming? The temperature rise is going to stop, but when is it going to stop, at two degrees or at eight degrees? What if we spend hundreds of billions of dollars to avoid global warming because we think the temperature will rise eight degrees when in fact, it rises two degrees? Deciding whether to spend money to ward off something that may not occur or to take the risk of global warming is a matter of policy.

§33 As lawyers, we understand this gamble on the error rates. Take the burdens of proof in civil versus criminal cases as an example. In civil cases, we do not care about false positives and false negatives as is reflected in our very light burden of proof; we have not decided whether it is better for plaintiffs or for defendants to win. In the criminal context, however, we have decided that false positives are much worse than false negatives. As Blackstone said, it is better to let ten guilty people go free than to convict one innocent person. This is a policy statement by a policymaker who has decided that it is better to avoid locking up innocent people than to worry about letting guilty people go free. Policymakers must make these judgments because they are empowered to do so by our constitutional form of government.

### C. "Science Policy" Requires Scientific Knowledge

§34 Next, "science policy" requires scientific knowledge. Policymakers are getting the tools by which to understand the basics of science. The trial courts now have reference manuals and court-appointed experts to help them. There is a program being run by the American Association for the Advancement of Science that aims to create a roster of experts for courts to turn to as court-appointed experts. These experts will be able to assist judges both in understanding the admissibility of scientific evidence and in explaining to the jury how certain technologies should be interpreted. Scientific advisory committees are already helping administrative agencies. Personally, I would like to give these committees more than advisory power. The Office of Technology Assessment, the one office that was empowered to give Congress in-depth reports on science and technology, was abolished by Congress in the early 1980s just to save money. This was a huge mistake since Congress needs to understand the science with which it is dealing.

### D. Obligations Under the Constitution

§35 That leads me to my final point, which is that legislators, administrators, and judges have an obligation under the Constitution to understand the science in the policy if they are making science policy. If they do not understand the science, they are unlikely to make very good policy. The bottom line is that lawmakers have a constitutional obligation to understand the science, and if they fail to do so, then they actually have violated their constitutional duty.

## V. CONCLUSION

§36 Science and the law are becoming increasingly intertwined and interdependent. Using scientific methods and knowledge in the courtroom and in public policy is very difficult, yet necessary. In order to meet the challenges posed by integrating science and the law, we must recognize that science is not to be confused with law, yet the two need to work together in order to achieve fair trial outcomes and appropriate public policies.

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[1](#) Daubert v. Merrell Dow Pharm., 509 U.S. 579 (1993).

[2](#) Frye v. United States, 293 F. 1013 (D.C. Cir. 1923).

[3](#) See FED. R. EVID. 702.

[4](#) Kansas v. Hendricks, 521 U.S. 346 (1997).

[5](#) See Heller v. Shaw Indus., 167 F.3d 146 (3d Cir. 1999).

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