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Judging Science

Chief Justice Robert French
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Nearly 40 years ago, as a newly minted lawyer who happened to have a science degree with a physics major, I was keen to take on cases which involved scientific questions. One such case concerned a young man riding a motor bike who was clocked at twice the speed limit by a radar gun. He insisted that he had only been travelling at the speed limit. The radar gun works by transmitting a radar beam at a certain frequency. When that beam hits a moving object it is reflected back and its frequency shifts upwards. This is called the Doppler Effect. The radar gun combines the reflected signal with the outgoing signal to produce a resultant frequency called the 'beat frequency' which is a function of velocity. According to that beat frequency, the gun produces a readout of speed.

I remembered from my basic physics that the speed of a wheel at the top is twice the speed at the axle. So if the motor bike were travelling at a speed 'V', the spokes at the top of the wheel would be travelling at the speed 2V relative to an external observer. Could this be the explanation for the disputed reading? Had some of the reflected beam come off spokes travelling at twice the speed limit even though the bike itself was travelling within the law? Could my client have been telling the truth? I engaged the services of a PhD student. We brought to court a bicycle wheel, a radio frequency generator and a couple of oscilloscopes. The magistrate was transfixed by the evidence. However, he didn't know very much about physics. In the end he said he would rely upon the policeman's personal estimate of the speed and convicted my client. He was probably right to do so. His approach had the virtue that he did not have to judge the difficult science put before him. For the most part, however, scientific questions cannot be so easily side-stepped by the courts. Every day, judges are asked to judge science.

Sometimes Parliament tries to save judges the trouble of judging science by writing scientific propositions into the law and making them presumptively, or in some cases conclusively, correct. Sometimes a law will provide that a certificate by this or that class of expert or technologist on a matter of fact, such as the identity of a substance which the expert or technologist has analysed, is to be taken as correct. An early example of such provisions were regulations governing the use and evidentiary effect of breathalysers in Western Australia in the 1970s. The breathalyser readings were given presumptive force, but depended upon an assumption about the relationship between the concentration of alcohol vapour in alveolar air and the concentration in the blood. This was called the 'partition coefficient' and was assumed to be 1500 to 1. The other assumption was used to calculate back from the time the test was administered to the time at which the accused had been last driving. The assumption was that alcohol was absorbed into the blood stream at .016 per cent per hour for the first two hours after the last drink and eliminated at the same rate thereafter – a handy linear relationship fairly untypical of biological systems. That may have been because it was proposed to Government by the Chief Government Chemist. The Chief Government Pathologist, who had not been consulted, turned out to be a willing witness for the defence in such cases pointing out the variability in partition coefficients and of absorption and elimination rates in real people. He was a feisty Scotsman. On one occasion he was asked by a frustrated police prosecutor whether there were not some people within his profession who disagreed with him. He said: 'There are peculiar people in every profession Sergeant, even yours.'

This talk is about judging cases in which evidence is given by people with scientific expertise. I include in that category medical experts. The subject can be approached at different levels. There are interesting questions about differences between legal method and scientific method and whether they can ever properly mesh or are fated to be like ships passing in the night. Those questions may be answered differently depending upon whether the scientific method under consideration is that of the researcher or that of the scientist who applies established principles and/or technologies to draw inferences, make predictions or assess risks. Their answers may depend upon differing approaches to factual certainty. Stephen Jay Gould once said:

> In science "fact" can only mean "confirmed to such a degree that it would be perverse to withhold provisional asset." I suppose that apples might start to rise tomorrow but the possibility does not merit equal time in a physics classroom.

Questions about the differences between legal and scientific approaches to factual certainty have great inherent interest and practical significance. It is necessary, however, for the purposes of this talk, to begin at a more concrete level by asking what it is that judges and courts do when they decide cases. Like many legal questions, the answer is not straightforward.

When a case comes before a court it usually involves a dispute about somebody's rights or liabilities. The proceedings may be civil. Typically, in such a case, one party sues another claiming some entitlement, such as damages for personal injury, or for breach of contract or an injunction to restrain some wrong, or a declaration of some right. The proceedings may be criminal, in which case the State prosecutes someone for committing an offence.

The elements of judging can be expressed in what appears to be a simple model of decision-making:

1. Identify the relevant rule of law.
2. Determine, after hearing the evidence, what the facts are.
3. Apply the rule of law to the facts to determine the rights and liabilities, if any, of the parties to the case.

In a criminal case where the judge sits with a jury, the judge identifies the relevant rules of law and tells the jury what they are and how to apply them to the facts. The jury decides, on the evidence which it has heard, what the facts of the case are. The jury applies the relevant rules of law to those facts as directed and finds the accused guilty or not guilty, unless of course they can't agree, in which case they are discharged and a new trial is started before another jury. The judge in such a case acts as a gatekeeper on the evidence that can go to the jury. Where expert evidence

is called, the judge decides whether the evidence is admissible or whether its probative value is outweighed by unfair prejudicial effects.

In both civil and criminal proceedings, arguments can arise around the first step, namely, deciding what the relevant law is. The rules of law which are to be applied by the courts are to be found in the Constitution of the Commonwealth or of the States, in Acts of Parliament made under those Constitutions, in regulations made under those Acts, and in judge-made rules, such as rules about contracts, equity and torts like negligence or deceit. The legal environment in the modern world does not offer exactness in the rules which have to be applied. That is not for want of trying. Lawmakers often pursue certainty by writing detailed prescription into statutes and regulations. This leads to longer Acts and more regulations. In the musical 'Amadeus', the Emperor complained to Mozart after performance of one of his works that it had 'too many notes'. Some statutes and regulations have too many words. The more words there are the more room there is for debate about their proper interpretation. The problems of interpretation thrown up by statutory language often yield more than one possible solution. Language is plastic and nuanced and has a history. For many words there is more than one core meaning and there are penumbral meanings. Relevantly to this paper, statutes sometimes use words importing concepts taken from or interacting with areas of specialised scientific knowledge. Sometimes they do not do so accurately. Let me give an example from a case which went all the way to the High Court.

In 1975, a young American woman was charged under the *Customs Act 1901* (Cth) with importing into Australia a prohibited import, namely cannabis. The word 'cannabis' was defined in the Act as a cannabis plant or any part of a cannabis plant. A cannabis plant was defined as a plant of the genus cannabis sativa. That definition raised a difficulty because, according to the International Code of Botanical Nomenclature, it was not proper to describe a genus by the use of two words unless they were joined by a hyphen. Under the Code the second word 'sativa' denoted a species.

At that time there were many botanists who took the view that the genus cannabis had only one species, namely, cannabis sativa. That was the view that

prevailed when the definition was introduced into the *Customs Act* in 1971. However, there was evidence of a different view among botanists that the genus contained other species, cannabis indica and cannabis ruderalis. Those species could be distinguished from cannabis sativa by their leaf and branch distribution. The accused had brought her cannabis into Australia in the form of Buddha sticks. In that form the cannabis is dried and crushed and rolled up. It was not possible to determine whether it was cannabis sativa, cannabis ruderalis or cannabis indica. The defence, therefore, was that the Crown could not prove that the imported plant was of the prohibited species. At trial, expert witnesses for both sides debated whether cannabis had only one species or more than one. The debate had raged between competing experts in a number of court cases in the United States. Nothing generates passion in the scientific breast like taxonomy. The evidence in the case was about classification, rather than scientific inference. Once again, however, science was side-stepped. The trial judge decided that whether or not there was one species or more than one species of cannabis, the definition of cannabis in the Act should be interpreted as applying to all species. That view was ultimately upheld in the High Court.[1] The Act was amended to make it clear that the cannabis plant referred to was a plant of the genus cannabis.

That case focussed on the first step in the judicial process which I have described, namely, the identification of the relevant rules of law. Three points come out of it. The first is that the law may use words whose application may involve scientific evidence, but may use the words in a way which does not fit comfortably with the science. The second is that some scientific issues which come before the court are really issues about taxonomy or classification. The third point is that a legal rule may import a factual issue so that its interpretation may give rise to a mixed question of law and fact.

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[1] *Yager v The Queen* (1977) 139 CLR 28.

Questions of fact – some categories

This paper is concerned principally with the second step in the judicial decision-making process, the role of the court in determining the facts on the basis of the evidence before it and the function of scientific evidence in taking that step. There are different kinds of facts which may have to be decided. One kind is historic – the answer to the question, 'what happened?' Another is predictive – the answer to the question, 'what is likely to happen?' Another we might call the retrospectively predictive – the answer to the question, 'what was foreseeable?' Then there is the hypothetical – the answer to the question, 'what would have happened if things had been done differently?'

Some questions of fact relating to the conduct of individuals involve assumptions about the working of the human mind and use verbal constructs that may engage, only with difficulty, with contemporary scientific knowledge. Nevertheless, they state the terms in which a judge or jury must decide the case. An example from the criminal law is the question, 'what was the intention of the accused person?' A related question is, 'did the accused person lack the capacity to form a particular intention because of intoxication or disease of the mind?' Another question is, 'was the accused capable of controlling his or her actions?' The answers of the judge or jury to these questions may be informed by medical evidence, including psychiatric evidence, and that evidence sometimes has to be framed in a way that engages with these non-scientific concepts.

Some questions of fact about conduct involve value judgments. Did somebody take due care? Did somebody act reasonably or in good faith? Others are really questions of legal classification, using language reflecting a classification which may mean something to scientists but which does not necessarily carry the same meaning in law. An example is the legal term 'a disease of the mind' which, for a long time, was used as a point of reference in deciding whether a person suffering from such a condition is criminally responsible for his or her actions. The medical classification of a condition as a disease or a disorder involves evaluative judgments made by those psychiatrists who decide what goes into such publications as the *Diagnostic and Statistical Manual of Mental Disorders*. The recent compilation of

the 5th edition of that Manual aroused debate about whether certain conditions such as compulsive shopping or binge eating should be regarded as 'mental disorders'.[2] Even here, evaluative and normative considerations may intrude into scientific taxonomy. The distinction between the classification of some conditions as diseases such as schizophrenia, and others as disorders such as psychopathy, may reflect underlying normative or moral judgments. Expert witnesses may be called to give evidence upon the basis of which the court will apply legal categories such as disease or disorder. The judge, the lawyers and the experts should be clear in such cases about the differences between the legal meaning of a term and the meaning which the expert witness is giving to it, as well as the methodology underlying the expert evidence.

Law borrows from science

Sometimes an Act of Parliament uses a term which is borrowed from, and intended to incorporate, the methodology of a particular discipline. In such a case the court can be assisted by experts from that discipline in applying the legal term. Australia's competition laws prohibit various forms of conduct which substantially lessen competition in markets for goods and services. The key concept of 'market' is borrowed from the discipline of economics. Frequently, the debate in competition cases is about the definition of the particular market. The larger the geographical range of the market and the range of the products competing with each other in the market, then the less likely it is that a particular firm's conduct will lessen competition. So a judge may be confronted with competing expert evidence from economists about the definition of the market. The regulator's economists may propose a narrower market, while the defendant's experts will propound a wider market.

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[2] Carey, "Psychiatrists Revise the Book of Human Troubles", *New York Times*, 18 December 2008.

In the late 1980s, the biscuit manufacturer Arnott's proposed to take over another biscuit manufacturer, Nabisco. The Trade Practices Commission (now the Australian Competition and Consumer Commission) went to court to block the acquisition on the basis that Arnott's would be in a position to dominate a market for goods and services if the acquisition proceeded. One of the questions concerned the scope of the market. Was it just biscuits, or was it biscuits and non-biscuit products such as Wagon Wheels, Rum Slices, After Dinner Mints and Snowballs.

In such cases, expert witnesses give evaluative evidence of an argumentative nature. That is to say, based on economic theory, they will put an argument that the best way of defining the market reflecting commercial realities and enabling adequate predictions to be made about the effect of a merger, is to draw a boundary around a particular set of products and a particular geographical range. Economists in such a case may also give evidence about whether a particular course of conduct is likely to cause, or has caused, a substantial lessening of competition in a market.

Similar evaluative or argumentative judgments are offered by anthropologists in native title cases. Indigenous groups seeking recognition of their native title are required under the current interpretation of the common law and the *Native Title Act 1993* (Cth) to show that they are members of a society which was in existence at the time that the Crown asserted its sovereignty over the land the subject of their claim and that the society continues to exist today. The term 'society' was defined by the High Court in 2002 as '… a body of persons united in and by its acknowledgment and observance of a body of law and customs'.[3] The determination by a court of whether a relevant 'society' exists for the purposes of native title proceedings and who it consists of involves drawing evaluative boundaries. This is particularly so where a spectrum of similar traditional laws and customs are observed by groups of Aboriginal people, distributed across substantial swathes of territory. In those cases

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[3] *Members of the Yorta Yorta Aboriginal Community v State of Victoria* (2002) 214 CLR 422 at 425.

the definition of the relevant society may be a matter of identifying a boundary not unlike the process of defining the limits of a market in competition law. The expert opinion in such cases, like that of economic experts, is by way of characterisation of primary evidence and is essentially argumentative in character, even though that characterisation is supported by relevant expertise.

Cause and causation

Perhaps productive of particular difficulty is the question whether one event caused or contributed to another and, if so, to what extent? The factual question of causal connection is not the same as the legal question of 'causation'. The legal concept of causation involves the assignment of legal responsibility for things that happen. This has typically been applied according to a test of what is called 'commonsense'. The leading case on this question *March v E & MH Stramare Pty Ltd*[4] was decided in 1991. It concerned an accident which happened at 1am on 15 March 1985 in Frome Street, Adelaide, not far from the intersection with Rundle Street. A fruit and vegetable merchant parked his truck in the middle of a six-lane road at 1:00 am in order to load it. His parking and hazard lights were on. A motor vehicle was travelling in the lane nearest the centre of the road at an excessive speed. The driver had a blood alcohol concentration of more than 0.18. The motor vehicle struck the truck and the driver was injured. He sued the owner of the truck and the driver of the truck. The High Court found that the truck driver's negligence was the cause of the accident for the purpose of liability. It rejected a 'but for' test which would have split responsibility between the truck driver and the driver of the car.

One area in which difficult questions of cause and effect can arise, is in the application of epidemiological evidence. It arose recently in a case called *AMACA Pty Ltd v Ellis*,[5] which was decided in the High Court in November 2009. The case concerned a man who died of lung cancer in 2002 at age 45. He had been diagnosed

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[4] (1991) 171 CLR 506.

[5] (2009) 240 CLR 111.

at age 43. He had smoked, on average, between 15 and 20 cigarettes a day for over 26 years before he was diagnosed. He had also been exposed to respirable asbestos fibres during two periods of employment. The first was between 1975 and 1976 while working for the State of South Australia with asbestos cement pipes, manufactured by AMACA, the former James Hardie Ltd. He was also exposed to asbestos fibres while employed by Millennium Inorganic Chemicals Ltd between 1990 and 2002. His estate sued the State of South Australia, AMACA and Millennium. The defendants were found liable at trial and appeals to the Court of Appeal were dismissed. However, the appeal to the High Court was allowed.

The appeal was allowed on the basis that it had not been shown that asbestos exposure had been a cause of the cancer. There was no medical evidence to say why the deceased man had developed his cancer. Evidence was given of epidemiological studies. Four experts gave evidence about relative risk that is, the ratio of the risk of disease or death among those exposed to a carcinogen compared to the risk among those not exposed. The relative risks assigned to smoking, according to the experts, ranged from 7.7 to 20. The relative risk assigned to exposure to asbestos ranged from 1.1 to 1.3. Evidence was given of the 'attributable fraction' among those exposed, being the probability that the cancer in question was caused by exposure to a particular carcinogen. Between the four expert witnesses, the probability that the cancer was due only to smoking ranged from 67 % to 92%. The probability that it was due only to asbestos ranged from 0.1% to 3%. The probability that it was due to asbestos and smoking in combination, was said to range from 0.9% to 20%.

None of the witnesses was able to assign a probability greater than 23% to the proposition that the cancer was caused by exposure to asbestos, with or without smoking. The Court held that causation was not established and that the evidence showed no more than that exposure to asbestos might have been a cause of the deceased's cancer. The evidence did not show that it was more probable than not that asbestos was a cause, in the sense of being a necessary condition for the cancer.

A passage in the Court's judgment throws up the difference between the judge's function and that of the scientist:

> When, as here, medical and scientific examination cannot say whether exposure to respirable asbestos fibres was a cause of Mr Cotton's cancer, the medical practitioner and scientist have little choice but, as one witness said at trial, to "take it into consideration in looking at what *might* have caused his lung cancer". In their inquiries, the uncertainty about cause means that they cannot "exclude it from the end result".
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> The court's response to uncertainty arising from the absence of knowledge must be different from that of the medical practitioner or scientist. The courts cannot respond to a claim that is made by saying that, because science and medicine are not now able to say what caused Mr Cotton's cancer, the claim is neither allowed nor rejected. The courts must decide the claim and either dismiss it or hold the defendant responsible in damages.[6]

A history of scientific evidence in the courts

Historically, there have been three ways in which scientific or other experts have been used in the determination of scientific issues in the courts:

1. To decide the question.
2. To assist the court to decide the question.
3. To give evidence as a witness for one of the parties.

The use of experts to determine disputed questions of fact requiring specialised knowledge has a long history.[7] For many centuries special juries were used for that purpose in England. A woman sentenced to death could claim a stay of execution if she could show that she was pregnant. In such a case the court could direct a jury of 12 matrons to decide whether she was pregnant.[8] It was common in the 14th century for the supervisors of various guilds to bring before the Mayor of London offenders against trade regulations. A jury consisting of men in the relevant trade would then be called upon to decide whether the defendant had offended the

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[6] (2009) 240 CLR 111 at 121-122.

[7] The history is set out in a celebrated article by Judge Learned Hand, "Historical and Practical Considerations Regarding Expert Testimony" (1901) 15 *Harvard Law Review* 40.

[8] A writ for the occasion known as a "Writ de Ventre Inspiciendo" developed. See Bracton De Leg Lib II vol 69 cited in Learned Hand, above n 7, at 40.

trade regulations. That method was also adopted in cases brought by public prosecutors and private citizens. In the 17th century, a jury of merchants was used to try merchants' affairs as they might have 'Knowledge of the Matters in Difference which were to be tried than others could who were not of that Profession'.[9]

A second technique involved the court itself calling upon persons with expertise whose opinion it might adopt, or not adopt, as it pleased. This technique can be traced back to 1345 in a case in which the court summoned surgeons from London to assist it in determining whether a wound was fresh.[10] In 1494, 'Masters of Grammar' were called upon to construe certain words in a bond. In 1555, courts called in grammarians to help them interpret the pleas before them when the court had some difficulty with the Latin.[11] And since the 16th century in England, judges in admiralty matters have sat with Master Mariners of Trinity House to assist them in assessing who was at fault in marine casualty cases. This custom was apparently adopted from the International Court of the Councils of the Sea, which in earlier times sat in Barcelona and settled disputes between members of the Merchants and Mariners Guild.[12]

There are provisions under which Australian courts can appoint independent experts to provide a neutral opinion to the court on a question of fact requiring particular expertise.[13] These provisions have not been widely used.[14] This is not

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9 Learned Hand, above n 7, at 42.

10 Ibid.

11 Ibid.

12 Tal Golan, *Laws of Men and Laws of Nature: The History of Scientific Expert Testimony in England and America* (2004) 20.

13 See, eg, *Uniform Civil Procedure Rules 2005* (NSW), Pt 20, Div 3; *Supreme Court Act 1935* (SA), s 67, *Supreme Court Civil Rules 2006* (SA), r 208(2); *Supreme Court (General Civil Procedure) Rules 2005* (Vic), O 50; *County Court (General Civil Procedure) Rules 2008* (Vic) r 34A.22; *Supreme Court Act 1935* (WA), Pt IV, Div 4; *Supreme Court Rules 1971* (WA), O 35; *Federal Court of Australia Act 1976* (Cth), s 54A; *Federal Court Rules 1979* (Cth), O 72A.

surprising in an adversarial system in which the parties want the facts to be determined by the judge or by the jury and not by somebody else, and in which the parties want to control the flow of information to the judge. A forensic concern would be that a court-appointed expert may express an opinion which cannot bind the court, but may nevertheless be more difficult to challenge or test than an expert called by the opposing party. There may also be concerns about the extent to which true objectivity would be achieved by even the most eminent court-appointed expert. This is particularly so in the area of the social sciences and in economics and anthropology.[15] Having said that, even expert witnesses called by the parties are expected not to be hired guns or advocates for the parties calling them. That is so even when the testimony involves an argued evaluation. Evidence which lacks objectivity will generally be discounted or disregarded.

Sometimes parties in dispute over a technical issue which requires expertise for its understanding may, instead of going to court, refer the dispute to an expert for what is called 'expert determination'. That is a process outside the court process. It is related to, although not identical with, the process of arbitration.

In a sense, concerns about the objectivity of expert witnesses raise a larger question about objectivity in science and applied sciences. Whether 'objectivity' is a meaningful concept, and whether it is even theoretically achievable in scientific judgment, may be the subject of a large debate. In an article about objectivity and expert evidence, appearing in the *Sydney Law Review* in 2003, Gary Edmond pointed to the context in which science today operates. There are social and economic pressures, institutional politics, diverse funding arrangements, shifting hierarchies and reward structures, ethical considerations, competition, complex relations with other professions through activities such as patenting, sensitivities to

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14 See, eg, I Freckelton and H Selby, Expert Evidence (4th ed, 2009) 465.

15 See, eg, Federal Court Guidelines for Expert Witnesses.

public concerns, especially around risk, and changing public perceptions, levels of trust and differing employment opportunities. He concluded:

> … appeals to some extra-social image of objectivity become untenable and expert knowledge becomes more complex and inescapably political. All of the factors shaping the practices and production of knowledge raise very serious implications for understanding the contemporary sciences as well as the utility of simplistic images of objectivity and method.[16]

The complexity of scientific research and development was exposed in a case on which I presided in 2007 involving a dispute about entitlement to patent rights between the University of Western Australia and one of its professors, Dr Bruce Gray.[17] The case concerned the use of microspheres for delivering different therapies to liver cancers. The development of the technology took place over more then 20 years. It involved a variety of funding sources and collaborations and varying institutional arrangements. It occurred within a legal setting defined in part by the researcher's contractual relationship with the University, the *University of Western Australia Act 1911* (WA), the operation of the University's statutes and regulations, its organisational structures, commercialisation processes and the general framework of the law relating to fiduciary duties and the entitlements of inventors. Illustrative of the demands upon modern medical researchers, there was evidence of innumerable applications for research grants, large and small, for general and highly specific purposes, each of which had to demonstrate the utility and value of the proposed use of the funds and things which had been achieved up to the time of the application.

The resolution by courts of disputed questions of fact involving scientific theory or its application today generally involve the use of expert witnesses called by the parties. That is the most common way in which law and science intersect within

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[16] G Edmond, "After Objectivity: Expert Evidence and Procedural Reform", (2003) 25 *Sydney Law Review* 131 at 134-135.

[17] *University of Western Australia v Gray (No 20)* (2008) 246 ALR 603.

the court. The use of expert witnesses in this way dates back to at least the 17th century.[18] One of the earliest reported English cases which turned into a battle of experts was *Folkes v Chadd*, decided in 1782. The silting up of Wells Harbour in North East England was blamed on developers who had constructed embankments in the vicinity to counteract natural tidal flooding and allow them to open up land for agricultural use. The Harbour Commissioners sued the developers. The Commissioners produced a long line of pilots, mariners and others to testify about the rapid deterioration of the harbour. The developers, towards the end of the case, produced a rather arrogant expert witness who told the jury that the Commissioners' witnesses were 'unfamiliar with the true principles of nature …' and that they had been 'misled by their own perceptions'.[19] The Commissioners appealed on the basis that they had been ambushed by this evidence. On appeal, the parties were ordered to exchange the opinions of their experts. The developers secured the services of England's leading civil engineer, John Smeaton. The Commissioners tried to hire him as well. He suggested that he act as an adjudicator rather than as a witness, but the Commissioners declined his offer and called four senior engineers as their own witnesses instead.

In the event, Smeaton's evidence at trial was rejected by Chief Justice Gould because it was based on a hypothetical natural process that could not be measured or otherwise verified, making it 'no foundation for the verdict of the jury'. The jury found in favour of the Commissioners.[20] The developers appealed on the basis that their expert's evidence had been wrongly rejected.

On appeal, Lord Mansfield held that Mr Smeaton's opinions should have been received. He said:

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[18] Golan, above n 12, at 41.

[19] Ibid at 22-23.

[20] Ibid at 39.

> I cannot believe that when the question is whether a defect arises from a natural or artificial cause, the opinions of men of science are not to be received … The cause of the decay of the harbour is also a matter of science and still more so now that the removal of the bank can be beneficial. On this, men such as Mr Smeaton alone can judge. Therefore we are of opinion that his judgment, formed on facts, was very proper evidence.[21]

The rise of the expert witness has also seen the rise of many species of expertise not always grounded in a body of scientific knowledge. This is sometimes referred to in the United States as 'junk science'. In his *Principles of Judicial Proof* published in 1892, Professor John Wigmore quoted a passage about expert evidence from a text of the day called 'Hints on Advocacy':

> [As] the diversity of climes and soils produce diversities of trees, so the various kinds of contentious legal businesses give rise to a vast variety of witnesses.[22]

The observation remains valid. The myriad subject matters upon which courts are required to make decisions inevitably attract many different kinds of claimed 'expertise' which it is said will assist them in their determinations. Their varieties are distinguished by more than their subject matters. Some areas of claimed expertise fall outside the field of science altogether. The essence of a scientific theory is its 'falsifiability, or refutability or testability', as Karl Popper said. A statement of theory is 'falsifiable, if and only if, there exists at least one potential falsifier – at least one possible basic statement that conflicts with it logically'.[23] That proposition was quoted with approval by a majority of the Supreme Court of the United States in the case of *Daubert v Merrell Dow Pharmaceuticals Inc*.[24] As one of the Justices, Blackmun J observed in that case:

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[21] [1782] 3 Doug KB 157 at 159.

[22] J Wigmore, *Principles of Judicial Proof* (1892) 423.

[23] Karl Popper, 'Realism and the Aim of Science' From the *Postscript to the Logic of Scientific Discovery*, (3rd ed, 1983) at xx.

[24] 509 US 579 (1993).

> Science is not an encyclopaedic body of knowledge about the universe. Instead it represents a *process* for proposing and refining theoretical explanations about the world that are subject to further testing and refining.[25]

There are areas of so-called pseudo science which consist of a body of assertions based on a theory which has not been subject to any experimental testing. It is unlikely that a party who produced an astrologer to explain or excuse particular behaviour or to predict events by reference to the alignment of the stars at a given time, would be allowed to adduce such evidence.

On the other hand, new technologies and new scientific methodologies emerge from time to time which, after repeated exposure in the courts become accepted as based upon an appropriate body of scientific knowledge. It is important that the probative value of such evidence be tested because, as the Supreme Court of Canada said in 2000, evidence can be accepted, by a jury, as being virtually infallible when it is dressed up in scientific language which a jury does not easily understand and is submitted through a witness of impressive antecedents.[26]

It is interesting to see the reaction of courts to new technologies when they first appeared. The District Court of Colorado in *Smith v Grant*, one of the first cases to deal with x-ray evidence, said in 1896:

> We have been presented with a photograph taken by means of a new scientific discovery the same being acknowledged in the arts and in the science. It knocks for admission at the temple of learning and what shall we do or say? Close fast the doors or open wide the portals? These photographs are offered in evidence to show the present condition of the head and neck of the femur bone which is entirely hidden from the eye of the surgeon. Nature has surrounded it with tissues for its protection and there it lies hidden; it cannot, by any possibility, be removed or exposed that it may be compared with its shadow as developed by this new scientific process. In

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[25] 509 US 579 at 590 (1993) quoting *Brief for American Association for the Advancement of Science et al as Amici Curiae* at 7-8.

[26] *R v DD* [2000] 2 SCR 275 at [39].

> addition to these exhibits in evidence, we have nothing to do or say as to what they purport to represent; that will, without doubt, be explained by eminent surgeons.[27]

There was much early scepticism about fingerprint evidence, a scepticism expressed in the Supreme Court of Victoria in 1912 by Chief Justice Madden who said:

> We are asked to accept the theory that correspondence between two sets of fingerprints is conclusive evidence of the fact of the identity of the person who made those fingerprints as an established scientific fact standing on the same basis as the propositions of Euclid or other matters vouched for by science and universally accepted as proofed.[28]

New technologies are intruding upon the legal process, probably with greater frequency today than at any time in history. The rise of forensic science in the investigation and detection of crime is well known. The law here intersects with fields such as forensic chemistry, toxicology, biology, mineralogy, serology and pathology. Forensic science provides techniques and tools for criminal investigation and prosecution that could scarcely be imagined even as recently as 25 years ago. It has the capacity to support determinations of guilt and innocence. But bad forensic science also has the capacity to seduce and mislead. A leading Australian example was the Chamberlain case.[29] The judicial process did not discover the mistakes that lead to the wrongful convictions in that case. It took a Royal Commission to do so. That is not to say that the accuracy and reliability of such evidence has not greatly improved since that time. Improvements to the processing and handling of evidence, including preservation of original samples, have resulted from the errors uncovered by the Chamberlain Royal Commission and other incidents. The challenge in communicating such evidence in a comprehensible way to courts and, in particular, to juries, remains ongoing.

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[27] 29 *Chicago Legal News* 145 (26 December 1896)

[28] *R v Parker* [1912] VLR 152 at 154.

[29] *Chamberlain v The Queen (No 2)* (1984) 153 CLR 521.

Beyond judging the reliability of the particular scientific method or technology that is brought to court, the judge may have to decide whether a witness is speaking within his or her area of expertise. Rules of evidence have been developed in Australia and in other jurisdictions to prevent judges and juries from being misled by experts who reach beyond their expertise. This involves, in a direct way, judging whether the claimed expertise derives from a body of specialised knowledge based on training, study or experience.

Under the *Evidence Act 1995* (Cth), expert evidence is admissible as an exception to the opinion rule. Under the opinion rule, an opinion is not admissible to prove the existence of a fact about the existence of which the opinion was expressed. This scepticism of lay opinion reflects an observation attributed to Hippocrates that:

> There are in fact two things, science and opinion, the first begets knowledge, the latter ignorance.

There are a number of exceptions to that rule and the exception relevant for present purposes is that relating to expert evidence. Section 79 of the *Evidence Act* provides:

> If a person has specialised knowledge based on the person's training, study or experience, the opinion rule does not apply to evidence of an opinion of that person that is wholly or substantially based on that knowledge.

Whether a witness's field of expertise confers on them the requisite specialised knowledge is a matter for the judge to decide. The precise line is sometimes difficult to identify. The modern trend in the cases has been towards a narrow construction of the scope of an expert's field of specialised knowledge in order to ensure that evidence received by the courts is based on specific knowledge of a particular area, rather than general expertise. By way of example, a person qualified as a psychologist has been held not qualified to give an opinion on

psycholinguistics.[30] In the case in question, Justice Brennan held that a psychologist's report and statement of qualifications failed to reveal the requisite expertise necessary to enable him to form a view about the accused person's understanding of particular questions or his use of particular words or phrases. In 2007, the South Australian Supreme Court held that a qualification in nuclear physics and extensive reading of papers on HIV-AIDS did not qualify a person to give evidence that there was little or no scientific basis for the proposition that HIV-AIDS is sexually transmitted. In a similar vein, an experienced emergency surgeon, in the same case, was also found to have knowledge of HIV-Aids derived from reading the literature which did not qualify him to give his particular evidence.[31]

Difficult science

There are cases in which factual questions must be answered which require the court to have a grasp of a mix of difficult scientific and evaluative issues. One such field, not necessarily the most difficult, is that of biotechnology. Not surprisingly, biotechnological issues arise in disputes about patents for inventions.

When the holder of a patent for an invention sues somebody for infringement of the patent, the court has to decide whether the allegedly infringing product falls within the description of the invention as set out in one of the claims in the patent. Typically the defendant will counter-attack by alleging that the grant of the patent itself should be revoked on one or more of a variety of grounds. One such ground is that the invention as claimed would have been obvious to a person skilled in the relevant art in light of the common general knowledge as it existed before the priority date of the claim.[32]

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30 *Murphy v The Queen* (1989) 167 CLR 94.

31 *R v Parenzee* [2007] SASC 316.

32 *Patents Act 1990* (Cth), s 18(1)(b)(ii) and s 7(2).

There has been much judicial exposition of the language of the relevant provisions of the *Patents Act 1900* (Cth) and much discussion of them among academics and practitioners who specialise in the field. It is enough for present purposes to say that a court asked to judge whether a claimed invention was obvious has to put itself in the mind of a skilled worker in the field and consider whether that worker would have found the invention to be an obvious step given what was already known. In the case of a biotechnological invention, the skilled worker would ordinarily be a person with a PhD or some other post-graduate qualification in the field. In such a case, the court will be provided with a body of evidence about the state of common knowledge and published literature in the area relevant to the invention. It is likely to hear conflicting expert opinions about the state of knowledge and what might have been inferred from it at the relevant time. If the parties are sensible, they will at least propose an agreed prima to the court covering the essential scientific background so that the court can better understand the evidence.

A case in which this was well done was one in which I sat on the Full Court of the Federal Court in proceedings between the drug company Pfizer, which held the patent for Viagra, and Eli Lilly Company, which manufactured Cialis.[33] In that case, Eli Lilly had begun proceedings against Pfizer alleging its patent was invalid on a number of grounds including obviousness. Pfizer counterclaimed, alleging that Eli Lilly was infringing its patent by the manufacture and sale of Cialis.

The obviousness question, which was one of a number of issues in the case, involved a basic understanding of the physiological and biochemical processes at work in the erectile function. Much of this was common ground and well explained in an agreed PowerPoint presentation by counsel. The obviousness judgment required consideration of a number of prior art publications in scientific journals.

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[33] *Pfizer Overseas Pharmaceuticals v Eli Lilly & Co* (2005) 225 ALR 416.

The active ingredient of Viagra is a compound which blocks the ability of an enzyme, called Phosphodiesterase 5, to lower the concentration of a certain messenger chemical designated by the initials cGMP. By so doing, it facilitates the relaxation of smooth muscle cells which is necessary for an erection to occur. It was important in developing the drug that the relaxant effect not extend to other organs of the body, such as the heart or lungs.

An important paper, published before the priority date for the Viagra invention, recounted an experiment using strips of penile tissue taken from 21 men who had been treated with prostheses for impotence. The strips were mounted on wire in organ bath chambers and electrically stimulated. In the course of the experiment a relaxant response was enhanced by the addition of a cGMP PDE inhibitor called zaprinast. A large number of researchers, medical specialists and pharmacologists gave evidence at trial. In the event, the Court concluded that the inventive step was not an obvious one in light of the prior art. The English courts came to a different conclusion. Without going into the detail of the reasoning and the argument, this case is a good illustration of the way in which the courts can be confronted from time to time with factual questions dependent upon scientific evidence, involving the application of evaluative concepts such as 'obvious'. Whether an invention is obvious or not, is not a question which can be answered simply by the application of scientific knowledge. The criteria for obviousness import policy considerations. How high or low the bar is set will affect perceptions of incentives for research.

The more technically or scientifically complex that an issue is for determination the greater the challenge for the courts, whether in patent law or in other fields. In some areas involving computer science and complex software, the complexity of the issues may test the limits of the capacity of the courts to answer the composite questions of science and law to which they give rise. The courts have attempted to mitigate these difficulties by procedural and case management mechanisms. Expert witnesses are required to understand that they are not hired guns and that they owe a duty to the court. It is not unusual for experts on both sides of a case to be directed to have a conference before the hearing to reduce their points of different so far as possible. In some cases, the less adversarial presentation of

experts' evidence allows their testimony to be given in a kind of conversation with each other and with the court, which is said to assist with communication and comprehension.

Conclusion

The challenge of judging science is more readily met by judges and lawyers who have a basic scientific literacy. It requires also a commitment by expert witnesses and lawyers to clear explanation of the scientific opinions advanced in a case. All experts are required to ensure that the court is aware of the facts and assumptions upon which their opinions are based. The court also needs to be able to understand the process of reasoning which leads to the opinion that is offered to the court. And that will ordinarily require some explanation of the underlying scientific principles and methodology which is being applied. This is subject to agreement between the parties to narrow the issues on which expert evidence is given to exclude matters which are not in dispute.

There are, undoubtedly, transaction costs associated with having courts determine scientific questions as part of the fact-finding process of the judicial function. Ultimately, however, those who come to court do not expect the judicial function to be handed over to a non-judicial expert, however eminent and well-qualified. The function of the court is to identify the law, ascertain the facts and apply the law to the facts in a public and principled way that reaffirms the rule of law to the parties and to the wider community. And, if in doing so, the court must make difficult judgments about science that is simply part of the job.